ISFA
Indonesian SEARCA Fellow Association

ISBN : 978-602-0860-10-7

CONFERENCE PROCEEDINGS 2016

August 23-24, 2016
Bandar Lampung, Lampung, Indonesia

UISFS
THE USR INTERNATIONAL SEMINAR ON FOOD SECURITY

"Improving Food Security : The Challenges for Enhancing Resilience to Climate Change"

Volume II

The University of Lampung

Indonesian SEARCA Fellow Association

Southeast Asian Regional Center for Graduate Study and Research in Agriculture

ISBN : 978-602-0860-10-7

USR INTERNATIONAL SEMINAR ON FOOD SECURITY

Improving Food Security : The Challenges for Enhancing Resilience to Climate Change

Emersia Hotel and Resort, Bandar Lampung, Lampung, Indonesia

23 – 24 August 2016
Volume II

Organized by

Research and Community Service Institution
The University of Lampung – Republic of Indonesia,
Indonesian SEARCA Fellow Association,
SEARCA

2016

EDITORS

Christine Wulandari, Ph.D
Dr. Maria Viva Rini
Hari Kaskoyo, Ph.D
Hidayat Saputra, S.P.,M.Si
Windi Mardiqa Riani, S.Hut.,M.Si
Aristoteles, S.Si.,M.Si
Ade Pamungkas

REVIEWERS

Prof. Dr. Neti Yuliana
Prof. Dr. Bustanul Arifin
Prof. Dr. Kukuh Setiawan
Prof. Dr. Udin Hasanudin
Prof. Dr. Yusnita Said
Dr. Dwi Hapsoro
Endang Linirin Widiastuti,Ph.D
Dr. Siti Nurjanah
Wamiliana,Ph.D
Dr. Yaktiworo Indriani

Preface
COMMITTEE CHAIR

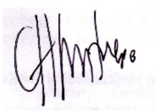
Recently, there are many discussions about food security as a complex issue of sustainable development. One of important topics is will the food needs in the future be met by the current production levels? In addition, the future production faces another sustainable development issues, one of which climate change that affects all four food security dimensions: food availability, food accessibility, food utilization and food systems stability. Improving food security, therefore whilst reconciling demands on the environment conditions which becoming the greatest challenges.

To response that challenges, The University of Lampung collaborated with ISFA (Indonesia SEARCA Fellow Association) and SEAMEO-SEARCA conduct an International Seminar on “Improving Food Security: The Challenges for Enhancing Resilience to Climate Change” in Bandar Lampung, Indonesia on August 23-24, 2016. There are 4 topics are offered as follows: (1.) Food Security and Food Production System, (2.) Food Security, Post Harvest Science and Technology, (3.) Food Security and Socio-Economic Environment Aspect and (4.) Ecological Perspectives on Food Security.

At this seminar, 111 research articles were submitted from 6 countries i.e. Indonesia, Lao, Malaysia, Myamar, Thailand, and Vietnam. The authors are researchers, practitioners included NGO, policy makers, academics as well as industrial professionals. The ultimate aim of this seminar is to deliver state-of-the-art analysis, inspiring visions and innovative methods arising from research in a wide range of disciplines. Through this activity, it is expected that research articles in all aspects related to food security can be documented, rapidly spread, communicated and discussed throughout the countries.

Thank you for your participation and looking forward to having productive discussion among participants.

Sincerely yours,



Christine Wulandari, Ph.D

Preface
The Universityof Lampung Rector

Many Asian countries face serious challenges on their food security due to changing consumption patterns including the demographics, declining of agriculture productivity, degradation of natural resources, rising input costs as well as cost for transportation of supplychains. All of these, need various trends anticipation of short to medium term, and this is clearly becomes efforts focused on mitigating towards the challenges. Together with SEAMEO-SEARCA and Indonesian Searca Fellows Association (ISFA), the University of Lampung (Unila) collaborated to conduct an international seminar with theme in "Improving Food Security: The Challenges for Enhancing Resilience to Climate Change" on 23-24 August 2016 in Emersia Hotel, Bandarlampung. From this international seminar, 111 research articles from six countries in Southeast Asia were compiled and expected to be used as a stepping stone for preparation of development strategies in Indonesia country or other Asian countries resolving the issues of Food Security.

This cooperation among Unila with ISFA and SEARCA in accordance with the Unila statement mission for Unila goals of 2005-2025, one of which Unila is able to build joint effort in many development aspects within various parties, including governments, publics, businesses, non-governmental organizations either national and overseas, with mutual benefit basis in sustainable frame for natural resources conservation in supporting Food Security. The other Unila goals related to the Food Security is the community welfare, in which Unila become the agent of changes and maintain the certainty and justice for the community benefits.

My very sincere appreciation to invited speakers and participants for their great contributions, to all advisory boards SEAMEO-SEARCA and Indonesian Searca Fellows Association (ISFA), reviewers, colleagues and staffs for putting remarkable efforts and their contribution to the organization of this seminar. Finally, I just hope that this seminar is able to inspire and deliver benefits to all participants, in which together we are able contribute to development of Food Security in our countries as well as to global.

We look forward to working with you and getting to know you in years ahead.
Thank You.

Your sincerely,

Prof. Dr. Hasriadi Mat Akin

Preface
SEARCA DIRECTOR

MESSAGE

The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) is pleased to support the Indonesian SEARCA Fellows Association (ISFA) in organizing this *International Seminar on Improving Food Security: The Challenges for Enhancing Resilience to Climate Change.*

SEARCA's support to this event and many similar others is a testament of our commitment to promote food and nutrition security via the route of Inclusive and Sustainable Agricultural and Rural Development (ISARD). Food and nutrition security continues to be a major problem in the region and in the rest of the world in varying degrees and complexities. This is further exacerbated by the impacts of climate change on agriculture which not only serves as the backbone of the economy but is also key to feeding a growing population that continues to struggle with poverty and hunger.

Addressing multi-faceted concerns such as food security and climate change requires collaborative efforts among various stakeholders across the region. That is why SEARCA has developed umbrella programs on food and nutrition security, and climate change adaptation and mitigation which identifies areas for cooperation in research, capacity building, and knowledge management in these two related concerns.

In all these, we are glad to have the cooperation of SEARCA's graduate alumni spread across the region. They have organized themselves into the Regional SEARCA Fellows Association, with at least 8 country chapters including ISFA. The country associations have conducted various knowledge sharing activities such as this International Seminar and plans are also underway for collaborative research projects in the regional alumni organization. By working in synergy, we have seen how the modest contributions of our graduate alumni can make a big difference to agricultural and rural development in the region – truly making them SEARCA's ambassadors in Southeast Asia and beyond.

I congratulate ISFA headed by Dr. Sugeng Prayitno Harianto for organizing this International Seminar which serves as a platform for knowledge sharing on various researches and development activities that contribute to food and nutrition security amidst the detrimental effects of climate change.

Finally, I also thank all our keynote speakers and delegates for their participation in this event and hope to see all of you again in future knowledge sharing events important to the development of the region.

Gil C. Saguiguit, Jr.
Director

KEYNOTES SPEECH

Dr. Siti Nurbaya Bakar
(Minister of Environment and Forestry, Republic Indonesia)

KEYNOTES SPEAKERS

Dr. Ageng S. Herianto, FAO Representative
"Climate Change and Sustainable Crop Production Intensification towards Community Resilence"

Prof. Dr. Wickneswari Ratnam FASc,Universiti Kebangsaan Malaysia
"Food Security and Climate Change: Are We Ready?"

Prof. Dr. Neti Yuliana, the University of Lampung
"Adaptation to Climate Change Impact on Food Security: The Importance of Lactic Acid Bacteria"

Prof. Dr. Meine van Noordwijk, Chief Scientist of World Agroforestry Research Center (ICRAF)
"Agroforestry, Food Security and SDG's"

Dr. Perci E. Sajise (Former Director of SEAMEO-SEARCA)
"Food and Nutrition Security, Agriculture and Climate Change: Understanding the Relationships and Some Challenges"

Dr. Irdika Mansur, Director of SEAMEO-BIOTROP
"Maximising the Use of Forest Land for Food Security and Climate Change Mitigation Through Improved Agroforestry System"

Prof. Dr. BuhriArifin, Prince of Songkla University – Thailand
"Food Security: Water for Mankind"

KEYNOTE SPEECH OF MINISTRY OF ENVIRONMENT AND FORESTRY REPUBLIC OF INDONESIA AT INTERNATIONAL SEMINAR "IMPROVING FOOD SECURITY: THE CHALLENGES FOR ENHANCING RESILIENCE TO CLIMATE CHANGE"

Bandar Lampung, Tuesday, August 23, 2016

Assalamu'alaikumWarahmatullahiWabarakatuh.
Good morning

Your Excellency:
- Rector of University of Lampung
- Head of Indonesian and Regional SEARCA Fellow Association
- Organizing Committee
- Distinguished Guest
- Ladies and Gentlemen

First of all, let's us pray to God Almighty for blessing us since we could meet here at the International Seminar title with"Improving Food Security: The Challenges For Enhancing Resilience To Climate Change".
May we are safe and sound, all.

Ladies and Gentlemen,

Efforts to achieve food security can be defined by efforts to provide enough food for the population. It relates to domestic production and imports. Therefore, in order to realize the resilience and self-sufficiency should be provided entirely from domestic production, both for the consumption of the population and food reserves, even if it can afford the worlds food supply needs, or export.

For it, increased production became the focus of attention, so the intensification and expansion of food commodity crops intensively conducted. Intensifying efforts can increase productivity of land, but in ways that are used in order intensification still using chemicals, whether as fertilizers and as a pesticides. The use of poorly controlled and condition of the food crop was generally a relatively open, often leaves impact adversely affect the health and increase the concentration of greenhouse gases that contribute to climate change. While extension effort very closely with an opening extending the area of land / forest, which is very related to carbon stock changes, as well as the addition of the release of CO2 and other gases into the air, if land clearing followed by burning, as the way to do in the preparation of planting areas.

Ladies and Gentlemen,

If the above things happened, then efforts to increase food production to achieve food security will actually contribute toward climate change. While climate change is happening will threaten food security. As we know that climate change negatively effect to produce food which causes harvest failure.
The question now is how do we improve food security which can we enhance resilience to climate change. This is an exciting challenge for us to try, either mitigation or adaptation.

For it, there are few things we can do, among others, : 1) using models of food development environmentally sound, which the adoption of environmentally friendly cultivation; 2) using agroforestry pattern on cropping food commodity; 3) enrich the diversity of food for consumption or food diversification; 4) rehabilitate degrade/critical land and planting trees, especially on steep slopes land and upstream/water springs; 5) community empowerment and involvement in food production activities; 6) made such efforts as part of forest and land fire prevention.
Judging from the things that must be done as effort of improving food security for enhancing resilience to climate change, as described above, in fact the rule of the Ministry of Environment and Forestry are very significant, among others in terms of : a) ensure food production is done in an environmentally friendly for food safety and enhance resilience to climate change; b) supports increased production and diversification of food, where food production donated from forest area with various types, as Non Timber Forest Products (NTFPs); c) the use of forest area in food production; d) supplying sufficient water as a vital component of food production; e) controlling climate change.

Relating to the rule of Ministry of Environment and Forestry to support National Food Security, program on Social Forestry can became solution. Social Forestry means giving access to the public in forest management has several schemes that greatly facilitate the public to participate seek and take advantage of the forest. Through scheme HTR (Public Plantation); HKM (Community Forest) and HD (Village Forest) with Agroforestry method, it is possible to increase people's food production. With Agroforestry method, clearing land cover is not required or is minimal, so it will prevent the release of carbon into the atmosphere, which in turn will hit the trigger factor climate change.

Social forestry can also reduce that often occur between local communities and the government regarding the use of forest.

The forest is an important part in the life of people in village surrounding forest. Therefore, it is fair if communities are empowered in forest management, not jus be spectator of parties in the capital to take advantage of forest products.

There are 31.957 villages that relating to forest area, consist of 1.305 villages in forest areas, 7.943 villages on the edge of the forest areas, and 22.709 villages around the forest areas. Community empowerment on forest management is a good strategy for conserving forest, because community have local wisdom in coexistence with nature. The value of local wisdom is an added value that community can prosper and remain sustainable forest.

In the other word, Social Forestry pattern give a complete answer in support National Food Security that is consistent with climate change control, also encourage the empowerment of forest communities in achieving prosperity.

Under the rule of the Working Cabinet under the leadership of the President Jokowi-JK, government has set a target area of forest management by communities through Social Forestry program covering 12,7million Ha. This is the government's efforts to make the forest as a source of employment supports people's economy, while supporting food security and the fight against climate change.

Ladies and Gentlemen

From the description above, we hope to be efforts to increase food security by both at the same time faces challenges in improving resilience to climate change. Synergy and cooperation between parties dealing with food security and climate change control is indispensable, in the form of Real Work.

That is all, thank you
Wassalamu'alaikumWarahmatullahiWabarakatuh.

Ministry

Dr. Siti Nurbaya Bakar

ABSTRACT OF KEYNOTES SPEAKERS

FOOD SECURITY AND CLIMATE CHANGE: ARE WE READY?

WICKNESWARI RATNAM AND NORAZIYAH ABD. AZIZ SHAMSUDDIN

Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
Email: wicki@ukm.edu.my

ABSTRACT

Agriculture industry is highly dependent on stability of climatic conditions. However, climate change resulting from global warming has increased incidence of drought and submergence, threatening the stability of world's food crops production. It was estimated that under current climate change scenario, rice yield may decline by 9.6 to 10.0% per 1^0C rise. Drought affects all stages of plant growth, however, severe drought during reproductive stage can cause 100% yield loss. Climate change has also increased precipitation levels which may encourage various diseases and crop pests leading to yield loss. Rice cultivars with resilience to abiotic and biotic stress are vital to meet the dietary demands of the growing global population. Rice in the human diet serves underprivileged populations in Asia as a means of nutritional replenishment for energy and protein as well serving as a vehicle for micronutrient fortification. The introduction of genes from wild sources is one approach to further improve yield and yield related traits besides grain quality, resistance to biotic and abiotic stress which has been demonstrated in many crop species. Another approach is the pyramiding or introgression of QTLs for abiotic and biotic stress to increase the tolerance levels of mega-varieties. Besides agronomic traits, rice breeding and improvement programs play a major role in safeguarding the food environment by taking into account traits that will improve rice quality in terms of glycaemic index (GI) as well as micronutrient capacity. Examples of successful transfer of favourable wild alleles from *O. rufipogon* into *O. sativa*, pyramiding of QTLs for yield under drought stress and introgression of QTLs for blast and sheath blight resistance into high yielding varieties will be discussed.

Keywords: Rice security, rice quality, drought tolerance, disease resistance, wild germplasm, quantitative trait loci.

ADAPTATION TO CLIMATE CHANGE IMPACT ON FOOD SECURITY: THE IMPORTANCE OF LACTIC ACID BACTERIA

PROF. NETI YULIANA, PH.D.

Agricultural Product Technology (THP), Faculty of Agriculture
The University of Lampung, Lampung , Indonesia
Email:neti.yuliana@fp.unila.ac.id

ABSTRACT

The climate change has significant impact on the agriculture productivity, primarily on food crops, live stocks, and fishery, in which all of these havefurther influenced to all dimensions of food security: availability, accessibility, utilization and food system stability. Therefore, adaptation approach is necessary to address great these impacts. Commonly, the concept of food security includes both physical and economical access to food that meets people's dietary needs as well as their food preferences. This presentation, first, will give an outline of the climate change impact on agricutural sector and food security in terms of production and availability. The second part will present the possibility adaptation to climate change impact on food security. The role of lactic acid bacteria (LAB) in reducing losses, adapt to food consumption pattern, increase utilization, exploring alternatives sources, and strengthening the potential of local value added products will be addressed to improve food security.

Keywords: lactic acid bacteria, climate change

MAXIMISING THE USE OF FOREST LAND FOR FOOD SECURITY AND CLIMATE CHANGE MITIGATION THROUGH IMPROVED AGROFORESTRY SYSTEM[1]

IRDIKA MANSUR[2,3]

[2]SEAMEO BIOTROP the Southeast Asian Regional Centre for Tropical Biology,
Jl. Raya Tajur Km 6 Bogor, West Java, Indonesia.
[3]Department of Silviculture Faculty of Forestry, Bogor Agricultural University, Kampus IPB Darmaga, Bogor, West Java, Indonesia.
Email :irdikam@biotrop.org

ABSTRACT

Agroforestry system is not a new concept nor practice. Various form of agroforestry systems have been practiced all over the world, including Indonesia. It is no doubt that this system could potentially addresses food security and at the same time to mitigate climate change. Securing food supply by clearing more forest is most common choice for some country when agricultural land is aggressively converted to other uses, especially settlement. Indeed, forest land is the easiest choice to expand the production of food cropping areas. However, it will jeopardize the environment that in return will affect the production of food crops that will eventually will threatened the food security. Despite of the potential contribution of agroforestry system to food security, efforts on food crop production under agroforestry system, especially in Indonesia is still limited. Input on genetically improved food crop species, best cultivation practice, and fertilizer is low. Development of silviculture technique to enhance food crop production is also still needed. A concept of agroforestry design (so called "Bolong Tengah") to improve sustainable production of food crop, and better sustainable and productive plantation forest will be described in this paper.

Keywords: Agroforestry, Food Security, Forest, Climate Change

[1]Paper presented at the International Seminar "Improving Food Security: the Challenges for Enhancing Resilience to Climate Change" 2016 organized by University of Lampung held on August 23-25, 2016 at Emersia Hotel, Bandar Lampung, Indonesia.

WATER FOR MANKIND

BUHRI ARIFIN, PHD

Prince of Songkhla University, Pattani, Thailand
Email :buhribin.a@psu.ac.th

ABSTRACT

Climate Change is inevitable. The world climate has been in a cyclic steady state for a long time. World population, on the other hand has grown by leap and bound. The population growth has cause a heavier demand on water availability for human activity. On the global basis, we have more than enough water to cater for human need, yet it is the local availability of water that varied tremendously. Water is needed for every human activities, either for agriculture to produce foods and feeds, to produce power, or for manufacturing of products, or just for human's personal consumption. Almost all of these human activities required fresh or potable water. Yet, it was estimated that only 1% of global fresh water is easily available, with another 6% were tied up in different degrees of difficulty to be accessed. Another source of water is the sea or saline water. In order to use seawater successfully, there is a need to remove the salts especially the sodium chloride. Desalination of seawater produced fresh potable water. On the other hand, removal of just the sodium chloride alone will produce a natural mineral water for drinking that is also good for human health. After the sodium chloride removal, the minerals content of the seawater was found to be very closely mimicking the mineral contents of human's blood. A new filtration technology is needed to be created in order to filter out the sodium chloride alone from the seawater. A potential candidate for the seawater's sodium chloride removal is a graphene based filter membrane.

Keyword: Climate change, fresh water, seawater, filtration, graphene

LIST OF CONTENTS

FOOD SECURITY POTENTIALS OF AGROFORESTRY SYSTEMS IN SELECTED UPLAND FARMING COMMUNITIES IN THE PHILIPPINES

LEILA D. LANDICHO, ROMNICK S. BALITON, ROWENA D. CABAHUG, ROSELYN F. PAELMO, REYNALDO A. COMIA, ROBERTO G. VISCO, ARNOLD KARL CASTILLO RUSSEL SON COSICO AND MARYANNE ABADILLOS

Institute of Agroforestry, College of Forestry and Natural Resources
University of the Philippines Los Banos

ABSTRACT

This paper argues that the practice of agroforestry provides potentials for ensuring food security of smallholder agroforestry farmers in the upland farming communities in the Philippines. This argument is based on the research conducted in the upland farming communities in the three major agricultural provinces, namely: Nueva Vizcaya, Benguet and Nueva Vizcaya, involving an interview of 215 farmer-respondents. Research results revealed that the smallholder farmers in the three study sites have moderate to high level of food security status having scores of 8.05, 7.19 and 7.74, respectively, based on four measures, namely: food availability, food accessibility, food stability and food utilization. With these findings, agroforestry should always be an integral part of all initatives toward ecological restoration with the smallholder farmers as potential partners. The agroforestry systems should consider all technical and socioeconomic considerations toward having diverse components to ensure food security among the smallholder farmers throughout the year.

Keywords: food availability, food accessibility, food stability, food utilization, smallholder farmers

I. INTRODUCTION

Agriculture occupies two-thirds of the land surface of the Earth and is the central activity for much of the world's population (UN Agenda 21, 1992). Southeast Asia, being tropical has vast potentials for agricultural production. While most of the people in the region are engaged in agricultural production, Southeast Asia remains vulnerable to food insecurity. Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2011). The Southeast Asian region, particularly the Philippines, has millions of hectares of upland areas, and these upland areas are mostly cultivated into agroforestry. It is sad to note, however, that the millions of upland inhabitants or practically those in the rainfed areas are classified as marginalized and poor, with very poor market integration because of their low income and limited production potentials. They are classically categorized as "poorest among the poor". These upland farmers who are the producers of food are oftentimes food insecure. Upland poverty has become a perennial issue for the simple reason that these people are hungry because they do not have the capacity to buy food.

The agriculture sector is the major stakeholder involved in food production. The question is whether the agriculture sector is able to address the issue on food security. Are the agricultural production systems able to produce enough food for the population? Can these agricultural production systems withstand or cope with the climatic, as well as the market policies and trade changes and variations, including the issue on globalization? Can these agricultural production systems sustain the lives of the Filipinos? Are agricultural products/produce available to the farmers themselves, and the local people all throughout the year? Can these farm produce be accessed by the low-income families? Can these farm produce reach farther communities and markets within the town? Can the farmer-producers consume their own produce? Can the agricultural resources primarily soil, water including the farming practice sustain food production for the geometrically growing Philippine population?

The abovementioned research questions are indeed very relevant to be able to help the agriculture sector, and the policy-makers to institute programs and policies that would help boost agricultural production. At the same time, this would also create awareness to the agricultural, social services and the planning and policy sectors about the potentials, opportunities, and limitations of the different agricultural production systems in the selected rainfed areas in the Philippines, in terms of addressing food security concerns.

This paper highlights the results of the study that aimed to assess the food security potentials of the different agroforestry systems that are being practiced by the selected smallholder farmers in the upland farming communities in the Philippines. The assessment centered on the four indicators of food security, namely: food availability, food stability, food accessibility, and food utilization.

II. METHODOLOGY

The research team developed a 20-page survey questionnaire that captured the socioeconomic information and farm characteristics of the farmer-respondents. The questionnaire also dwelled on assessing the agroforestry practices that are currently being employed by the smallholder farmers; and the household food security concerns.

From the total number of farmers in the three study sites, the research team computed a sampling size of 89, 76 and 50 farmer-respondents in Barangay Baayan, Tublay, Benguet; Barangay Masoc, Bayombong, Nueva Vizcaya; and, Barangay Concepcion Banahaw, Sariaya, Quezon, respectively. The selection of respondents was made using simple random sampling. The research team developed a 20-page questionnaire that captured the socioeconomic information and farm characteristics of the respondents; and, analyze the food security potentials of the agroforestry systems being practiced by the farmers. A focus group discussion (FGD) was organized to assess the current state of the different agroforestry systems, and identify their technical and skills needs to improve their agroforestry production system.

The food security potentials of these agroforestry systems were analyzed based on the four indicators of food security as follows:

a) *Food stability* was measured by asking whether the farming system they employ produce multiple crops throughout the year; whether the crop components in their farms could withstand or cope with typhoons, drought and pests and diseases. Each item was given one (1) point. Food stability score is described as follows:

1.50 – 2.00	Food is highly stable
1.00 – 1.49	Food is moderately stable
<1..00	Food is not stable

b) *Food availability* was determined by asking the respondents the level of food availability in their households, which ranged from “always available”, “sometimes available” and “not always available”; eating frequency of the household members per day; experiences of food shortage; experiences of skipping meals and hunger; having no balanced diet; and, the sources of the basic food needs of the household. The sum of weighted scores for each item represents the food availability score as follows:

2.00 –3.00	Food is highly available in the household

ISBN 978-602-0860-10-7

1.00 – 2.99	Food is moderately available in the household
<1.00	Food is not available in the household

c) *Food accessibility* was measured by asking the respondents whether farm produce are used for their home consumption; able to meet their basic food needs; and, whether the market is accessible for food items that may not be available in their farms. Food accessibility score is described below:

1.50 – 2.00	Food is highly stable
1.00 – 1.49	Food is moderately stable
<1..00	Food is moderately stable

d) *Food utilization* was assessed by asking the respondents whether their farm produce are consumed by their household; by the local communities; and those outside the community. The scores are described as follows:

1.50 – 2.00	Food is highly stable
1.00 – 1.49	Food is moderately stable
<1..00	Food is moderately stable

The average score of food security status was computed by adding up the scores in each of the four measures/indicators divided by the total number of indicators. Scoring was based on the following:

8.00 – 9.00	High level of food security
7.00 – 7.99	Moderate level of food security
6.00 – 6.99	Low level of food security
<6.00	Food insecure

III. RESULTS AND DISCUSSION

The Study Sites

The study sites include Barangay Masoc within the Barobbob Watershed in Bayombong, Nueva Vizcaya; Barangay Ba-ayan in Tublay, Benguet; and, Barangay Concepcion Banahaw inSariaya, Quezon. Barangay Masoc is composed of farming households who are engaged mainly in fruit tree based- multistorey agroforestry system, with intercropped root crops. Meanwhile, Barangay Ba-ayan in Benguet is composed of agroforestry farmers who are engaged in coffee-based and chayote-based agroforestry system. Finally, Barangay Concepcion Banahaw in Sariaya, Quezon generally showcases a coconut-based agroforestry system. The study sites are all classified as upland communities, whose major livelihood activity is agriculture/farming.

Socio-demographic characteristics of upland farmers in the three study sites

Survey results revealed that in general, the farming activities in the three study sites were performed generally by males (66%) as shown in Table 1. This finding indicates that currently, the men still dominates the agricultural activities. However, it may be noted that women were also engaged in agricultural activities in Baayan, Tublay, Benguet. Majority (83%) of them were married, and whose household size ranged from 4-6 members as reported by 50%of the respondents. Meanwhile, most of the farmers (29%) have ages within the range of 41-50. This suggests that the farmer-respondents were still in their productive stages of their farming. It is noteworthy that majority of the farmer-respondents (72%) were natives in their respective upland communities. As such, they share the same symbols and meanings, which could facilitate group activities and collaboration, and foster information exchange. This could have helped facilitate the formation of the social organizations in the three upland communities. As shown in Table 1, majority (78%) of the farmer-respondents are members of the farmers' organizations.

Economic information of upland farmers in the three study sites

Table 2 shows that farming is the major source of income in the three study sites as reported by 50% of the farmer-respondents. However, it may be noted that most of the farmers gained an estimated annual income ranging from Php10000-20000. This could be the reason why many of them have household members who were engaged in non-farm activities as additional source of household income. The relatively low farm income that the upland farmers derived from agricultural production activities (farming) could have also been brought about by the limited size of the farms that they cultivate. As shown in Table 2, most of the farmers cultivate an area of less than one hectare to around 1-3 hectares. Thus, this finding confirms that the upland farmers are generally smallholder farmers.

The limited farm sizes could have also been the reason why only few household members (ranging from 1-3 members) were involved in farm development activities as reported by 80% of the farmer-respondents. In most cases, only the husband and wife rendered full-time engagement in farm activities. It is either that the children were still young to till the land; busy schooling; or not interested in farming at all.

It is good to note, however, that despite the limited farm sizes, the farmer-respondents were able to maximize the use of their lands by engaging in crop diversification. Table 2 highlights that most (50%) of the farmer-respondents were engaged in agroforestry. Agroforestry is defined as the combined production of annual crops and woody perennials and/or livestock in the same unit of land, with the twin purpose of socioeconomic productivity and ecological stability (IAF, 1999). As such, the farmers have been cultivating cereals, root crops, vegetables, fruit trees and forest trees, including livestock production. Primarily, these farm components were raised by the farmer-respondents for home consumption, while surpluses are brought to the market as additional source of income.

Agroforestry systems being practiced in the upland farming communities

Different agroforestry systems are being practiced in the three study sites. In Masoc, Bayombong, Nueva Vizcaya, the dominant agroforestry systems are alley cropping (Figure 1), contour planting (Figure 2), boundary planting, fallow system, and fruit tree-based agroforestry system. Among the crop components include mahogany, gmelina (*Gmelina arborea*) and ipil-ipil (*Leucaena leucocephala*) as live fences in boundary planting. Besides serving as boundary, these trees also act as windbreaks that protect the agricultural crops from strong winds. The fruit trees that are cultivated in the farms include: jackfruit, rambutan (*Nephelliumlapacceum*), lanzones (*Lansium domesticum*), papaya (*Carica papaya*), coconut (*Cocos nucifera*) santol, banana (*Musa sp*) , and mango (*Mangifera indica*). These fruit tree species are considered as high value crops. They also grow vegetable crops such as baguio beans, pechay, tomato and cucumbers; cereals such as rice and corn; and root crops like ginger (*Oryzum sattivum*), cassava (*Manihot esculenta*) and camote (*Ipomoea batatas*).

Meanwhile, the study site in Baayan, Tublay, Benguet employed coffee-based agroforestry system (Figure 3), vegetable-based agroforestry system (Figure 4), and rice-based agroforestry system (Figure 5). Among the major crops that are being cultivated include vegetables such as cabbage (*Brassica oleracea***),** sayote (*Sechium edule),* string beans (*Phaseolus vulgaris*); rice *(Oryza sativa),* root crops such as sweet potato *(Ipomoea batatas); and fruit trees such as coffee (Coffea sp),* and forest trees like Benguet pine *(Pinus kesiya).*

Lastly, the farmers in Barangay Concepcion Banahawin Sariaya, Quezon are engaged in vegetable-based agroforestry system with some fruit and forest trees integrated in the farms. But it is noticeable that elevation comes into play in terms of what vegetable species grown by the farmers. Farmers in upper portion of the barangay cultivate carrots, cabbage and other high value vegetables while upo, ampalaya, sibatse, sitaw, patani, kadios are cultivated in lower elevation areas. Farmers in the area also utilized the existing coconut and coffee plantation as the foundation of their balag (trellis) system (Figure 6). In cases where coconut and coffee are not present in a farm, they used large trunks of trees with ability to produce sprouts as the main foundation and reinforced by a bamboo called "Usiw" or Bikal. Farmers also practiced relay cropping and overlapping crop rotation particularly in the trellis. The overlapping and relay cropping system is characterized by multiple crops in the same trellis. The first crops planted include those which bear fruits late such as patani, sibatsi and bataw. While waiting for the first crop, the trellis is planted by crops that bear fruits immediately such as pole sitao and baguio beans. The FGD results suggest that there are farmers in the community who practice organic farming in their vegetable production. They claimed that the farm income generated from their vegetable production is also seasonal.

Food security status of farm households engaged in agroforestry systems

a) Food availability

Because of the multiple crops and livestock that are being raised by the farmer-respondents, almost all of them (93%) mentioned that food is always available in their respective households. While some literature claim that poverty is highly observed in rural communities, the results of the household survey indicates that majority (88%) of the upland farmers in the three study sites eat three times a day, while about 11 per cent eat even more than three times a day.

This finding suggests that the individual family has available food at all times. It is good to note that almost all (97%) of the farmer-respondents sourced their food from their own crop production as highlighted in Table 3. As discussed earlier, the primary purpose of their agricultural production is for home consumption. Meanwhile, most of the respondents also sourced their food from the market. This is true in cases when the farmers do not produce the basic food needs, particularly rice, which is the staple food among the Filipinos.

As such these are sourced from the market. This finding suggests that the farmer-respondents have enough resources/money to buy the food items which are not available in their farms.

From among the food items of the farmer-respondents, rice has the highest rank (1.01) in terms of availability and consumption in the household (Table 4). The respondents claimed that rice being the staple food is the basic food need of every family. Thus, for farmers who grow rice, they already have an assured supply of rice throughout the year. For others, however, rice is bought from the market. Vegetables are the second-ranked food because of the health benefits derived from these crops, and at the same time, these are being cultivated by the farmer-respondents while junk foods gained the lowest rank (2.21) in terms of availability and consumption because of the relatively higher market prices, and health concerns of the respondents.

Computing the scores of each of the item under this category, the food availability status in the three study sites fall within the range of 2.00-3.00, which means that the food is highly available in the households. This could be because of the multiple products that the farm households derived from their farming systems which enabled them to eat even more than the basic three times a day. Their crops are mostly short-term or early-maturing crops which are integrated with woody perennials, which could address their food needs immediately.

While the farmer-respondents are classified as smallholder farmers, a large proportion of them have not experienced food shortage, did not skip meals, have balanced diet, and have not experienced hunger. This finding only validates the claim that agroforestry which involves the combination of many different crop species ensures multiple harvests and therefore, ensures food security among the farmers. Only few of the respondents have experienced food shortage, especially during rainy season where strong and frequent typhoons hit the study sites.

This research finding is supported by the study of Tolentino et al. (2010), where farmers who practice agroforestry in the different parts of the Philippines affirmed that this system ensures food security for the whole family. They now have a year-round supply of corn as their staple food, as well as vegetables. The farmers have a ready source of feeds for their livestock right in their own farms – the forage grasses and leguminous trees. They no longer rely so much on chemical fertilizers, because they also apply animal manure from their livestock production.

b) Food stability

Research results indicate that the food is highly stable in the three study sites as shown in Table 5. Specifically, the existing agroforestry systems in the three study sites have the capacity to produce food throughout the year. This is because of the multiple crops that they grow, which are either short-term or perennial crops. Annual and short-term crops include vegetables, corn, rootcrops such as camote and cassava; while perennial crops are banana, fruit trees and forest trees. However, these crops could not withstand the strong winds and rains during the typhoon season in the Philippines. Otherwise, the farmer-respondents have steady supply of food and cash throughout the cropping period from their agroforestry farms. According to Cunningham et al (2008*)*, the range and rotation of high-performing annual crops provide income and reduce disease incidence. When one crop fails because of pest and disease infestation, strong rains and winds or drought, the farmers still have other crops that would compensate for the losses. This, therefore, suggests the need for further crop diversification.

c) Food accessibility

Food accessibility is defined in this research as an indicator of farmers' access to basic food items either in their own backyard or nearby market. As shown in Table 6, food is highly accessible to the farm households in the three study sites as indicated by a mean score of 1.95, 1.84 and 1.56 in Masoc, Concepcion Banahaw and Baayan, respectively. The production of food crops in their farms ensures the availability of vegetable crops, fruit trees and root crops. If food items are not found in their farms, however, they could readily access these items in the nearest market where basic food items are available.

d) Food utilization

This research defines food utilization as the consumption of the farmers' farm produce by the local community members, and those outside the community. Table 7a shows that farm produce is highly utilized in the three study sites. Most of the farmer-respondents sell their products to their neighborhood, and market outlets outside their community. This finding suggests, therefore, that the income that the farmers get from marketing their produce, enable them to purchase other food items that may not be available in their farms.

Rice is the highly utilized food item of farming households in the three study sites having a mean score of 1.01 (Table 7b). This confirms that rice is the main staple food of the farming families. Vegetables ranks as the second highly utilized food item in the farming with a mean score of 1.22. Meanwhile, junkfoods, noodles and canned goods are the least utilized food items in the farm households having a mean score of 2.21, 2.19 and 1.94, respectively. This finding indicates that the farm households are already aware about the health implications of consuming these food items.

Overall food security score

The overall status of food security of farmer-respondents in the three study sites was computed by summing-up the scores in each of the four indicators of food security.The farm households in Masoc, Bayombong, NuevaVizcaya have high level of food security having a total score of 8.05 (Table 8). This could be because their agroforestry systems are dominated by short-term agricultural crops which are grown throughout the year, and therefore, they have available food sources which are also highly utilized and consumed by the households.

The farmer-respondents in Barangay Masoc also grow cereals which serve as sources of staple food. Meanwhile, the farm households in Concepcion Banahawand Baayanhave moderate levels of food security as indicated by their total score of 7.74 and 7.19, respectively. While the farmer-respondents in this community have been engaged in vegetable production, there are other basic food needs which are not available in their farms throughout the year. Besides vegetables, the dominant crops in Concepcion Banahaw are fruit trees, which are just supplementary food sources, and whose produce are seasonal.

REFERENCES

Beetz, A. (2002) Agro-forestry Overview. Horticulture Systems Guide. Appropriate TechnologyTransfer for Rural Areas (ATTRA).1-800-346-9140. Online. Available HTTP: < www.attra.ncat.org > (accessed 26 February 2009).

Cunningham, P.J., Nicholson, C., Yaou, S. and Rinaudo, T. (2008) ccessed 26 February 2009).acacias for improving food security and environmental sustainability in the Sahel, West Africas for *Proceedings of the International Symposium on 'Underutilized Plants for Food,Nutrition, Income and Sustainable Development'* held 3-7 March in Arusha, Tanzania.Available at http://www.icuc-iwmi.org/Symposium2008/.Accessed on February 12, 2016.

International Federation of Red Cross. 2007. Global food security assessment guidelines: A step-by-step guide for national societies. In http://www.ifrc.org/Global/global-fsa-guidelines-en.pdf.(Accessed on March 20, 2016).

Tilman, D., C. Balzer, J. Hill and BL Befort. 2011. Global food demand and the sustainable intensification of agriculture. In http://www.pnas.org/content/108/50/20260.full (Accessed on April 6, 2016)

Tolentino, LL, LD Landicho, CC de Luna and RD Cabahug. 2010. Case study: Agroforestry in the Philippines. In: Constance, LT (ed). Routledge Handbook of Climate Change and Society. Routledge Publishing.

UN Agenda 21, 1992).

FAO, 2011

IAF, 1999

Table 1.Socio-demographic information of the farmer-respondents in the three study sites.

SOCIO-DEMOGRAPHIC INFORMATION	FREQUENCY			TOTAL	%
	Masoc, Bayombong, Nueva Vizcaya	Concepcion Banahaw, Sariaya, Quezon	Baayan, Tublay, Benguet		
Sex					
Male	48	45	48	141	66
Female	28	5	41	74	34
Total	**76**	**50**	**89**	**215**	**100**
Civil status					
Single	7	1	12	20	9
Married	64	47	67	178	83
Separated	1	0	1	2	1
Widow/er	4	2	9	15	7
Total	**76**	**50**	**89**	**215**	**100**
Household size					
1-3	32	8	20	60	28
4-6	33	33	44	110	51
>6	11	9	25	45	21
Total	**76**	**50**	**89**	**215**	**100**
Age range					
<30	10	2	3	15	6
30-40	26	12	15	53	24
41-50	21	16	27	64	29
51-60	11	12	29	52	24
>60	8	8	15	31	14
Total	**76**	**50**	**89**	**215**	**100**
Level of education					
No formal education	1	1	2	4	19
Elementary level	16	9	11	36	17
Elementary graduate	12	26	32	70	32
High school level	13	2	12	27	12
High school graduate	15	7	18	40	19
College level	4	1	7	12	6
College graduate	7	0	7	14	6
Vocational course graduate	8	4	0	12	6
Total	**76**	**50**	**89**	**215**	**100**
Migration					
Number of migrants	48	6	84	59	27
Number of native	28	44	5	156	72
Total	**76**	**50**	**89**	**215**	**100**

Table 2.Economic information of upland farmers in the three study sites.

ECONOMIC INFORMATION	FREQUENCY			TOTAL	%
	Masoc, Bayombong, Nueva Vizcaya	Concepcion Banahaw, Sariaya, Quezon	Baayan, Tublay, Benguet		
Sources of household income					
Farming	43	37	27	107	50
Off-farm activities	1	0	0	1	0.5
Non-farm activities	5	0	0	5	2.3
Farming+off-farm	14	1	35	50	23
Farming+non-farm	10	5	20	35	16
Farming+off-farm+non-farm	4	7	7	18	8
Estimated annual farm income					
<10000	24	3	9	36	17
10000-20000	25	16	31	72	33
21000-30000	15	8	20	43	20
31000-40000	1	4	12	17	8
41000-50000	6	13	8	27	12
>50000	4	6	9	19	9
Total	**76**	**50**	**89**	**215**	**100**
Farm size					
<1 hectare	36	12	56	104	48
1-3	38	36	32	106	49
3.1-5	2	1	0	3	14
>5	0	1	1	2	9
Total	**76**	**50**	**89**	**215**	**100**
Number of household members involved in farming					
1-3	49	43	79	171	80
4-6	12	6	10	28	13
>6	15	1	0	16	7
Total	**76**	**50**	**89**	**215**	**100**
Agricultural production system					
Monocropping	7	2	10	19	10
Relay cropping	23	2	3	28	14
Multiple cropping	19	2	30	51	26
Agroforestry	24	30	46	100	50
Livestock production	0	6	0	0	0
Farm components					
Cereals	23	0	36	59	8
Vegetables	67	29	66	162	22
Root crops	23	5	15	43	6
Fruit trees	61	42	89	192	26
Forest trees	43	6	63	112	15
Livestock	52	36	80	168	23
Total	**269**	**118**	**349**	**736**	**100**

Table 3.Levels of food availability in the household of farmer-respondents in the three study sites.

ITEM	WEIGHTED SCORES OF EACH OF THE STUDY SITES*					
	Masoc	Weighted Score	Concepcion Banahaw	Weighted Score	Baayan	Weighted Score
Food availability at home						
Always available	76	3.00	48	2.88	77	2.60
Sometimes available	0	0.00	2	0.08	12	0.13
Not available	0	0.00	0	0.00	0	0.00
Eating frequency						
Once a day	0	0.00	0	0.00	0	0.00
Twice a day	0	0.00	1	0.40	0	0.00
Three times a day	74	2.92	44	2.64	72	2.43
More than three times a day	2	0.10	5	0.40	17	0.76
Experience of skipping meals						
Yes	0	0.00	2	0.04	0	0.00
No	76	2.00	48	1.92	89	2.00
Experience of having no balanced diet						
Yes	0	0.00	6	0.12	20	0.22
No	76	2.00	44	1.76	69	1.55
Experience of food shortage						
Yes	14	0.18	18	0.36	18	0.20
No	63	1.65	32	1.28	71	1.60
Experience of hunger						
Yes	0	0.00	0	0.00	0	0.00
No	76	2.00	50	2.00	89	2.00
Food availability score	13.85		13.88		13.49	
Mean Score	2.30		2.31		2.25	

**weighted score was computed by multiplying the rate of each indicator with the frequencies divided by the total number of respondents. Numbers in parenthesis represent the rate given for each item*

Food availability scores:
2.00 –3.00 Food is highly available in the household
1.00 – 2.99 Food is moderately available in the household
<1.00 Food is not available in the household

Table 4. Food sources and food items available in the households

FOOD SOURCES*	FREQUENCY					
	Masoc	%	Concepcion Banahaw	%	Baayan	%
Own crop production	76	100	44	88	89	100
Own livestock production	13	17	18	36	38	43
Purchased from the market	42	55	41	82	88	99
Exchange of labor	0	0	0	0	16	18
Shared with relatives	0	0	0	0	17	19

Food items available in the households	WEIGHTED SCORES			
	Masoc	Concepcion Banahaw	Baayan	MEAN
Rice	1.02	1.00	1.01	1.01
Corn	1.60	2.16	1.28	1.68
Vegetables	1.12	1.41	1.12	1.22
Fruits	1.40	1.61	1.99	1.67
Bread	1.36	1.92	1.95	1.74
Canned goods	1.60	1.94	2.29	1.94
Noodles	1.92	1.90	2.75	2.19
Meat	1.42	2.02	1.05	1.50
Fish	1.34	1.97	2.25	1.85
Junk foods	1.66	2.09	2.88	2.21

*multiple responses

Food availability scores:
2.00 –3.00 *Food is highly available in the household*
1.00 – 2.99 *Food is moderately available in the household*
<1.00 *Food is not available in the household*

 ISBN 978-602-0860-10-7

Table 5.Level of food stability of farm households in the three study sites.

ITEM	WEIGHTED SCORES OF EACH OF THE STUDY SITES*					
	Masoc	Weighted Score	Concepcion Banahaw	Weighted Score	Baayan	Weighted Score
Capacity of the farming system to produce food throughout the year						
Yes (2))	65	1.71	46	1.84	26	0.58
No (1)	11	0.15	4	0.08	63	0.71
Capacity of the farming system to withstand natural calamities						
Yes (2)	0	0.00	0	0.00	0	0.00
No (1)	76	2.00	50	2.00	89	2.00
Capacity of the farming system to meet the basic food needs of the family						
Yes (1)	71	1.87	41	1.64	42	0.94
No (1)	5	0.06	9	0.18	47	0.53
Food stabilityScore	5.79		5.74		4.76	
Mean Score	1.93		1.91		1.58	

**weighted score was computed by multiplying the rate of each indicator with the frequencies divided by the total number of respondents. Numbers in parenthesis represent the rate given for each item*

Food stability
1.50 – 2.00 Food is highly stable
1.00 – 1.49 Food is moderately stable
<1..00 Food is moderately stable

Table 7. Level of food accessibility among the farm households in the three study sites

ITEM	WEIGHTED SCORES OF EACH OF THE STUDY SITES*					
	Masoc	Weighted Score	Concepcion Banahaw	Weighted Score	Baayan	Weighted Score
Farm products are for home consumption						
Yes (2))	76	2.00	50	2.00	89	2.00
No (1)	0	0.00	0	0.00	0	0.00
Farm products are enough to meet the basic food needs						
Yes (2)	70	1.84	33	1.32	42	0.94
No (1)	6	0.08	17	0.34	47	0.53
Market is accessible as immediate food source if items are not available in the farm						
Yes (1)	71	1.87	43	1.72	18	0.40
No (1)	5	0.06	7	0.14	71	0.80
Food accessibility score	5.85		5.52			4.67
Mean Score	1.95		1.84			1.56

**weighted score was computed by multiplying the rate of each indicator with the frequencies divided by the total number of respondents. Numbers in parenthesis represent the rate given for each item*

Food accessibility score
1.50 – 2.00 Food is highly accessible
1.00 – 1.49 Food is moderately accessible
<1..00Food is not stable

Table 7a.Levels of food utilization among the farmer-respondents in the three study sites.

ITEM	WEIGHTED SCORES OF EACH OF THE STUDY SITES*					
	Masoc	Weighted Score	Concepcion Banahaw	Weighted Score	Baayan	Weighted Score
Farm produce are for marketing within the community/village						
Yes (2))	61	1.60	26	1.04	63	1.41
No (1)	15	0.20	24	0.48	26	0.29
Farm produce are sold outside the village/community						
Yes (2)	61	1.60	26	1.04	63	1.41
No (1)	15	0.20	24	0.48	26	0.29
Farm produce is consumed at home						
Yes (1)	76	2.00	50	2.00	89	2.00
No (1)	0	0.00	0	0.00	0	0.00
Food accessibility score	5.60		5.04		5.40	
Mean Score	1.87		1.68		1.80	

**weighted score was computed by multiplying the rate of each indicator with the frequencies divided by the total number of respondents. Numbers in parenthesis represent the rate given for each item*

Food utilization score:

1.50 – 2.00 Food is highly utilized

1.00 – 1.49 Food is moderately utilized

<1..00 Food is not utilized

Table 7b.Food items that are consumed and utilized by the farm households in the three study sites.

ITEMS	WEIGHTED SCORES			
	Masoc	Concepcion Banahaw	Baayan	MEAN
Rice	1.01	1.00	1.02	1.01
Corn	1.28	2.16	1.6	1.68
Vegetables	1.12	1.41	1.12	1.22
Fruits	1.99	1.61	1.40	1.67
Bread	1.95	1.92	1.36	1.74
Canned goods	2.29	1.94	1.6	1.94
Noodles	2.75	1.90	1.92	2.19
Meat	1.05	2.02	1.42	1.50
Fish	2.25	1.97	1.34	1.85
Junk foods	2.88	2.09	1.66	2.21

Table 8. Food security scores of farmer-respondents in three study sites.

INDICATORS OF FOOD SECURITY	BASE SCORE	MEAN SCORE		
		Masoc	Concepcion Banahaw	Baayan
Food availability	3	2.30	2.31	2.25
Food stability	2	1.93	1.91	1.58
Food accessibility	2	1.95	1.84	1.56
Food utilization	2	1.87	1.68	1.80
FOOD SECURITY SCORE	**9**	**8.05**	**7.74**	**7.19**

Food Security Score:

8.00 – 9.00 High level of food security
7.00 – 7.99 Moderate level of food security
6.00 – 6.99 Low level of food security
<6.00 Food insecure

Figure 1. Alley cropping

Figure 2.Contour planting

Figure 3. Coffee-based AF system cropping

Figure 4.Sayote-based AF system

Figure 5. Rice-based AF system cropping

Figure 6.Coconut and coffee integrated with vegetable trellissystem

SHELF LIFE PREDICTION OF LOCAL ORANGES USING SPECTRAL INFORMATION IN UV-Vis-NIR REGION COMBINED WITH PLS REGRESSION

DIDING SUHANDY[1*], DWI DIAN NOVITA[1], MEINILWITA YULIA[2], ARION OKTORA[1] AND YUNI KURNIA FITRI[1]

[1)] Department of Agricultural Engineering, The University of Lampung, Jl. Soemantri Brojonegoro No. 1 Gedong Meneng Bandar Lampung, Lampung, Indonesia 35145.
[2)] Department of Agricultural Technology, Lampung State Polytechnic, Jl. Soekarno Hatta No. 10, Rajabasa Bandar Lampung, Lampung, Indonesia.

*corresponding author: diding.sughandy@fp.unila.ac.id

ABSTRACT

Oranges is easy to be broken during handling and long transportation. One of the most challenging issues in this supply-demand chain of oranges is to separate the fresh orange fruits from the older ones. During storage, the quantity of flavonoid substances in oranges is decreasing. In this research we investigate the potential application of using absorbance spectral information in UV-Vis-NIR region for prediction of shelf life in local orange fruits (Siam oranges from Jember) during storage. For this, we perform spectral acquisition of extracted orange samples in 1, 4, 7, 10 and 13 days of storages using a UV-Vis spectrometer in absorbance mode (Genesys™ 10S UV-Vis, Thermo Scientific, USA). For extraction samples we use 2 x 2 cm of skin part of oranges. The sample preparation was done with chloroform as solvent for fluorescence substance extraction purpose. The calibration model for shelf life prediction of local oranges was developed using PLS regression with full cross validation. The calibration resulted in good correlation with $r = 0.89$ for calibration step and $r = 0.63$ for validation step, respectively. The prediction using different samples resulted in root mean square error of prediction (RMSEP) = 3.34 days. It can be concluded that there is a potential application of using spectral information in UV-Vis–NIR region combined with PLS regression for shelf life prediction of local oranges.

Keywords: local oranges, chemometrics, PLS regression, calibration, UV-Vis-NIR region

1. INTRODUCTION

There is an increasing in the consumption of fresh food in Indonesia. Especially for citrus, the consumption has been increasing at a faster rate compared to other horticultural products. City consumers are becoming more health conscious and this has opened up opportunities for the modern retail sector to expand further into fresh foods.

Over the last six years, citrus production in Indonesia has increased by about 400% to reach 2.2 million tons in 2005. Citrus represented about 10% of fruit production in 2005. Five provinces dominate citrus production - North Sumatra, East Java, South Sumatra, South Sulawesi and West Kalimantan – accounting for 70% of Indonesia's production. Jember in East Java is one of the main producers of Siam citrus. Citrus from this place are traded not only in Java Island but also transported into several places in Sumatera including Lampung province. The long transportation of citrus from Jember to several places in Sumatera including Lampung provides a major challenge to distribute fresh products nationally. Most of Indonesia's locally produced fresh fruit is distributed throughout Indonesia in non refrigerated trucks. One of the most challenging issues in this supply-demand chain of oranges is to separate the fresh orange fruits from the older ones. Some retailers may do mixing between fresh and old orange fruits in order to gain more financial benefit. So, in order to establish a fair trading and to protect our customer from any unfair trading including mixing between fresh and old products, it is very important to develop a method to detect and quantify the freshness condition in orange fruits.

It has been reported that most oranges species accumulate substantial quantities of flavonoid substances, that fluorescence under ultraviolet (UV) light (Kondo *et al.,* 2009; Benavente-Garcia, *et al.,* 1993; Castillo, *et al.,* 1992). The peel of the oranges fruits will fluorescence when the peel oil is released by some defects and can become visible when exposed to UV (Uozumi *et al.* 1987; Latz and Ernes, 1978). In a recent study, Blasco *et al.* (2007) examined the use of UV-induced fluorescence as a part of a multispectral analysis to identify defects in citrus caused by the green mould. In another study Slaughter *et al.* (2008) evaluated the feasibility of using machine vision and long wave UV fluorescence to detect and separate freeze-damaged oranges.

It is also interesting that the quantities of flavonoid substances in most orange fruits are changed during storage. This information can be used to assess the freshness in orange fruits if we can obtain the information of flavonoids contents during storage. In the previous report, Suhandy *et al.* (2016) reported that there is a correlation between storage times of orange fruits with its spectral absorbance in UV-Vis region. To establish a simple method for shelf life prediction of local oranges, in this paper we use UV-Vis spectral data coupled with partial least squares (PLS) regression method to evaluate the storage time of oranges. This method may contribute to separate local oranges precisely based on appropriate storage time and predict its shelf life to establish a fair trading of local oranges.

2. MATERIAL AND METHODS

2.1. Sample preparation

A number of 75 orange fruits (Siam Jawa from Jember, East Java) were collected directly from fruits retailers at Bandar Lampung, Lampung, Indonesia. All samples were divided into five groups of storage (1 day, 4 day, 7 day, 10 day, and 13 day, respectively). The storage conditions were the same for every sample. These experiments were performed at room temperature (around 27-29°C).

An aqueous extraction procedure of the orange fruits was performed both for skin part and flesh part without seed. First, for skin part, cut 1 cm x 2 cm of skin and then was crushed using a mortar then mixed with 2 mL of chloroform. For flesh part without seed, weighed 1 g of the flesh and then crushed with 2 mL of chloroform. Then the samples were filtered using a 25 mm pore-sized quantitative filter paper. After cooling process to room temperature (for 20 min), all extracts were then diluted with 5 mL of chloroform. UV-Vis-NIR spectra from the aqueous extracts were acquired using a UV-Vis spectrometer (Genesys™ 10S UV-Vis, Thermo Scientific, USA).

2.2. Instrumentation and measurement of spectra

The UV-Vis-NIR spectra in the range of 190-1100 nm were acquired by using a UV-Vis spectrometer (Genesys™ 10S UV-Vis, Thermo Scientific, USA) equipped with a quartz cell with optical path of 10 mm, and spectral resolution of 1 nm at a room temperature. Before the measurements step, blank (the same chloroform used in extraction process) was placed inside of the blank cell to adjust the 100% transmittance line. It is noted that during spectral data measurement, all cell were closed to avoid rapid evaporation of the samples.

2.3. Data analysis

All recorded spectra data were transferred to computer via USB flash disk and then convert the spectra data from .csv extension into an excel data (.xls). The samples were divided into two groups. One group consist of 50 samples were used for developing calibration and validation model using full-cross validation method. The other group consists of 25 samples were used for performing prediction step. The calibration model and validation test for storage time prediction was developed using Partial Least Squares Regression 1 (PLSR1) for smoothing spectra. Performance of the calibration model was evaluated using following statistical parameters such as coefficient of correlation between predicted and measured storage time (r), standard error of prediction (SEP), and bias between actual and predicted storage time. The calculation of smoothing spectra, PLSR1 and prediction were done by using multivariate software of The Unscrambler® V.9.1 (CAMO AS, Trondheim, Norway).

3. RESULTS DAN DISCUSSION

3.1. Spectra of oranges extraction samples in UV-Vis-NIR region

Fig.1 demonstrated the smoothing average spectra of extracted local oranges in the range of 190-1100 nm. We can observe very high absorbance in the range of 200-400 nm (ultraviolet range). In the visible and near infrared range we can see a small amount of absorbance. High absorbance in UV range may come from the high absorbance of flavonoid substance contained in skin part of oranges.

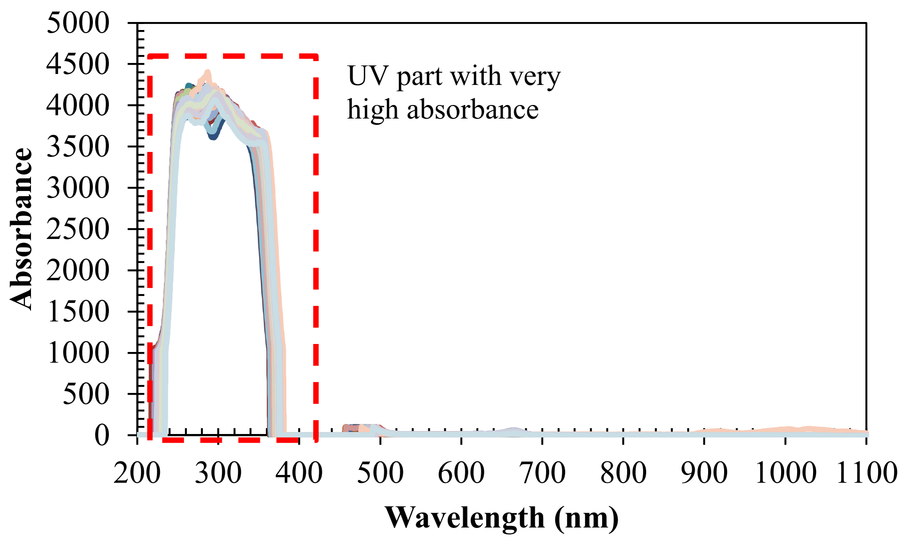


Figure 1. Absorbance spectra of extracted local oranges fruits in the range of 190-1100 nm acquired using UV-Vis spectrometer.

ISBN 978-602-0860-10-7

In order to check the quality of the obtained spectra, we perform principal components analysis (PCA) and checking the Hotelling's T2 test and taking 95% confidence intervals (Constantinou *et al.,* 2004). Fig. 2 showed the result of Hotelling's T2 test of 75 spectral data. In general we can saya that the quality of the spectral data was quite good. It can be seen that all spectral data lied inside the ellipse. However, there four samples including sample S73 locate outside the ellipse and for this reason we omitted those sample from further modelling steps. Here, we observe that after doing Hotelling's T2 test, the calibration samples was 48 samples and the prediction samples was 23 samples, respectively.

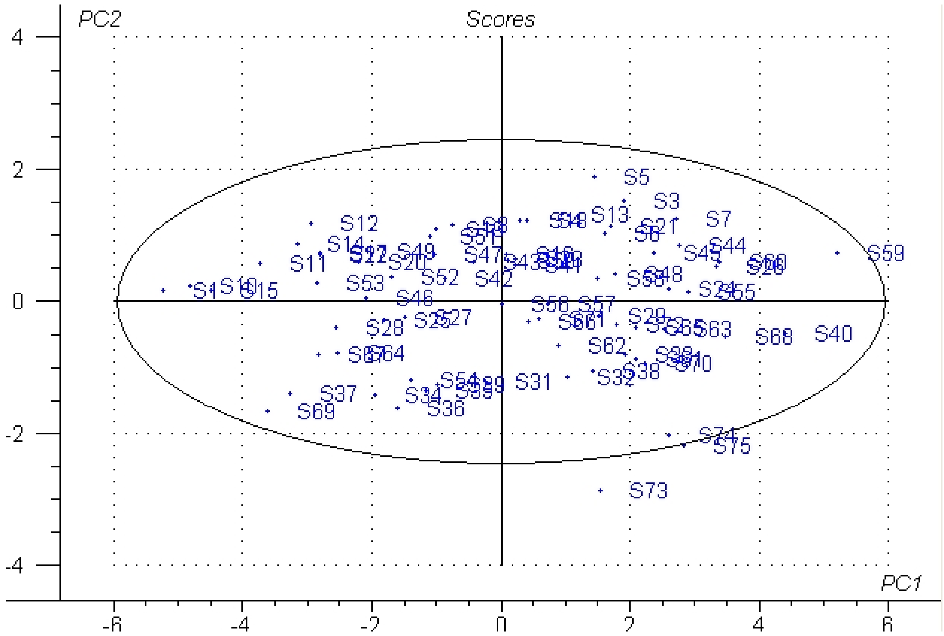


Figure 2. Scores scatter plot with Hotelling's T2 Ellipse for local oranges in the range 190-1100 nm.

3.2. Developing a calibration model

Using smoothing spectra (moving average smoothing with 11 segments for averaging), the calibration and validation results were very promising. Fig. 3 showed the calibration results for storage time determination for local oranges. The calibration has coefficient correlation (r) =0.89. The calibration model also had low standard error of calibration (SEC). The SEC was 1.93 day and the RMSEC was 1.91 day with low bias. From Fig. 3 it is also clear that the calibration model resulted in low SEP = 3.42 day. The RMSEP was 3.39 day with bias = 0.28 day.

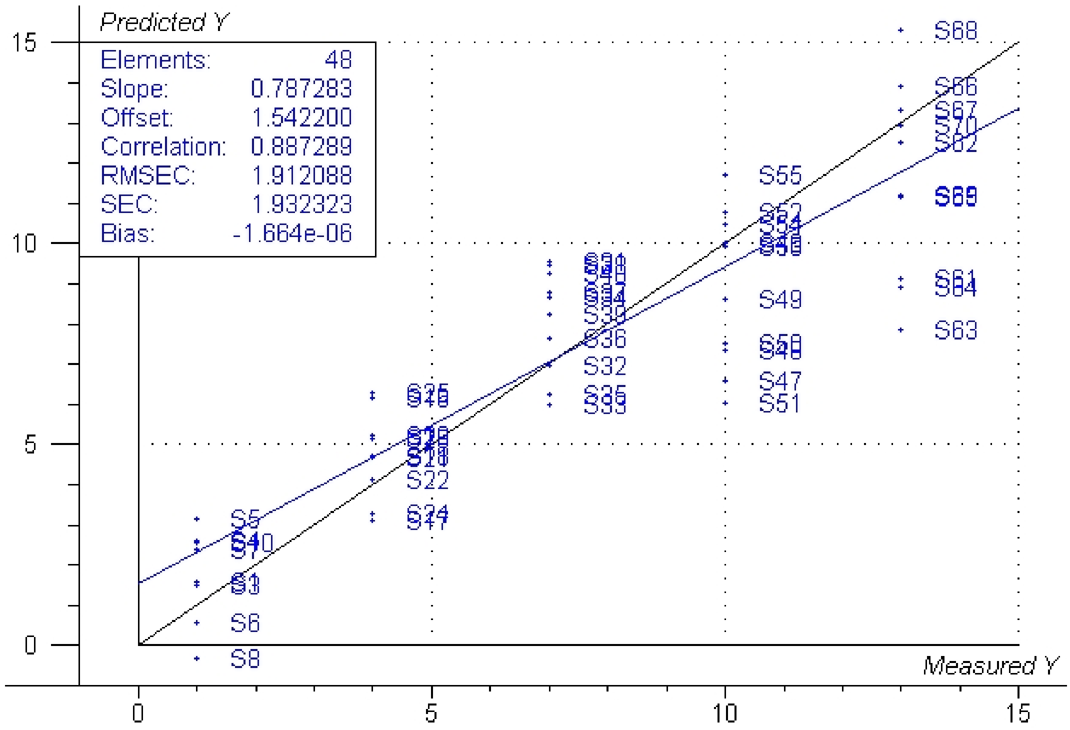


Figure 3. The calibration result for storage time determination using smoothing average spectra in the range of 190-1100 nm.

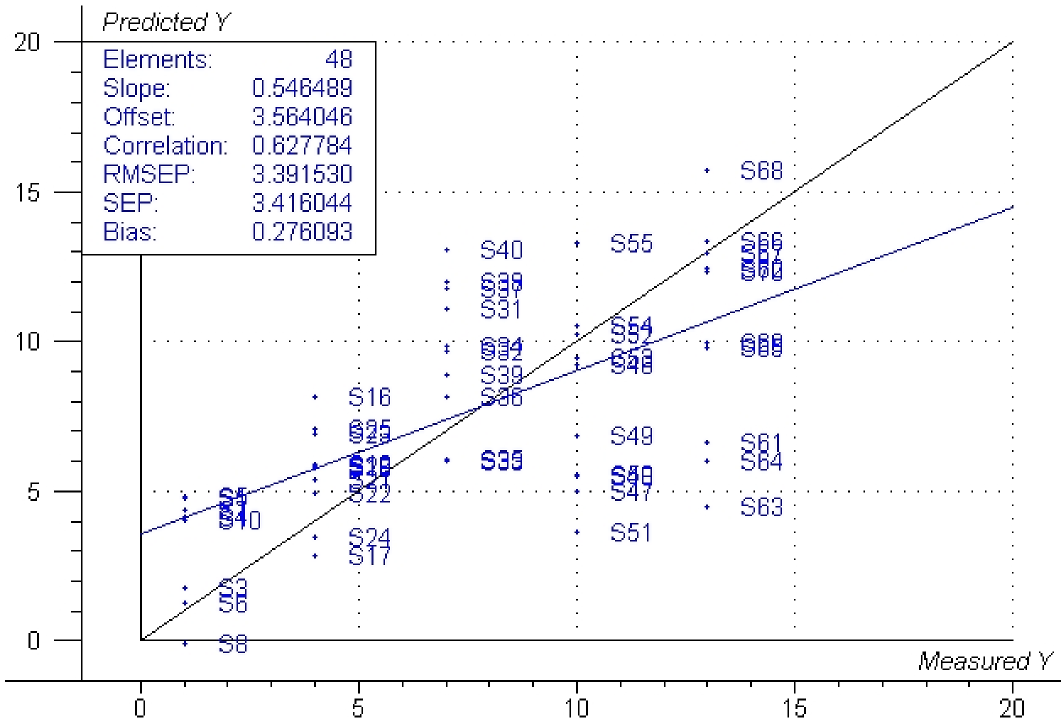


Figure 4. The validation result for storage time determination using smoothing average spectra in the range of 190-1100 nm.

ISBN 978-602-0860-10-7

3.3. Prediction of storage time using developed calibration model

Fig. 5 showed the result of prediction step. It showed the scatter plot between actual storage time and predicted storage time (day). We can see that there is a promising result with coefficient of correlation between actual and predicted storage time was 0.69. Increasing number of samples in the prediction step may improve the quality of prediction with higher coefficient of correlation. The RMSEP in prediction step was 3.34 day and bias was -0.12 day.

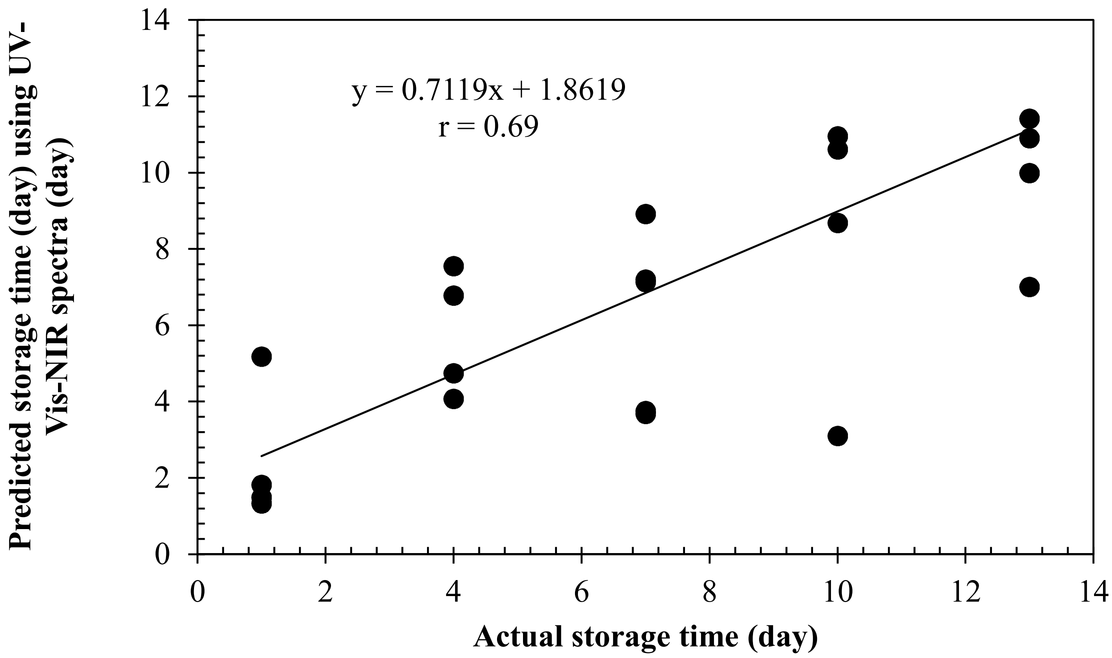


Figure 5. The scatter plot between actual and predicted storage time in the prediction step in the range of 190-1100 nm.

The calibration and validation was developed in the range of 190-1100 nm and resulted in high coefficient of correlation (r) = 0.89. The storage time of local oranges were then predicted using the developed calibration model and resulted in promising coefficient of correlation (r) = 0.69. In this research we successfully show that there is a potential application of using spectral absorbance in UV-Vis-NIR region of extracted local oranges to predict storage time (day) of local oranges. This method may be useful to establish a technology to predict shelf life of local oranges and define freshness of local oranges based on the decreasing of flavonoid substances.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge support of the Indonesian Ministry of Research, Technology and Higher Education (KEMENRISTEKDIKTI) via Hibah Fundamental 2016 (Nomor: 76/UN26/8/LPPM/2016) and The University of Lampung, Indonesia. We also thank to the Department of Agricultural Engineering, The University of Lampung for their permission to use their facilities for spectral data acquisition.

REFERENCES

Benavente-Garcia, O., Castillo, J., and Del Rio, J.A. 1993. Changes in neodiosmin levels during the development of Citrus aurantium leaves and fruits postulation of a neodiosmin biosynthetic pathway. Journal of Agricultural and Food Chemistry **41** (11):1916–1919.

Blasco, J., Aleixos, N., Gomez, J., and Molto, E. 2007. Citrus sorting by identification of the most common defects using multispectral computer vision. Journal of Food Engineering **83** (3):384–393.

Castillo, J., O. Benavente and Del Rio, J.A. 1992. Naringin and neohesperidin levels during development of leaves, flower buds, and fruits of Citrus aurantium. Plant Physiology **99**(1):67–73.

Constantinou, M. A., Papakonstantinou, E., Benaki, D., Spraul, M., Shulpis, K., Koupparis, M. A., et al. 2004. Application of nuclear magnetic resonance spectroscopy combined with principal component analysis in detecting inborn errors of metabolism using blood spots: a metabonomic approach. Analytica Chimica Acta, **511** (2): 303–312.

Kondo, N., Kuramoto, M., Shimizu, H., Ogawa, Y., Kurita, M., Nishizu, T., Chong, .K.V., and Yamamoto, K. 2009. Identification of fluorescent substance in mandarin orange skin for machine vision system to detect rotten citrus fruits. Engineering in Agriculture, Environment and Food **2** (2):54-59.

Latz, H. W., and Ernes, D.A. 1978. Selective fluorescence detection of citrus oil. Components separated by high-pressure liquid chromatography. Journal of Chromatography **166** (1): 189–199.

Slaughter, D. C., Obenland, D.M., Thompson, J., Arpaia, M.L., and Margosan, D.A. 2008. Non-destructive freeze damage detection in oranges using machine vision and ultraviolet fluorescence. Postharvest Biological Technology **48** (3):341-346.

Suhandy, D., Novita, D.D., Yulia, M., Oktora, A., and Fitri, Y.K. 2016. The potential application of using information from absorbance spectra in UV-Vis region for prediction of shelf life in local orange fruits during storage. Seminar Nasional Tempe, 28 Mei 2016 di Bandar Lampung.

Uozumi, J., Kawano, S., Iwamoto, M., and Nishinari, K. 1987. Spectrophotometric system for the quality evaluation of unevenly colored food. Nippon Shokuhin Kogyo Gakkaishi **34** (3):163–170. (*In Japanese*).

FOOD SECURITY UNDER PARTNERSHIP SCHEME AT PRODUCTION FOREST REGISTER 42 WAY KANAN, LAMPUNG PROVINCE

CHRISTINE WULANDARI[1)] AND PITOJO BUDIONO[2)]

[1)] Graduate Program of Forestry, University of Lampung – Jl. S. Brojonegoro 1, Bandar Lampung 35145, Indonesia
chs.wulandari@gmail.com

[2)]Centre of Public Policy and Spatial Planning, University of Lampung
Jl. S. Brojonegoro 1, Bandar Lampung 35145, Indonesia
ptj.budiono@gmail.com

ABSTRACT

Food security is a major thing in the development of a nation to achieve prosperity. In other words, whatever is the condition in an area, the food must be available in sufficient quantities, both in the harvest time or famine, distributed evenly throughout the region, at reasonable prices to all residents, quality and safety. This means that food security must be occurring anywhere in Indonesia, including in the conflict-prone areas such as around the production forest area Register 42, Way Kanan - Lampung. The study conducted in July - August 2015 aims to determine food security in the conflict-prone areas so that it can be taken into consideration in the development of food security policy in the region or other conflict-prone regions. From the analysis results it is known that the stability score of food security in the study site is 1.85 (good), score of availability is 1.72 (moderate), and a score of access is 1.98 (good). Especially for utilization is in a low level, that is 0.98. It has concluded that food security in research area is 6.53 (low) therefore must be developed planning on short, moderate and long period of proper policy towards to increasing community food security.

Key words: food security, production forest, proper policy

INTRODUCTION

Generally, the community came to Sidoarjo and KaryaAgungin 1965 through transmigration program. At that time the transmigration program did not provide the facilities of houses, but only provided land around 2 ha for each household. Deforestation of Forest Register 42 at surrounded those 2 villages occur generally due to population growth so that the cultivated land is shrinking. Population growth in the subdistrict of BlambanganUmpu, Way Kanan district is 2.47 (Lampung Post, 2011). According to respondents, population growth in this village is due to marriage and also migration from other sub districts.

High increasing in the number of population make the cultivated land of each family smaller. It is known from the results of field survey that a lot of families began to lost their cultivated land, as a result they began to go out of the village and worked as a laborer. Additionally, the hunger of land in this community also causes an increase of encroachment on the production forest Register 42 which is under the management of PT Inhutani V. They were generally planting forest land with cassava but without permission, so they must be ready if one day they have to leave it due to the instructionof PT Inhutani V. They planted cassava on production forest to meet the needs of everyday life.

Based on the existing conditions in the field and the partnershipprogram imposed by the PT InhutaniV, so the communities are expected to be wisein meeting their life needs and use their local habits. Local habitsrefers to is the use of natural resources based on local knowledgeowned by community from generation to generation to meet the everydayhousehold needs. The purposes of the study are to: (1) analyzefood stability, food availability, food accessibility and food utilizationbased on local knowledge of the communities in pursuing strategiestowards natural resource limitations surrounding their village. (2)provide policy recommendations so that FS in the research sites isassured.

MATERIALS AND METHODS

Study was conducted in two villages i.e. Sidoarjoand KaryaAgung in July - August 2015 which have 3,609 person of population (BlambanganUmpuMonography, 2014). The sampling of respondents using Slovinformula (Wulandari *et al.* 2015), that is:

$$n = \frac{N}{1 + Ne^2} = \frac{3,609}{1+3,609\ (0.05)^2} = 360 \text{ respondents}$$

notes:

n = number of sample

N = number of population at research sites

e = 5% margin of error

Based on the Slovin analysis, then determined the number of respondents = 360 persons. As proportionally based on the number of population in each village, sampling was conducted in the two villages namely Sidoarjoand KaryaAgung subsequently as follows: 157 and 203 person. Then all respondents were interviewed based on a questionnaire that had been prepared. The questions in the questionnaire are divided into four categories,that is food stability, food availability, food accessibility and food utilization. Each answer of respondents is weighted so that would be obtained certain values in each category.

Each indicator was measured using the following methodology (Landicho*et al.,* 2015): (1.) *Food stability.* Its indicator was measured that they produces multiple crops throughout the year. Food stability score is described as follows: 1.50 – 2.00: Food is highly stable. 1.00 – 1.49: Food is moderately stable and <1.00 when Food is not stable. (2.) *Food accessibility.*It was measured by the level of food availability in their households, which ranged from “always available”, “sometimes available” and “not always available.” The weighted score for each item was computed by determining the frequency count for each item, divided by the total number of respondents. Sum of weighted scores for each item represents the food accessibility that can classified byscores i.e. 2.00 –3.00: Food is highly accessible in the household, 1.00 – 2.99: Food is moderately accessible in the household, and <1.00: Food is not accessible in the household. (3.) *Food availability.* Its indicator was measured by farm produce are used for their home consumption; able to meet their basic food needs; and, whether the market is accessible for food items that may not be available in their farms. Score of food availability is described as follows:1.50 – 2.00: Food is highly available, 1.00 – 1.49: Food is moderately available and <1.00 when Food is not available. (4.) *Food utilization*. It was measured whether their farm produce are consumed by their household; by the local communities; and or by those outside the community. Food utilization scores are described as follows:1.50 – 2.00: Food is highly stable, 1.00 – 1.49: Food is moderately stable, and <1.00 when Food is not stable. Average score of status of food securitywas computed by adding up the scores in each of the four indicators divided by the total number of indicators. Scoring was based on the following:8.00 – 9.00: High level of food security, 7.00 – 7.99 :Moderate level of food security, 6.00 – 6.99 : Low level of food security and <6.00 : Food insecure.

Especially for the preparation of the policy recommendations are made in desk study. Policies at the national and regional level, as well as at the company of PT Inhutani V are made as reference in drafting policy analysis to support increased food security in the 2 research villages. The policy referred to is the policy of the ministry of forestry and the ministry of agriculture which is relevant to the food security program.

RESULTS AND DISCUSSION

Food security in Indonesia is alarming because of the high dependence on food imports. There are several factors contributing to this occurred in Indonesia, such as, due to the relatively small percentage of agricultural land, which is only 29.75% of the land or any terrestrial or an area of 536,000 km2 (Kompas, 2013). Unlike the United States, which is currently has a vast agricultural land area of 44.1% or 4.04095 million km^2 that make them able to export food (Kompas, 2013). Associated with a crisis of food availability, according to Deputy Chairman of Kadin on the Sector of Food and Livestock, FAO has estimated that most of the countries in the world will begin to experience the food crisis in 2015 (Kompas, 2013). In facing the food crisis which is expected to be occur in 2015, then Indonesia must immediately prepare a food security strategy, both at national and regional levels.

According to the Act No. 41 of 2009 on the Protection on Sustainable Food Agricultural Land and Act No. 18 of 2015 on Food, definition of food security refers to the conditions of food fulfillment for household food which is reflected in the availability of adequate food, both in quantity and quality, safe, equitable and affordable. Food supply can be done by: (1) self production, and (2) imported from other countries. This study analyzes the food security through four parameters of FAO (1996) namely:food stability, food availability, food accessibility and food utilization. Food security through partnership programs in the two research villages is important to examined because it is the prime program in anticipated the increasing encroachment on the forest of register 42 that carried out by the communities in the those villages to meet the needs of daily life (Nyanga, 2012).

The partnership program of PT InhutaniV did not specifically regulate the methods of land management by the community. It means that community should be able to manage it well with the farming habit based on local knowledge they possess. It said so, because as long as no intensive assistance program in the field and also no increase of community capacity in terms of cultivated land management (Wulandari, 2007). It means that the knowledge of cultivated land management by the community is indeed what they had so far and there is no knowledge from outside. Despite minimal assistance, this partnership got positive impact, because forest encroachment can be controlled and does not extend as the Village Leader and the Chairman of Cooperative helped the operations in the field.In addition, the sustainability of this partnership program could occur because the community get the official recognition from the government cq PT Inhutani V over the management rights at the same time obligations in managing state forest lands Including benefit sharing between community and Inhutani V. This right is only short term of 2 years and can be renewed again (APHI, 2014).

Based on the survey results, it is revealed that the partnership program of PT InhutaniV with the community which is just implemented since 2013 gives the score of food security parameters results of the levels 0.98 to 1.98.In detail result it is known that the stability score of food security in the study site is 1.85 (good), the food availability has a score of 1.72 (moderate) and food accessibility of research sites is 1.98 (good). Although it is easy access to the location of the research villages but the food availability is only moderate, this probably because food security influenced by geological factors of a region (Premanandh, 2011), for example, the road conditions are poor or many rocky and potholes roads that make only none to a few people who intensively manage their land so that the productions are less optimal.Foodavailability moderate could occur possibly due to the lack of community’s capacity building in the land management in addition of agricultural land management practice that they get from generation to generation of their parents and grandparents (Wulandari, 2007)

If food accessibility is good and food availability is moderate means the region does not have serious problem about food security. It is evident that the food stability in these 2 villages is in the category of good (1.85), meaning that community can still continuously meet the needs of everyday life.

It is reasonable if local knowledge influence to Food Securityas Adam (2008) showed at his research result that household's food security is highly dependent on the factors of demographic, ecology, social, economic and cultural. Specific correlation of food security to social aspects, particularly to local knowledge and gender issue has been proven in research sites. . The effect of local knowledge can be seen from the moderate score of Food avalability when the score of Food accessibility and Food stability are in the good category.Food availability moderate may occur because the community have not hadan increased knowledge to manage the land so that the land produce optimally, they manage the land only on the basis of local knowledge they had so far (Wulandari, 2007).Women respondents at both sites said that there are other advantages of the partnership program by PT Inhutani V, their husbands no longer need to go out of their villages to earn money for their families. It means that the majority of households in two villages headed by a father. According to Zakari, Liu Ying, and Song (2014), male as the head of family will give better food security level to their household than the female one.

Sunderland (2011) said that the nutritional and livelihood benefits of diverse production systems are one way of achieving food security. Thus, it is very understandable if the conditions in the research villages, obtained from the analysis results that the food securityat Sidoarjo and KaryaAgungis in the category of low (6.53) because of the diversity of food-plant species is low (either agriculture and non timber forest products).In addition, because the community managed their land only based on their local knowledge, so there is no modification of agricultural patterns on the types of plants at the research sites. Based on the score research results of 4 food security pillars,to increase food security in the two villages should be prepared diversification strategies with the development of food technology which is easily done by the community with affordable cost (Arifin, 2004 and Wulandari *et al.*, 2014).

Based on the low food security in these villages there should be a government policy development efforts so that the partnership program implemented by PT Inhutani V can increase the existing level of food security (Arifin, 2004 and Downey and Richter, 2013). Currently the partnership policies implemented by Inhutani V still solely based on the Ministry of Environment and Forestry policy, namely: regultion of Ministrial Forestry No.

P.39/2013. On the other hand, food security aspects often tangent to the main task and function of also based on the policy of Agricultural Ministerial, e.g Acts No. 18 year 2012 about Food. As definition of food security quoted above, then there should be policy development synergies between those 2 ministerial in addition also synergized with the policy of Industrial and Trade Ministerial for the products marketing. Besides works and program synergy of 3 ministrial, food security policy should be prepared based on short, medium and long term (Darwanto, 2005) because in principle, the food should always be there and the supply can not be done at once.Thus for the policy aspects, it can be given 2 recommendations as follows: (1.) For short-term policies are still needed to support the development of key commodities such as rice, corn that grown in agroforestry accompanied by the completeness development of infrastructure and facilities. (2) Medium and long-term policy can be as community-based agro-industrial development as well as to encourage the development of households agro-industry in order to improve the welfare of rural households in the study area and as well as the surrounding villages which have partnered or not with PT Inhutani V.Thus, it is required a program of community's knowledge and capacity improvement so that it can support the two policy recommendations above.

REFERENCES

Act No. 41 of 2009 on the Protection on Sustainable Food Agricultural Land.

Act No. 18 of 2015 on Food

Adam, Felecia P. 2008. *Ketahanan Pangan Rumah Tangga di Wilayah Pulau Kecil (Studi Kasus Di Kabupaten Maluku Tenggara Barat).* Tesis Program Studi Kependudukan Jurusan Antar Bidang Pascasarjana UGM. Tidak dipublikasikan

Arifin, B. 2004. Penyediaan dan Aksesibilitas Ketahanan Pangan. Makalah Disampaikan Pada Widya Karya Nasional Pangan dan Gizi VIII. Jakarta.

APHI, 2014. Resolusi Konflik Lahan dalam Hutan Tanaman Industri: Studi Kasus di PT Inhutani V (Persero). Laporan Penelitian. APHI, WWF Indonesia dan IFC. Jakarta.

Blambangan Umpu Monograph. 2014

Darwanto, Dwidjono H, 2005. *Ketahanan Pangan Berbasis Produksi dan Kesejahteraan Petani* Dalam Jurnal Ilmu Pertanian Vol.12. No.2, hal: 152-164

Downey MG, Richter D. 2013. Farmer preferences and the production strategies of agroforestry nurseries in Southern Madagascar. *Madagascar Conservation Development Journal*8(2):55−62.

FAO. 1996. Food and Agriculture Organization. Rome Declaration on World Food Security and World Food Summit Plan of Action. In Proceedings of the World Food Summit, Rome, Italy, 1–17 November 1996; Food and Agriculture Organization: Rome, Italy

Kompas. 2013. Kebijakan Ketahanan Pangan Mengkhawatirkan. Diterbitkan oleh PT Gramedia pada hari Jumat tanggal 27 September 2013 Hal 18

Ministrial of Forestry Regulation No. 39 Year 2013 on Community Empowerment through Partnership

Nyanga PH. 2012. Factors influencing adoption and area under conservation agriculture: a mixed methods approach. *Journal of Sustainable Agriculture Research*1(2):27−40.

Kompas. 2013. KebijakanKetahananPanganMengkhawatirkan. Diterbitkanoleh PT Gramedia padahariJumattanggal 27 September 2013 Hal 18

Lampung Post. 2011. Pemkab Waykanan Tangani Pengangguran dan Kemiskinan. Sumber: http://lampung.antaranews.com/berita/261161/pemkab-waykanan-tangani pengangguran-dan-kemiskinan. Tuesday, 13 December 2011 downloaded on 9 July 2016.

Landicho, L. D., Wulandari, C., Baliton, R.S.,Cabahug, R.D., Paelmo, R.F., Comia, R.A. Comia, Budiono, P., Herwanti, S., and Rusita. 2015. Assessing Ecological Services and Food Security Potentials of Agroforestry Landscapes in Makiling Forest Reserve in the Philippines and Way Betung Watershed in Indonesia. Research Report. Funded by SEAMEO-BIOTROP. Bogor, Indonesia

Premanandh, J.2011. Factors affecting food security and contribution of modern technologies in food sustainability.Journal of Science Food Agriculture. 2011 Dec;91(15):2707-14. doi: 10.1002/jsfa.4666. Epub 2011 Oct 17.

Sunderland, T.C.H. 2011. Food security: why is biodiversity important? Journal of International Forestry Review Vol.13(3), p 265-274

Wulandari, C. 2007. Local Ecological Knowledge on Forest Conservation: Importance Factor to Consider of Forest Regulation Development. Journal of Rimba Kalimantanp. 115-123 Vol. 12 No. 2.ISSN 1412-2014 Faculty of Forestry, University of Mulawarman.

Wulandari, C., Budiono, P., Yuwono., S.B., and Herwanti, S. 2014. Adoption of Agro-forestry Patterns and Crop SystemsAround Register 19 Forest Park, Lampung Province. Journal Of Manajemen Hutan Tropika (JMHT) Vol. XX, (2): 86 , 2014 EISSN: 2089-2063 DOI: 0.7226/jtfm.20.2. (p. 86 – 93) August Scientific Article ISSN: 2087-0469

Wulandari, C., Yuwono., S.B., Budiono, P., and Herwanti, S. 2015. Status and Development of Payment Watershed Services Program in Taman Hutan Raya Register 19,Lampung Province. International Journal of Agriculture and Environmental Research. ISSN: 2455-6939. Volume:02, Issue:02 p. 267 - 279

ANALYSIS FOR SELF-SUFFICIENCY OF RICE IN INDONESIA: FORECAST OF ITS PRODUCTION AND CONSUMPTION

AGUS HUDOYO, DWI HARYONO AND INDAH NURMAYASARI

(Department of Agribusiness, College of Agriculture, University of Lampung)
Email: agus.hudoyo@gmail.com

ABSTRACT

While there are different opinions whether or not Indonesia should be self-sufficient in rice, the data for analyzing its production and consumption are not reliable according to some experts. This paper, therefore, attempts to forecast the possibility of self-sufficiency in rice for Indonesia. The empirical models of the production and the consumption are econometric models. By using the FAO's data in the period 1961-2014, the result revealed that Indonesia will be self-sufficient in 2028 and after.

Keywords: Rice, Production, Consumption, Self-sufficiency

INTRODUCTION

Indonesia has been a rice importer since 1900 (Rosnerand McCulloch, 2008, for the data in the period 1900-2000; FAO, 2016, for the period 1961-2013; and BPS-Statistic Indonesia, 2016, for the period 2014-2015).Indeed, in the period 1985-1990 after Indonesia was a self-sufficient in 1984, the quantity of rice imported had been very low, i.e. 0.03-0.05 million tons for certain purposes.Since 1991, Indonesia has been back as a big rice importer country.

The Indonesia Government has been trying to get back as a self-sufficient in rice. However, according to Simatupang and Timmer (2008), based on the experience of reaching self- sufficiency in 1984, itwas very costly. In this regard, McCulloch and Timmer (2008) suggested that Indonesia should engage more fully in the world rice market to fulfill the Indonesian demand of rice.

Whether Indonesia will be self-sufficient in rice is a big question.To answer this question, we need to forecast the production and the consumption of rice and then compare them. However, it is almost impossible to get a sound forecast result since the data of production are overestimated and the data of consumption are underestimated (Rosnerand McCulloch, 2008; and Arifin, 2015). In this circumstances, this paper attempts to analyze the possibility of Indonesia be self-sufficient in rice.

METHOD

The empirical models can be seen in Equation (1) for the rice production and Equation (2) for the rice consumption.

$$Prod_t = b_o + b_1 AH_t + b_2 Seed_t + b_3 Year_t + e_{1t} \quad (1)$$

$$Cons_t = c_o + c_1 GDP_{t,} + c_2 Pop_t + e_{2t} \quad (2)$$

Where:

t : For production, t: 1961. 1962, …, 2014;
For consumption t: 1970, 1971, …, 2013
Prod : Rice production (million tons of paddy)
AH : Rice Area Harvested (million hectares)
Seed : Seed planted for rice (million tons)
Year : 1961=1, 1962=2, …, 2014=54
Cons : Rice consumption (million tons, paddy equivalent)
GDP : Indonesia Gross Domestic Product ($US billion, 2005 price)
Pop : Population (million people)
b and *c* : Parameter estimates
e : Error term

The source of all data is the FAO's website: http://faostat3.fao.org/home/E. Those two empirical models are firstly analyzed by using Ordinary Least Square (OLS). Since the data are time series, the OLS results should be evaluated for the existence of autocorrelation (Greene, 2000). If there is autocorrelation, then we use Feasible Generalized Least Square (FGLS) in order to get the efficient standard error.

RESULTS AND DISCUSSION

For analyzing the rice production, the data are from 1961 to 2014. The rice production and the area harvested data are depicted in Figure 1. It reveals that the rice production has been increasing affected more by the increasing of yield than by the additional harvested area. Moreover, there were two periods when the yields of rice drastically increased, i.e. the 1981-1989 due to the green revolution and the 2008-2014 due to the agricultural revitalization.

The average yield of rice in 2014 is 5.13 ton/ha. It may be too high because of the average value. However, if we compare with the potential yield, it is still low. According to

Indonesian Agency for Agricultural Research and Development (IAARD), 2016, the potential median yield of the rice is 8.85 ton/ha.

The result of the estimation for the rice production model can be seen in Table 1. It shows that the production forecast model resulted by FGLS is the best model since it is not only the best linear unbiased estimator (BLUE) of the coefficients, but also it has the efficient standard error. Therefore, it is used for forecasting the rice production (Table 2). In this table, there are three values for each forecast year, i.e. average, lower limit and upper limit of the 95% confidence interval. We used the lower limit for the rice production projection.

For analyzing the rice consumption, we use the data from 1970 to 2013. The rice consumption data and its calculated coput (consumption per capita) are depicted in Figure 2. It shows that the rice coput almost has the same trend with the rice consumption in the period 1970-2013. Only in the period 2002-2005, the coput had been declining, while the rice consumption had been increasing.

The calculated coput in 2013 is 134 kg/capita/year. Based on the National Economic Survey, it is 85 kg/capita/year, while according to OECD/FAO (2015), the average of Indonesian rice coput in the 2010-2014 is 163 kg/capita/year.

The result of the estimation for the rice consumption forecast model can be seen in Table 3. The model resulted by FGLS is BLUE and has efficient standard error. Based on this estimated consumption model, the forecast for the rice consumption is calculated and revealed in Table 4. We used the upper limit of the 95% confidence interval for the projection of the rice consumption.

The domestic production of rice is used for consumption, feed, seed, processing and others. Some rice is waste before reach the end user, such as consumers. The domestic supply for rice consumption (DS) is the rice production minus others (seed, feed, processing, other uses, and waste). If the DS equals to the consumption of rice, Indonesia is self-sufficient in rice. The DS data in the period 1961-2013 are revealed in Figure 3. It shows that there were 13 years when Indonesia self-sufficient in rice, i.e. 1962, 1968, 1981, 1983, 1984, 1985, 1986, 1989, 1992, 2007, 2009, 2010, and 2013. Since the self-sufficient happened for several years in the period 1983-1986, we say the 1984 is the year when Indonesia achieving self-sufficiency in rice.

After forecasting the rice production and consumption, then we use them for predicting whether Indonesia will be self-sufficient in rice. For production, we choose the lower limit of the 95% confidence interval. Conversely, we use the upper limit for the rice consumption forecast. This means our prediction will be in the 5% level of significant. The forecast of the rice self-sufficiency in Indonesia can be seen in Table 8. This table reveals that Indonesia will be rice self-sufficient in 2028 and after.

REFERENCES

Arifin, Bustanul. 2015. The Problem of The 1.5 Million Ton Rice Import (Soal Impor Beras 1,5Juta Ton). Kompas, 3 October, 2015.

BPS-Statistics Indonesia.2016. Foreign Trade Statistics 2015, Import, Volume II. Jakarta.

FAO.2016. http://faostat3.fao.org/home/E.

Greene, W.H. 2000.Econometric Analysis.Fourth Edition.Prentice Hall, Upper Saddle River, New Jersey.

Indonesian Agency for Agricultural Research and Development (IAARD).2016. http://en.litbang.pertanian.go.id/research/400/Food-Crops.

McCulloch, Neil andTimmer, C. Peter.2008. Rice Policy in Indonesia: A Special Issue. Bulletin of Indonesian Economic Studies, Vol. 44, No. 1: 33-44, 2008.

OECD/FAO.2015. OECD-FAO Agricultural Outlook, OECD Agriculture statistics (database). doi: dx.doi.org/10.1787/agr-outl-data-en.

Rosner, L. Peter and McCulloch, Neil.2008. A Note on Rice Production, Consumption and Import Data in Indonesia. Bulletin of Indonesian Economic Studies, Vol. 44, No. 1: 81–91, 2008.

Simatupang, PantjarandTimmer, C. Peter. 2008. Indonesian Rice Production: Policies and Realities. Bulletin of Indonesian Economic Studies, Vol. 44, No. 1: 65-79, 2008.

Table 1. The Estimated Forecast Model for Rice Production

Independent Variables	OLS		FGLS	
	Coefficients	t-value	Coefficients	t-value
Intercept	-24.00*	-4.38	-27.31*	-4.72
Area Harvested	4.03*	4.55	4.30*	4.62
Seed	30.01*	4.02	37.90*	4.98
Year	0.40*	3.98	0.31*	2.94
F value	1,891*		2,241*	
R Square (R^2)	0.9913		0.9928	
Adj. R^2	0.9907		0.9923	
Standard Error	1.7174		1.4910	
Observations	54		53	
Durbin Watson	0.644		2.326	

*: Statistically significant at the 1% level
Note:
Dependent variable: Rice Production (million tons)
Independent variables: Area Harvested (million hectares); Seed (million tons); and Year (1961=1, 1962=2, …, 2014=54)

Table 2. The Forecast of Rice Production in Indonesia (million tons)

Year	Average	Confidence Interval 95%	
		Lower Limit	Upper Limit
2016	75.75	72.76	78.75
2017	77.37	74.38	80.37
2018	79.02	76.02	82.01
2019	80.68	77.68	83.68
2020	82.36	79.37	85.36
2021	84.07	81.08	87.07
2022	85.80	82.81	88.80
2023	87.56	84.56	90.56
2024	89.34	86.34	92.33
2025	91.14	88.15	94.14
2026	92.97	89.97	95.97
2027	94.82	91.83	97.82
2028	96.70	93.71	99.70
2029	98.61	95.61	101.60
2030	100.54	97.54	103.53

Table 3. The Estimated Forecast Model for Rice Consumption

Independent Variables	OLS		FGLS	
	Coefficients	t-value	Coefficients	t-value
Intercept	-11.74*	-3.75	-12.27*	-3.90
GDP	-0.02**	-2.42	-0.02*	-2.68
Population	0.28*	-10.85	0.28*	10.98
F value	588*		615*	
R Square (R^2)	0.9663		0.9685	
Adj. R^2	0.9647		0.9669	
Standard Error	1.6944		1.5515	
Observations	44		43	
Durbin Watson	0.414		2.142	

*: Statistically significant at the 1% level, and ** at the 5% level
Note:
Dependent variable: Rice Consumption (million tons of paddy equivalent)
Independent variables: GDP (billion US$, 2005 price); and Population (million people)

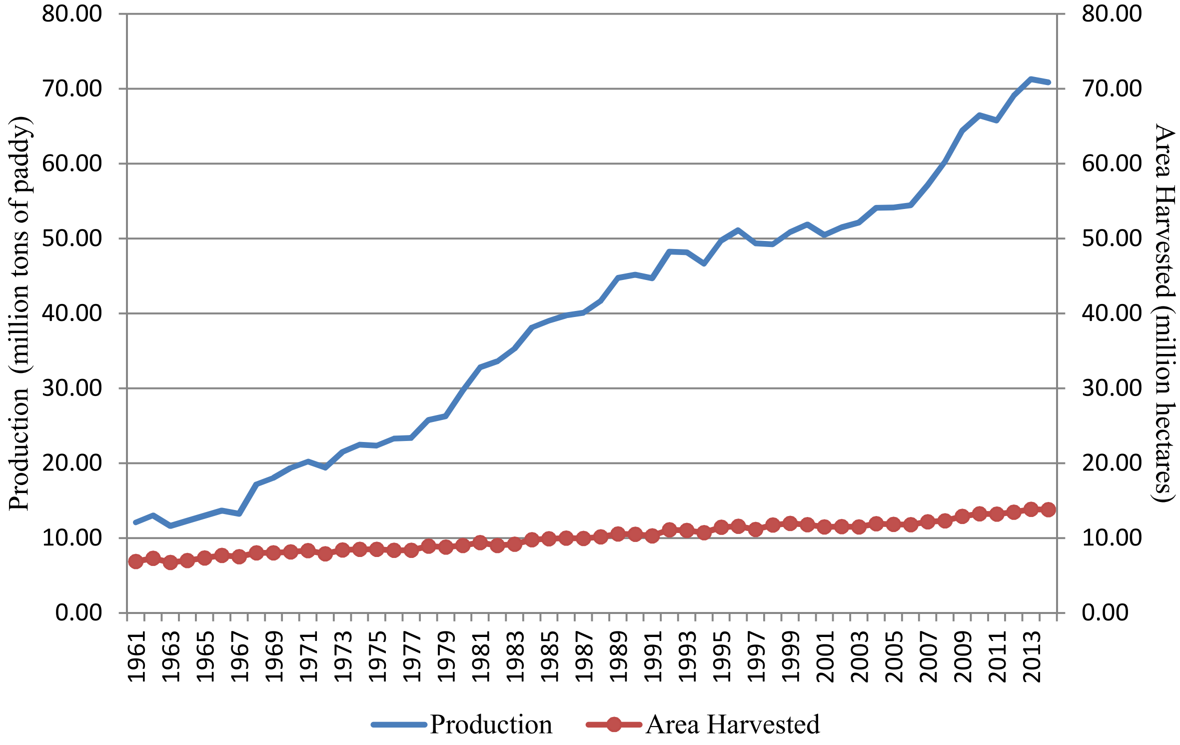
Table 4. Forecast of Rice Consumption in Indonesia (million tons, paddy)

Year	Average	Confidence Interval 95%	
		Lower	Upper
2016	52.33	49.19	55.46
2017	52.96	49.82	56.09
2018	53.54	50.40	56.67
2019	54.07	50.94	57.21
2020	54.84	51.71	57.98
2021	55.29	52.15	58.42
2022	55.94	52.81	59.08
2023	56.27	53.13	59.41
2024	56.81	53.68	59.95
2025	57.14	54.01	60.28
2026	57.51	54.38	60.65
2027	57.84	54.70	60.98
2028	58.12	54.98	61.26
2029	58.35	55.22	61.49
2030	58.53	55.39	61.66

Table 5. Forecast of Rice Self Sufficiency in Indonesia

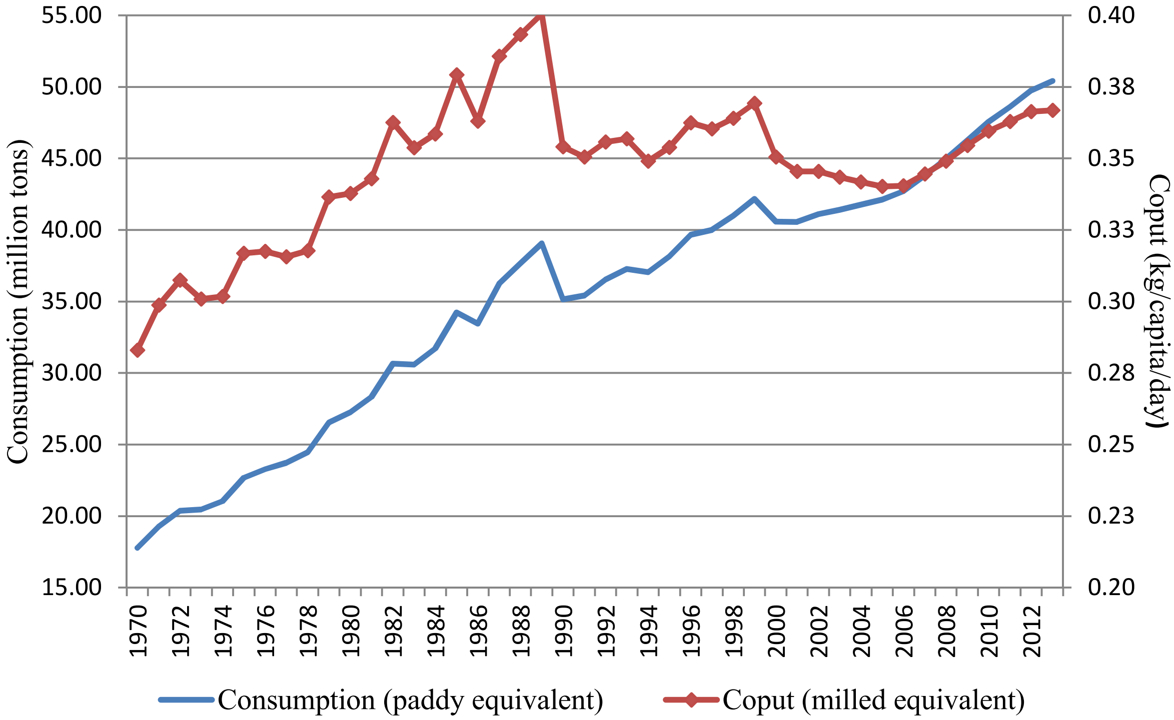
Year	Consumption [C]	Others	Production	Domestic Supply for Cons. [DS]	[DS-C]	[DS-C]/DS (%)
	<== = = = = = = = = = = = = (million tons of paddy) = = = = = = = = = = = = == =>					
2016	55.46	22.07	72.76	50.69	-4.77	-9
2017	56.09	22.78	74.38	51.59	-4.50	-9
2018	56.67	23.53	76.02	52.49	-4.18	-8
2019	57.21	24.29	77.68	53.39	-3.82	-7
2020	57.98	25.08	79.37	54.28	-3.70	-7
2021	58.42	25.90	81.08	55.18	-3.25	-6
2022	59.08	26.74	82.81	56.06	-3.02	-5
2023	59.41	27.62	84.56	56.95	-2.46	-4
2024	59.95	28.52	86.34	57.83	-2.12	-4
2025	60.28	29.44	88.15	58.70	-1.58	-3
2026	60.65	30.40	89.97	59.57	-1.08	-2
2027	60.98	31.39	91.83	60.43	-0.54	-1
2028	61.26	32.42	93.71	61.29	0.03	0
2029	61.49	33.47	95.61	62.14	0.65	1
2030	61.66	34.56	97.54	62.98	1.32	2

Figure 1. The Production and Area Harvested of Rice in Indonesia



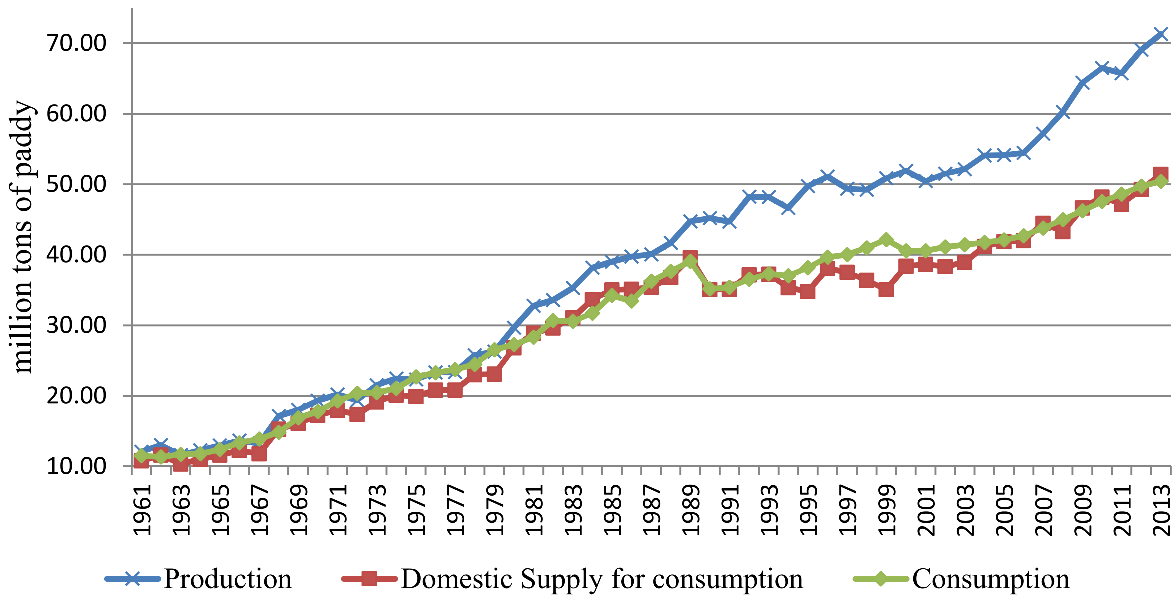
ISBN 978-602-0860-10-7

Figure 2. The Rice Consumption and Coput in Indonesia



ISBN 978-602-0860-10-7

Figure 3. The Rice Consumption, Production and Domestic Supply
in Indonesia (paddy equivalent)



 ISBN 978-602-0860-10-7

RISK MANAGEMENT AS A PILLAR IN FOOD SECURITY FOR PEPPER SMALLHOLDER FARMER

SUCI WULANDARI

Indonesian Center for Estate Crops Research and Development, Indonesia
suciwulandari@hotmail.com

ABSTRACT

Climate change are more severely impacted to poor farmers. They are more vulnerable because of their high dependence on natural resources and limited capacity to cope with climate variability and extremes. This condition will effect to the four dimensions of food security: availability, access, stability and utilization. The objective of this study are: (1) identifying climate change risk in pepper farming system, (2) mapping risk management, (3) formulating risk management improvement and support system development. This study was conducted in West Bangka. The analytical method used is Descriptive Analysis and Analytical Hierarchy Process. Climate change causing crop failure, decrease crop productivity, and changes in cropping pattern and cropping index due to changes in season length. The focus of risk management in pepper farming system is altering input to add maximum value in all the activities of the system. Technology is the most important support facilities for implementing risk management and followed by financial support, policy formulation and institutional development, capacity building and system information development.

keywords: climate change, pepper, risk management, support facilities.

INTRODUCTION

Indonesia is a major producer and exporter of pepper in the world. Pepper from Indonesia consists of black pepper (Lampung Black Pepper) produced in Lampung and white pepper (Muntok White Pepper) produced in Bangka Belitung, have an important role in the world pepper market. Indonesia in 1995 still controlled 40.32% of the pepper world market, but continue to decline. While Vietnam pepper market share in the world market is tend to increase. In 1995 the contribution Vietnam only reached 13.86%, so on at this time have dominated the world pepper market. In 2014, exports of black pepper Indonesia is about

19.496 MT and Vietnam is about 140.067 MT, while exports of white pepper Indonesia is about 15.237 MT and Vietnam is about 16.329 MT (IPC 2015).

Volatility of price has affected the production, marketing and utilisation of pepper. The income from pepper cultivation depends on the system of cultivation practiced, productivity, prevailing price and the share the farmer receives of the final price. Pepper price volatility have affected farmers incomes seriously and consequently led to poor maintenance, high incidence of disease and pests, and even abandonment of farms. Subsequent shortages of supply and high prices affect industrial users and consumers adversely, increasing costs of production and sometimes requiring changes in food product formulations (IPC 2005).

Maintaining productivity is a challenge in the pepper producing countries, especially for the traditional producing countries like India, Indonesia and Sri Lanka. The strategy to increase productivity are consist of replanting of the old plantations, soil and moisture conservation to face the climate change uncertainties, adoption of more effective pest and disease control measures and safe use of pesticides (IPC 2015). Pepper is quite sensitive to soil conditions, rainfall and temperature during the various growing stages. The risk related to climate change causes crop failure, decrease crop productivity, and changes in cropping pattern and cropping index due to changes in season length.

The objective of this study are: (1) identifying risks of climate change in pepper farming system, (2) mapping risk management, (3) formulating risk management improvement and support system development. A risk assessment aims primarily to further our understanding of the problems we face, at the same time it may provide some insight into the better solutions.

METHOD

This study was conducted in West Bangka in Bangka Belitung province. Research was conducted in 2015. The study used primary data and secondary data. The primary data obtained through literature study, baseline surveys and indepth interview. The number of respondents is 70 farmers. Secondary data were obtained from the International Pepper Community and the Directorate General of Plantation. The analytical method used is Descriptive Analysis and Analytical Hierarchy Process (AHP). The stages of this study are: (1) identifying climate change risk in pepper farming system through literature study and indepth interview, and analysis by using Descriptive Analysis, (2) mapping existing risk management through baseline surveys, (3) formulating risk management improvement and support system development through indepth interview, and analysis by using AHP.

Data analysis by using AHP decompose into the following steps: (1) define the problem and determine the kind of knowledge sought, (2) structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels to the lowest level which usually is a set of the alternatives, (3) construct a set of pairwise comparison matrices., and (4) use the priorities obtained from the comparisons to weigh the priorities in the level immediately below.

RESULTS AND DISCUSSION

Risks of Climate Change in Pepper Farming System

Risk is a situation where there is uncertainty outcome or result of an event (Field 2003). Risk indicates the variation of results, expressed as a measurement of the probability and severity. The risk categories can be done through several approaches. Based on its source, the risks can be divided into: (1) hardware failure, (2) software failure, (3) organizational failure, and (4) human failure (Haimes 2009). In the framework of supply chain management, supply chain risk is divided into two, namely the risk of external and internal risks (Kim et al. 2004).

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC 2015). It refers to any change in climate over time, whether due to natural variability or as a result of human activity. Climate change may be due to internal natural processes or external forcing, or by persistent changes in the composition of the atmosphere or land use as a result of human activity.

Climate change is a serious risk to food security. A food system is all processes and infrastructure involved in satisfying a population’s food security, that is, the gathering, growing, harvesting, storing, processing, packaging, transporting, marketing, and consuming of food, and disposing of food waste. It includes food security outcomes of these activities related to availability and utilization of, and access to, food as well as other socioeconomic and environmental factors (Porter et al. 2014).

The shocks of climate change are already happened in Indonesia, with more frequent droughts, heat waves and floods, and will pose an increasing threat to the country's development. About 40% of Indonesia's population is at risk of such hazards, and their number will increase under climate change which is expected to exacerbate droughts on southern islands, floods and cyclone intensity across the country, and sea level rise effects in coastal areas (Netherlands Commission for Environmental Assessment, 2015)

Pepper plants grow well in areas with altitudes ranging from 0-700 m above sea level. The spread of pepper plants are in tropical areas between 20^0 N and 20^0 LS, with rainfall of 1,000-3,000 mm per year, evenly distributed throughout the year and have a rainy day 110-170 days per year, the dry season is only 2-3 months per year, Air humidity 63-98% during the rainy season, with a maximum temperature of 35^0C and a minimum temperature of 20^0C (BBP2TP 2008; Balittro 2005).

Climate change causes risks of pepper plants specifically on: (1) increasing the frequency and intensity of extreme climate events (floods, droughts, high winds, etc.), and (2) the emergence of attack or explosion pest of new plants, (3) rise in temperature, changes in rainfall, and (4) increase in groundwater salinity on agricultural areas near the coast. The risk causing crop failure, decrease crop productivity, and changes in cropping pattern and cropping index due to changes in season length.

Many impacts, such as increased land degradation and soil erosion, changes in water availability, biodiversity loss, more frequent and more intense pest and disease outbreaks as well as disasters need to be addressed across sectors (FAO 2006). Climate change will have mostly negative effects on the food security dimensions (FAO 2008). In availability dimension, food will be reduced by a drop in food production caused by extreme events, changes in the suitability or availability of arable land and water, and the unavailability or lack of access to crops, crop varieties and animal breeds that can be productive in conditions have lead to changes in pests and diseases. In access dimension, access to food will be worsened by climate change events that lead to damages in infrastructure and losses of livelihood assets as well as loss of income and employment opportunities. In stability dimension, food supply could be influenced by food price fluctuations and a higher dependency on imports and food aid. In utilization aspect, food can be affected indirectly by food safety hazards associated with pests and animal diseases as well as the increased presence of human diseases.

While climate change is global, its negative impacts are more severely impacted to poor farmers. They are more vulnerable because of their high dependence on natural resources and limited capacity to cope with climate variability and extremes. This condition will effect to the farmer's capacity in the four dimensions of food security: availability, access, stability and utilization.

Existing Risk Management in Pepper Farming System

Pepper has an important role in the economy of Bangka Belitung province. Pepper area in 2014 is about 42.908 ha. It is separated on 21.651 ha in South Bangka Regency, 3.549 ha in Bangka, 4.635 ha in West Bangka, 2.528 ha in Central Bangka, 7.131 ha in Belitung, and 3.141 ha in East Belitung. The condition of the crop area are 16.048 ha of immature plants, 20.455 ha of produtive plants, and 6.405 ha of old or damaged plants (Ditjenbun 2015).

Adaptation is an actions taken to assist communities and ecosystems cope with changing climate condition. It is also define as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. From how governments perceive their country's vulnerability, and the priority given to responses by different actors, ASEAN countries can be grouped in three categories (SEI, 2014): (1) *adaptation pioneers* (Philippines and Vietnam), (2) *emerging champions (Cambodia,* Indonesia and Myanmar), and *wait-and-see adaptors* (Laos, Malaysia and Thailand).

Adaptation strategies in pepper farming are done at this point are diversifying Income and Multiply Cropping. Most of farmers also diversify their activities (Figure 1), almost 65.71% respondents have a rubber plantation and 48.47% also plant maize, while the others are palm oil and cassava. Farmers who doing inter cropping system is about 78.57%.

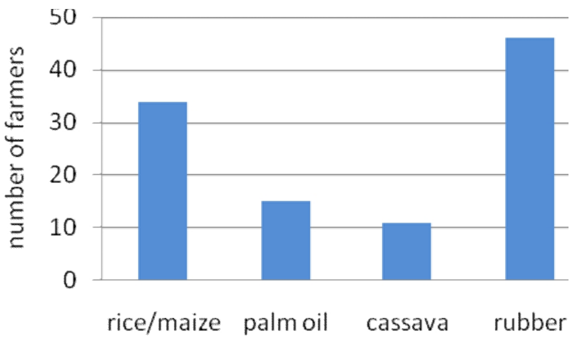


Figure 1. Diversifying Income through the Farming Integration

Farmers have conducted adaption in climate change through adjusting in cropping calendars. Pepper plants are usually planted during the rainy season. The global climate is changing and will continue to change, in ways that affect the management of pepper farming.

In regional scope, local goverment of West Bangka is targeting 200,000 rejuvenating stem pepper plants owned by farmers. The superior pepper seed supply is one of the activities to encourage farmers to farm intensively pepper. Assistance is provided to farmers farmer group members (Gapoktan) legal entities, in line with the Ministry of Agriculture for intensification and rehabilitation of commodities pepper in Bangka Belitung.

The low production of pepper in the region partly due to the pepper plant is a plant that is old, sick or damaged. Through the intensification it is expected within the next few years farmers will be able to increase the productivity of pepper. It is also considering the expansion of the low chances of pepper. At this time it is not possible to carry out the expansion due to the limited land available. Therefore, the development program directed at increasing production by increasing productivity of crops, from seed selection, land preparation, crop maintenance, and post harvest handling.

Risk Management Improvement and Support System Development in Adaptation of Climate Change

Risk management is defined as a comprehensive approach to address all of the events that cause harm (COSO 2006). Risk management is a process by using certain methods, which the companies consider the risks faced in any activities of the organization in achieving its objectives (Bowe 2006). Procedurally, risk management consists of context-setting activities, risk identification, risk analysis, risk evaluation and risk management activities in which accompanied the development of communication, and monitoring and evaluation at every stage (GRA 2006).

Risk management aims to identify risks that can estimate the impact if the risk occurs, make informed decisions about the effects that have been predicted, implementing control programs such risks, as well as continuously to measure and estimate whether the programs that have been implemented have been effective or are still in need of repair (Olson 2008; Reuvid 2008). Risk management improvement and support system development in adaptation of climate change diagram is describe in Figure 2.

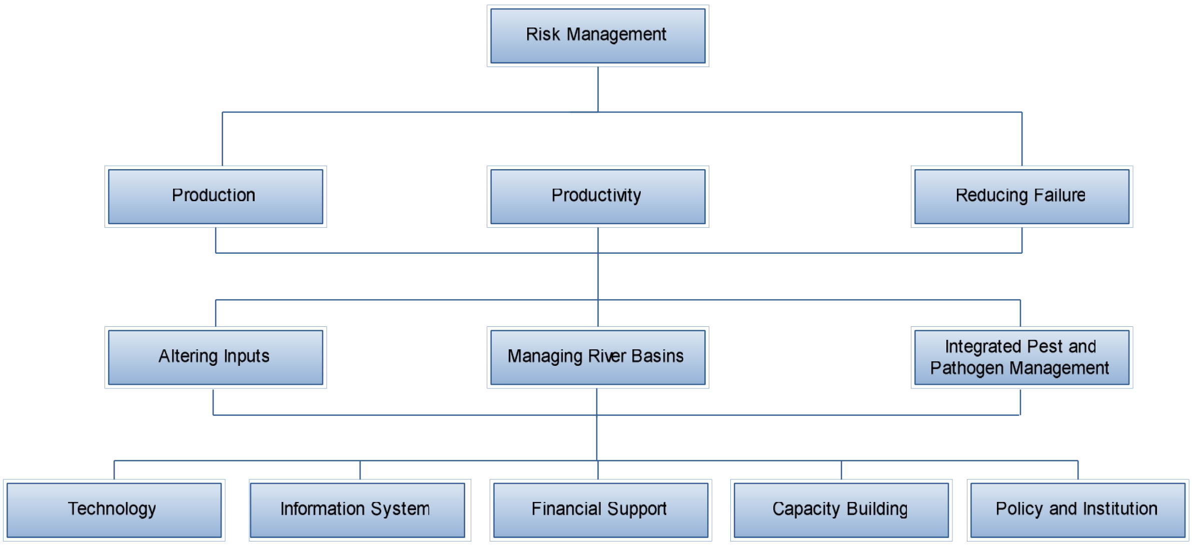


Figure 2. Risk management improvement and support system development

The focus of good risk management in pepper farming system is to increase production (0,3333), productivity (0,5833), and reduces the probability of failure (0,0833) (Figure 3). Its objective is to add maximum sustainable value to all the activities of the system. It organizes the understanding of the potential upside and downside of all those factors which can affect the system.

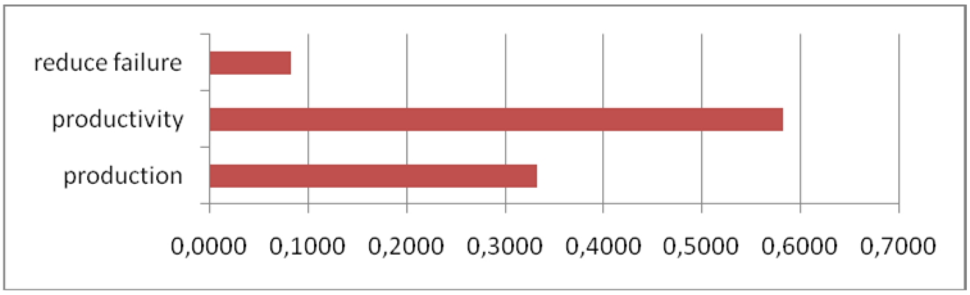


Figure 3. Relative Importance Value of Risk Management Objectives

Instruments of risk management to improve risk management in the supply chain of agricultural commodities can be grouped into (Jaffee 2008): (1) technologi development and adoption; (2) business unit management, (3) financial instrument; (4) infrastructure; (5) policy; and (6) the partnership.

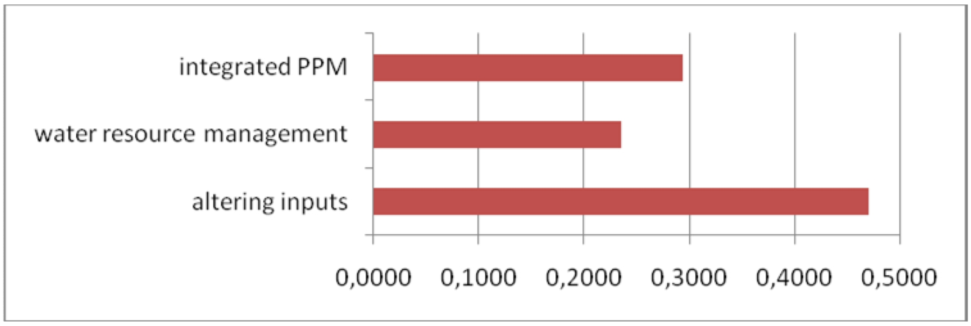


Figure 4. Relative Importance Value of Risk Management Strategy

Altering inputs (0,4706) is the most important instruments of risk management to improve risk management in pepper farming, followed by managing river basins (0,2353) and integrated Pest and Pathogen Management (PPM) (0,2941) (Figure 4). Instrumen of risk management can be divided into some action progam (FAO 2008) as mentioned below. Altering inputs consist of: varieties and species for increased resistance to heat shock and drought, flooding and salinization; altering fertilizer rates to maintain grain or fruit quality; altering amounts and timing of irrigation and other water management; altering the timing or location of cropping activities. Water resources management consist of managing river basins for more efficient delivery of irrigation services and prevent water logging, erosion and nutrient leaching; making wider use of technologies to harvest water and conserve soil moisture; use and transport water more effectively. The integrated pest and pathogen management can be achieved by implementing wider use of integrated pest and diseases management, developing and using varieties and species resistant to pests and diseases; improving quarantine capabilities and monitoring programmes.

In conditions where there are limited resources and capabilities, the facility management activities need support in the form of risk management instruments. Facilitation is modifications of a system that will make things become easier in the process of achieving goals. Facilitation is described as a state of opportunities, resources, and support for a group to achieve their goals (NAPSF 2008). Facilitation for commodity development involving governments, the private sector, donors, and community. Forms of facilitation of every actor in line with the role in the development of commodity development.

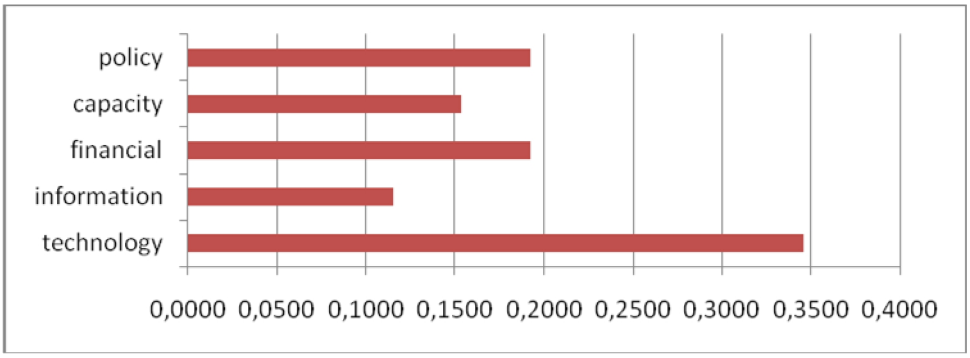


Figure 4. Relative Importance Value of Support Facilites for Implementing Risk Management

There are various forms of facilities which can be provided in an effort to accelerate the achievement of objectives, namely: technical facilities, financial facilities, resources facilities, legal and administrative facilities (BSFMCT 2008). Implementation of risk management in pepper commodity system showed that technology (0,3462) is the most important support facilities for implementing risk management and followed by financial support; policy formulation and institutional development (0,1923), capacity building (0,1538) and system information development (0,1154) (Figure 4).

Climate change is at significant risk to its food security and the capacity for sustainable economic growth if risk management are not adopted and implemented in the near future. On the other hand, because of lack resources and capabilities of the farmers, the facility management activities need support in the form of risk management instruments. Recognizing this, implementation of the risk management need support facilities from government and other stakeholders.

Technical facilities conducted with the aim to improve the technology infrastructure. Through this facilitation it is hoped will awaken technological innovation that will accelerate the development process of the commodity. Capacity Building aims to improve the learning process that results in increased productivity and efficiency. Training for new jobs based on new land uses, industry relocation and human migration: needed where climate impacts lead to major land use changes. Facilitation of the organization carried out with the aim to improve the capacity of organization to improve the performance of system commodity. The method can be done by forming the methods, techniques, tissue organization, and management practices. Financing facilities given in an attempt to improve access to financial institutions that become obstacles for SMEs. Policies that support research, systems analysis, extension capacity, industry and regional networks: need to be strengthened in order to provide managers with understanding, strategic and technical capacity to protect their enterprises. System Information development to educate and inform stakeholders about climate change. Climate monitoring efforts and communication of information will be essential to convince farmers that climate changes projections are real and require response actions. Information services should include surveillance of pests, diseases and other factors of importance to production systems.

REFERENCES

Balittro. Balai Penelitian Tanaman Rempah dan Obat. 2005. *Pedoman Budidaya Tanaman Lada (Piper nigrum Linn)*. Bogor. Balittro.

BBP2TP. 2008. Teknologi Budidaya Lada. Badan Penelitian dan Pengembangan Perkebunan.

Bowe JK. 2006. *Enterprise Risk Management Specialty Guide*.

BSFMCT, Business Support Facilities Management of Cape Town, 2008. *Business Support Framework.* Business Support Facilities Management

COSO, Committee of Sponsoring Organization. 2006. *Enterprise Risk Management Framework*. Committee of Sponsoring Organization of The Treadway Commission. COSO

Ditjenbun. 2015. Statistik Perkebunan Indonesia: Lada

FAO. 2006. Food Security. Policy Brief June 2006 Issue 2. FAO's Agriculture and Development Economics Division (ESA). http://www.fao.org/es/esa/ EC-FAO.

FAO. 2008. Climate Change Adaptation And Mitigation In The Food And Agriculture Sector Technical Background Document From The Expert Consultation.

Field P. 2003. *Modern Risk Manajemen: A History*. Risk Books, Incisive RWG Ltd.

GRA. Global Risk Alliance. 2006. *Risk Management Guide for Small Business*. NSW Department of State and Regional Development.

Haimes YY. 2009. *Risk Modeling, Assesment, and Management*. John Willey and Sons Inc.

IPC, International Pepper Community. 2015. Pepper Statistical Year Book 2014.

IPC, International Pepper Community. 2005. Pepper Production Guide for Asia and The Pacific.

IPCC, Intergovernmental Panel on Climate Change. 2015. Climate Change 2014 Synthesis Report Summary for Policymakers.

Jaffee S, Paul S, Colin A. 2008. *Rapid Agricultural Supply Chain Risk Assessment. Conceptual Framework and Guidelines for Application*. Commodity Risk Management Group Agriculture and Rural Development Department. World Bank.

Kim CS, James T, Mike B, Richard F, Bing C, Mahendrawati E. 2004. *State of The Art Review. Techniques to Model Supply Chain in an Extended Enterprise*. Operation Management Division. University of Notingham.

NAPSF. Nigeria Agriculture Policy Support Facilities. 2008. *National Economic Empowerment and Development Strategy*. National Economic Empowerement and Development.

Netherlands Commission for Environmental Assessment. 2015. Climate Change Profile: Indonesia. Netherlands Commission for Environmental Assessment, Dutch Sustainability Unit. 21p.

Olson DL, Desheng W, editor. 2008. *New Frontiers in Enterprise Risk Management*. Springer-Verlag Berlin Heidelberg

Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso. 2014. Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 485-533

Reuvid J. 2008. *Managing Business Risk*. 5th edition. Kogan Page Limited.

INDIRECT SELECTION OF SOYBEAN ELITE LINES DERIVED FROM WILIS X B3570 CROSSES

NYIMAS SA'DIYAH, VISKA NURISMA, SETYO DWI UTOMO AND MAIMUN BARMAWI

Department of Agrotechnology Faculty of Agriculture, University of Lampung
Jln. Prof. Soemantri Brodjonegoro, No. 1, Bandar Lampung 35 145.
email: nyimas_diyah@yahoo.com

ABSTRACT

The objectives of this study were to estimate the correlation between yield components and seed yield (weight of dry seed per plant) of soybean, to estimate the direct and indirect effects of yield components to seed yield, and to conduct indirect selection of elite lines. This study was conducted at Research Station of BPTP Lampung, Village of Negara Ratu, Natar Sub-District, South Lampung from December 2014 to April 2015. Eleven F_6 lines derived from crosses between Wilis x B3570 were evaluated using completely randomized block design with two replications. Wilis, B3570, and Gepak Kuning were used as checks. The results indicated that flowering date, harvesting date, number of productive branches, pod numbers, and 100-seed weight were positively correlated with seed yield. Based on path analysis, indirect selection using harvesting date and 100-seed weight was expected to be effective; two elite lines were selected, i.e., 142-159-5-1-6 dan 142-159-1-14-1.

Keywords: Correlation, *Glycine max* [L.] Merrill, path analysis, indirect selection

INTRODUCTION

One effort to increase the productivity of soybean is by crossing two parents which have different superior traits. This can be achieved by selecting genotypes that have superior traits compared to the two parents (Kasno, 1992). Selection can be effective if there is a relationship or correlation between the intended characters and other characters as probes (Welsh, 1991). The relationship between the characters is a representation of the correlation phenomenon between the characters (Rachmadi, 2000). To determine the correlation, a correlation analysis is conducte. However, correlation analysis has a weakness, which does not adequately describe the relationship among yield components. To overcome this, the path analysis is used, because each trait correlated with the results that parsed to direct and indirect effect (Singh and Chaudhary, 1979). The purpose of this study was to (1) estimate the correlation value among yield components in F_7 generation from a cross between Wilis and B3570, (2) estimate direct and indirect effects of the yields components of the soybean seed weight of F7 generation from a cross between Wilis and B3570, and (3) select soybean elite lines of F7 generation from crossing Wilis and B3570.

MATERIALS AND METHODS

This study was conducted at Research Station of BPTP Lampung, Village of Negara Ratu, Natar Sub-District, South Lampung from December 2014 to April 2015. The materials used were 11 F_6 lines derived from crosses between Wilis x B3570: 142-159-1-14-1, 142-159-1-14-12, 142-159-1-16-2, 142-159- 1-16-10, 142-159-1-16-12, 142-163-1-1-2, 142-163-1-1-10, 142-163-1-1-14, 142-163- 1-16-10, 142-102-4-6-4, and 142-159-5-1-6. Parents in this study were Wilis, B3570, and Gepak Kuning.

This study used a completely randomized block design with two replications with a spacing of 50 cm x 25 cm. The plot consists of 14 genotypes of plants, which each contained 20 plant genotypes. The data obtained were analyzed using ANOVA, followed by calculating the analysis of covariance, correlation value, and path analyzes based on the Singh and Chaudhary's formula (1979). To test the correlation, t-test was used. If the t-count > t-table (db = n-2), then the correlation coefficient declared significant. Interpretation of cross coefficient can be based on Singh Chaudary's three guidelines (1979). Elite lines selected using Boxplot analysis. From the analysis, selected plants are plants that have exceeded the mean value of the comparison based on the seeds-weight per plant.

RESULTS AND DISCUSSION

Results

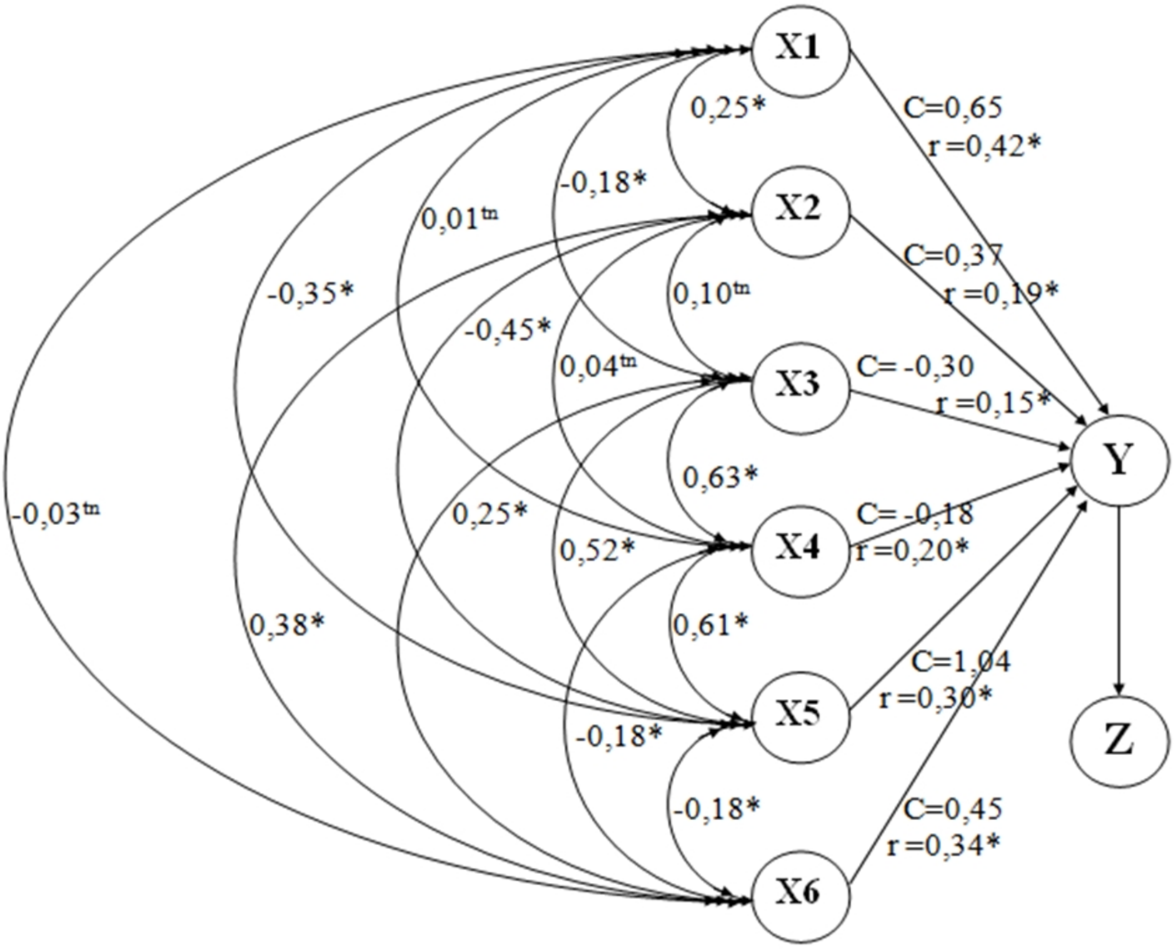


Figure 1. Correlation and Path Analysis. X1 = Flowering Date (days); X2 = Harvesting Date (days); X3 = Plant Height (cm); X4 = Number of Productive Branches; X5 = Pods Number; X6 = 100-Seeds Weight (g); Y = Seed Yield per Plant (g); Z = Residual Factors; C = Direct Effect; r = Correlation.

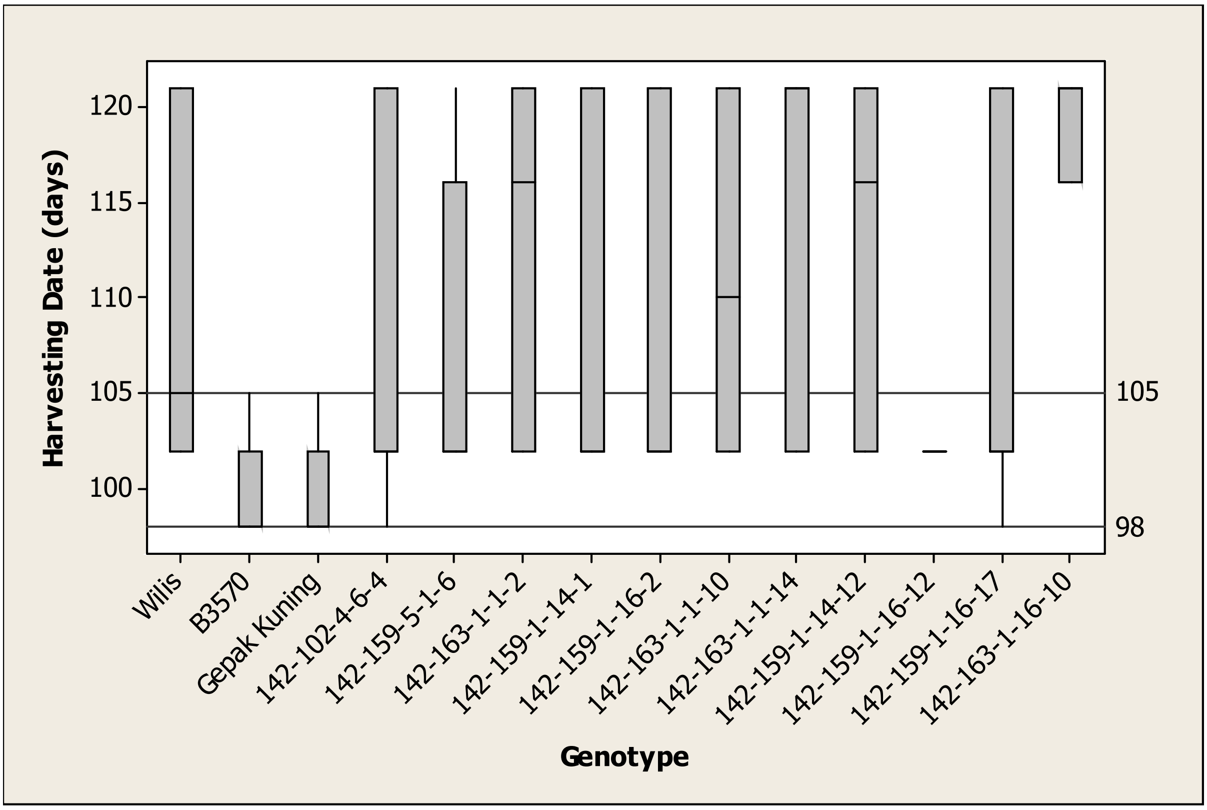


Figure 2. Boxplot analysis for Harvesting Date per plant. The horizontal line shows the median values for three comparators.

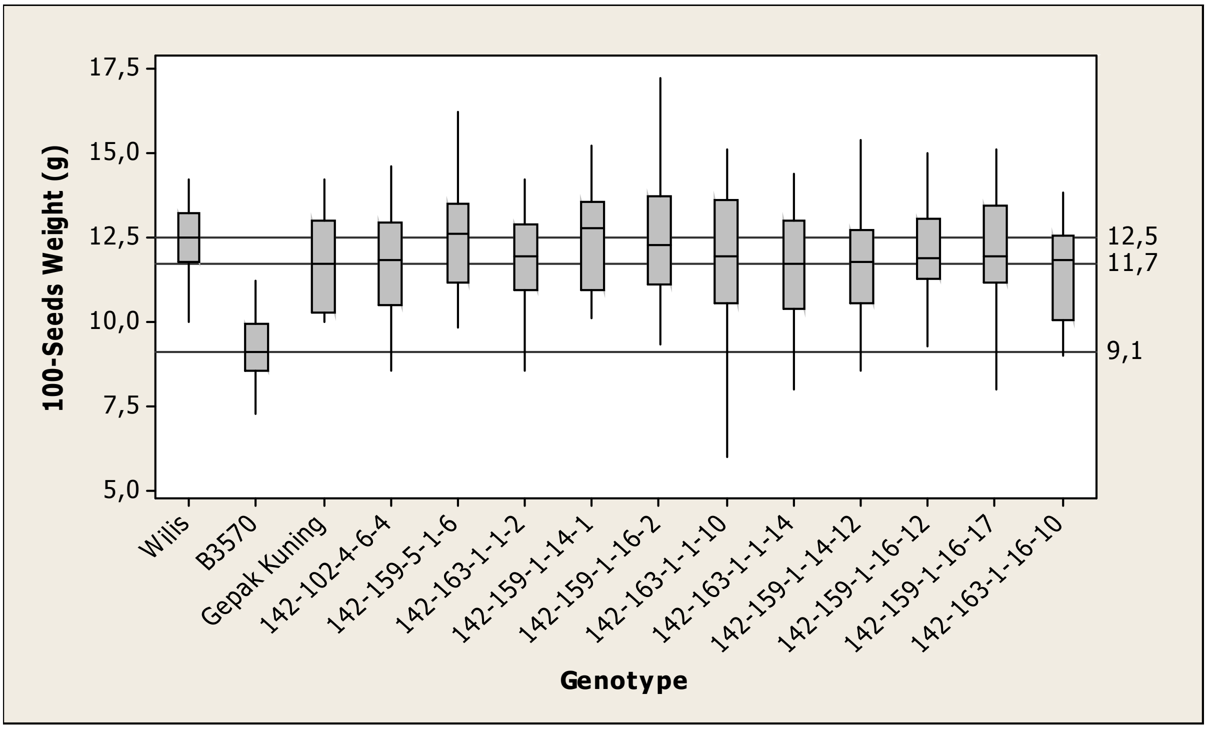


Figure 3. Boxplot analysis for 100-seeds weight per plant. The horizontal line shows the

median values for three comparators.

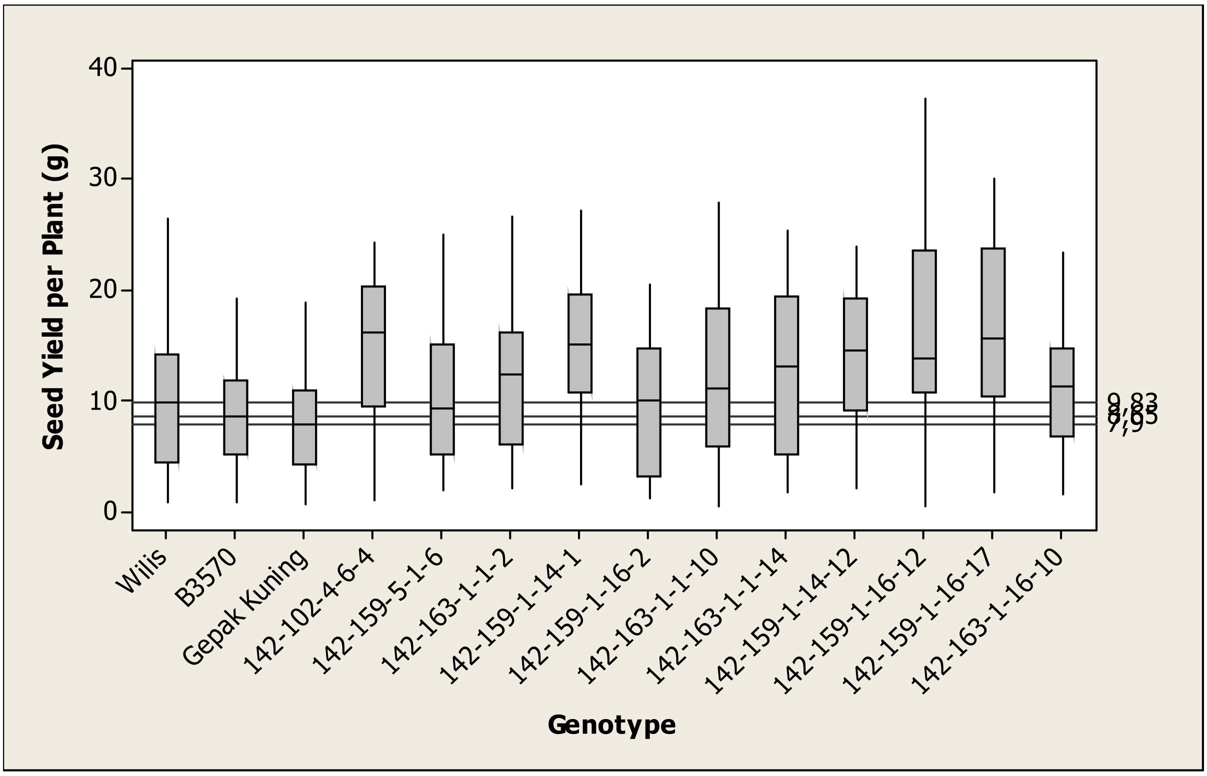


Figure 4. Boxplot analysis for seed yield per plant. The horizontal line shows the median values for three comparators.

DISCUSSION

The characters that have correlation with seed weight per plant were: flowerin date, harvesting date, number of productive branches, pods number and 100-seed weight (Figure 1). Based on three basic guidelines common in the interpretation of cross coefficients proposed by Singh and Chaudary (1979), the effective selection was based on the harvesting date and 100-seed weight (Figure 1).

According to Adie (2007), harvesting date of all genotypes were under a group of harvesting date a very deep old or more than 90 days (Figure 2). Based on seed size groupings, all genotypes tested were under group of medium size which was between 10-14 g /100 grains (Figure 3.) (Adie and Krisnawati, 2007). Almost all genotypes tested had a weight of seeds per plant that exceeds three peers (Figure 4.) Therefore, based on harvesting date, 100-seed weight and seed yield per plant, the genotypes considered elite lines were selected . They were genotype 142-159-5 -1-6 and 142-159-1-14-1. From these results it can be concluded: (1) the characters correlated with seed yield per plant were flowering date, harvesting date, number of productive branches, pods number and 100-seed weight; (2) the selection would be effective by harvesting date and 100-seed weight; and (3) Genotypes 142-159-5-1-6 and 142-159-1-14-1 were selected as elite lines.

ACKNOWLEDGEMENT

The authors gratefully thank Ministry of Research and Higher Education, The Republic of Indonesia for funding this research through the Program of National Strategic Research in 2014 financial year. The authors also thank the students at The Department of Agrotechnology, The Faculty of Agriculture, The University of Lampung for their helps during the execution of this research.

REFERENCES

Adie, M.M and A. Krisnawati. 2007. The potential for increasing the quality of soybean seeds. Proceedings. Minutes of the Seminar. 23 November 2008. Agricultural Research Agency. pp.216-230.

Kasno, A. 1992. Nuts Plant Breeding. Pp 39-69. In Proceedings of the Symposium on Plant Breeding I. (Ed. A. Kasno, M. Dahlan, and Hasnam). PPTI. East Java.

Rachmadi, M. 2000. Introduction to vegetative replication Plant Breeding. Padjadjaran University. Bandung. 159 p.

Singh, R.K. and B.D. Chaudhary. Biometrical 1979. Quantitative Methods in Genetic Analysis. Ludhiana-New Delhi. Kalyani Publishers. 302 pages.

Welsh, J.R. 1991. Fundamentals of Genetics and Plant Breeding. Erlangga. Jakarta. 224 p.

INDIRECT SELECTION OF SOYBEAN ELITE LINES DERIVED FROM WILIS X B3570 CROSSES

Nyimas Sa'diyah[1], Viska Nurisma[2], Setyo Dwi Utomo[1], and Maimun Barmawi[1]
[1] Lecturers Department of Agrotechnology Faculty of Agriculture, University of Lampung
[2] Alumni Department of Agrotechnology Faculty of Agriculture, University of Lampung
Jln. Prof. Soemantri Brodjonegoro, No. 1, Bandar Lampung 35 145.
email: nyimas_diyah@yahoo.com

ABSTRACT

The objectives of this study were to estimate the correlation between yield components and seed yield (weight of dry seed per plant) of soybean, to estimate the direct and indirect effects of yield components to seed yield, and to conduct indirect selection of elite lines. This study was conducted at Research Station of BPTP Lampung, Village of Negara Ratu, Natar Sub-District, South Lampung from December 2014 to April 2015. Eleven F_6 lines derived from crosses between Wilis x B3570 were evaluated using completely randomized block design with two replications. Wilis, B3570, and Gepak Kuning were used as checks. The results indicated that flowering date, harvesting date, number of productive branches, pod numbers, and 100-seed weight were positively correlated with seed yield. Based on path analysis, indirect selection using harvesting date and 100-seed weight was expected to be effective; two elite lines were selected, i.e., 142-159-5-1-6 dan 142-159-1-14-1.

Keywords: Correlation, *Glycine max* [L.] Merrill, path analysis, indirect selection

INTRODUCTION

To increase the productivity of soybean is doing activities that can be started by crossing two parents with different characteristics and has superior traits, in order to obtain the new lines that are expected to inherit traits are crossed parents. This can be achieved by selecting genotypes that have superior traits compared to the two parents (Kasno, 1992). Selection can be effective if known to the relationship or correlation between the intended character with another character as a probe (Welsh, 1991). The relationship between the characters is a representation of the correlation phenomenon between the characters plant (Rachmadi, 2000). To determine the correlation between the yield components with the results, then do correlation analysis, but correlation analysis has a weakness, which does not adequately describe the relationship between yield components. To overcome this, the path analysis is used, because each trait correlated with the results that parsed to direct and indirect effect (Singh and Chaudhary, 1979). The purpose of this study is (1) Estimate the correlation value between yield components and soybean yields generation F_7 from crossing Wilis and B3570, (2) Estimating the amount of direct and indirect effects of the yields components of the soybean seed weight F7 generation from crossing Wilis and B3570, and (3) Selecting soybean elite lines of F7 generation from crossing Wilis and B3570.

MATERIALS AND METHODS

This study was conducted at Research Station of BPTP Lampung, Village of Negara Ratu, Natar Sub-District, South Lampung from December 2014 to April 2015. The materials used are Eleven F_6 lines derived from crosses between Wilis x B3570: 142-159-1-14-1, 142-159-1-14-12, 142-159-1-16-2, 142-159- 1-16-10, 142-159-1-16-12, 142-163-1-1-2, 142-163-1-1-10, 142-163-1-1-14, 142-163- 1-16-10, 142-102-4-6-4, and 142-159-5-1-6. Parents in this study are Wilis, B3570, and Gepak Kuning.

This study uses a completely randomized block design with two replications with a spacing of 50 cm x 25 cm. The plot consists of 14 genotypes of plants, which each contained 20 plant genotypes. The data obtained were analyzed using ANOVA, followed by calculating the analysis of covariance, correlation value, and path analyzes based on the Singh and Chaudhary's formula (1979). To test the correlation, t-test was used. If the t-count > t-table (db = n-2), then the correlation coefficient declared significant. Interpretation of cross coefficient can be based on Singh Chaudary's three guidelines (1979). Elite lines selected using Boxplot analysis. From the analysis, selected plants are plants that have exceeded the mean value of the comparison is based on the seeds-weight per plant.

RESULTS AND DISCUSSION

Results

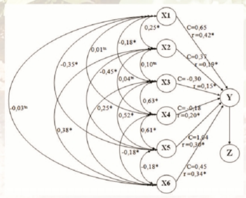


Figure 1. Correlation and Path Analysis. X1 = Flowering Date (days); X2 = Harvesting Date (days); X3 = Plant Height (cm); X4 = Number of Productive Branches; X5 = Pods Number; X6 = 100-Seeds Weight (g); Y = Seed Yield per Plant (g); Z = Residual Factors; C = Direct Effect; r = Correlation.

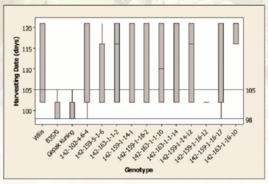


Figure 2. Boxplot analysis for harvesting date per plant. The horizontal line shows the median values for three comparators.

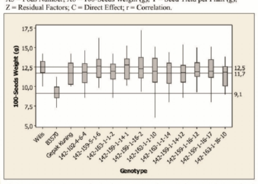


Figure 3. Boxplot analysis for 100-seeds weight per plant. The horizontal line shows the median values for three comparators.

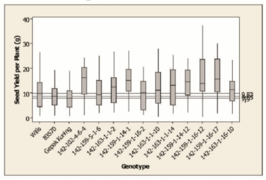


Figure 4. Boxplot analysis for seed yield per plant. The horizontal line shows the median values for three comparators.

Discussion

The characters are correlated with seed yield per plant are: flowering date, harvesting date, number of productive branches, pods number and 100-seed weight (Figure 1). Based on three basic guidelines common in the interpretation of cross coefficients proposed by Singh and Chaudary (1979), then the effective selection based on the harvesting date and 100-seed weight (Figure 1).

According to Adie (2007), harvesting date all genotypes tested including a very deep old or more than 90 days (Figure 2). Based on seed size groupings, then all genotypes tested including medium size which is between 10-14 g / 100 grains (Figure 3.) (Adie and Krisnawati, 2007). Almost all genotypes tested has a weight of seeds per plant that exceeds three peers (Figure 4.) Therefore, based on harvesting date, 100-seed weight and seed weight per plant, the genotype was selected as an elite lines are genotype 142-159-5 -1-6 and 142-159-1-14-1.

CONCLUSION

From these results it can be concluded: (1) the characters are correlated with seed yield per plant are: flowering date, harvesting date, number of productive branches, pods number and 100-seed weight; (2) the selection will be effective by harvesting date and 100-seed weight; and (3) Elite lines genotype selection results are 142-159-5-1-6 and 142-159-1-14-1.

ACKNOWLEDGEMENT

The author gratefully thanks to the Higher Education Grant through the National Strategy for 2014 so that this research can work. Thanks also to the students who have been jointly conducting this research.

REFERENCES

Adie, M.M and A. Krisnawati. 2007. The potential for increasing the quality of soybean seeds. Proceedings. Minutes of the Seminar. 23 November 2008. Agricultural Research Agency. pp.216-230.

Kasno, A. 1992. Nuts Plant Breeding. Pp 39-69. In Proceedings of the Symposium on Plant Breeding I. (Ed. A. Kasno, M. Dahlan, and Hasnam). PPTI. East Java.

Rachmadi, M. 2000. Introduction to vegetative replication Plant Breeding. Padjadjaran University. Bandung. 159 p.

Singh, R.K. and B.D. Chaudhary. Biometrical 1979. Quantitative Methods in Genetic Analysis. Ludhiana-New Delhi. Kalyani Publishers. 302 pages.

Welsh, J.R. 1991. Fundamentals of Genetics and Plant Breeding. Erlangga. Jakarta. 224 p.

ISBN 978-602-0860-10-7

A REVIEW ON FOOD SECURITY IN MALAYSIA: TOWARDS SUSTAINABILITY AND CHALLENGES

KAMZIAHABD KUDUS

Faculty of Forestry, Universiti Putra Malaysia
kamziah@upm.edu.my

ABSTRACT

This paper gives an overview of food security policies and strategies towards its sustainability in Malaysia. The Malaysian National Food Security Policy was formulated in 2008 following the world food crisis.The objectives are to increase output and productivity of agro-food sector to Self-sufficiency Level (SSL), enough food of quality and safe to consume and promote agriculture entrepreneurship.Much attention was given to the paddy and rice programs under the National Food Security Policy. The 10-year National Agro-Food Policy (2011-2020) was formulated to replace the 3rd National Agricultural policy. The main objectives of the National Agro-food Policy are to address food security and safety to ensure availability, affordability andaccessibility;to ensure the competitiveness and sustainability of the agrofood industry; andto increase the income level of agropreneurs. The activities towards sustainability and strategies outlined in the Tenth Malaysia Plan (2011-2015) are also discussed.

Keywords: Food security, Malaysia, policy, challenges, sustainability

INTRODUCTION

Food security is not just the problem for poor countries. Food security issue is getting more attention by world today. What is food security? For the USDA research center, food security for a household means access by all members at all times to enough food for an active, healthy life. Food security includes at a minimum the ready availability of nutritionally adequate and safe foods; and assured ability to acquire acceptable foods in socially acceptable ways (that is without resorting to emergency food supplies, scavenging, stealing or other coping strategies) (Babu et. al. 2014).With the overgrowing population in the world today, food security can become an important issue to deal with not only by international organizations but also governments across the globe. Every country is basically fighting to provide continuous supply of foods to match every demands and this seems to be a big struggle especially in currently develop and poorer nations (Paul 2013).

POLICY

Malaysia today is giving attention to ensure security of food supply in Malaysia. The Malaysian National Food Security Policy was formulated in 2008 following the world food crisis. Prior to the food crisis in 2008, the price of cheap rice for the past 25 years started to rise in 2005 and escalated into a surge in 2007 and 2008. This led to export restriction introduced by main exporting countries: India and Vietnam, followed by China and Cambodia. Philippines, the world's largest importing country were forced to purchase from Thailand at a price of about US$700/ metric tonne (MT), even at the peak of international rice prices (about US$1,000/MT). Soon after that, many countries were alerted and fought to secure enough supplies for domestic consumption and storage(Tey 2010).

Malaysian National Food Security Policy

The policy was formulated in 2008. RM3billion was allocated for the period 2008-2010. The objectives are (i) to increase output and productivity of agro-food sector to Self-sufficiency Level (SSL) (ii) enough food of quality and safe to consume (iii) promote agriculture entrepreneurship.

Paddy and Rice Programs in the National Food Security Policy

The policy objectives in Malaysia's paddy and rice sector can be looked back since the 1st Malayan Plan to the 9th Malaysian Plan and the 1st National Agricultural Plan to 3rd National Agricultural Plan. Food security has been the thrust of the policy for the sector. The objective is to attain a reasonable self-sufficiency level (SSL) in rice which has been used as an index to food security in the country. The paddy and rice programs in the National Food Security Policy includes irrigation, pest control, fertilizers, land leveling, lime application, mechanization, miller subsidy and productivity incentives. In addition, BerasNasional subsidized 15% broken rice. The program alsopromotesresearch and development to increase productivity and to increase stockpile level from 92k to 239k MT.

For 2011, Ministry of Agriculture was allocated RM2.77 billion to help farmers to increase rice production, ensure adequate supply of rice in the market, develop large scale aquaculture zone and to expand livestock breeding-oil palm plantation integration (Tey 2010)

National Agro-Food Policy (2011-2010)

Until year 2010, the development for agriculture and forestry was under the directive of the 3rd National Agricultural policy (1998-2010). The policy focused on enhancing food security, increasing the productivity and competitiveness, deepening linkages with other sectors, venturing into new frontier areas as well as conserving and utilizing natural resources on a sustainable basis (Third National Agricultural Policy 1998-2010)

The 10-year National Agro-Food Policy (2011-2020) was approved by the Malaysian Cabinet on 28 September 2011 to replace the 3rd National Agricultural policy. The main objectives of the National Agro-food Policy are to address food security and safety to ensure availability, affordability andaccessibility;to ensure the competitiveness and sustainability of the agro food industry; and to increase the income level of agropreneurs (Economic Planning Unit 2013).

The main programs implemented to ensure the food security and safety of the country includes:

- Increasing food production through optimization and sustainable land use including integrated farming, intensive farming and mini estate paddy farming in granary areas;
- Maintaining rice stockpile at 292,000 MT to sustain consumption for 45 days;
- Upgrading agriculture infrastructure to increase food productivity especially in the concentrated area for food production such as the Permanent Food Production Park (TKPM), Aquaculture Industrial Zone (ZIA) and Targeted Area Concentration for Livestock (TAC);
- Securing long-term contract agreements to import rice with matching agreements to export palm oil or oil; and
- Increasing the quality and safety of food by expanding the compliance to good agriculture practice (GAP), good manufacturing practice (GMP), Hazard Analysis Critical Control Point (HACCP), Sanitary and Phytosanitary (SPS), halal accreditation to more farms as well as increasing the quality of food packaging, labeling and branding.

TOWARDS SUSTAINABILITY AND STRATEGIES: TENTH MALAYSIA PLAN, 2011-2015 (Economic Planning Unit 2015).

Agro-food Value Added.

The agriculture sector recorded an average growth of 2.4% in the plan period. The agro-food subsector is estimated to contribute 38.8% to total agriculture value added. Among the industries that recorded the strongest average annual growth rate were vegetables at 9.7%, fruits at 9%, and livestock at 8.1%.

Food Trade Balance

.The export of food increased at an average annual growth rate of 9% from RM20.5 billion in 2011 to RM25.6 billion in 2014. However, food imports also grew at an average rate of 9% per annum from RM34.5 billion to RM42.6 billion. Food trade balance showed an increasing deficit at an average rate of 8.9% from 2011-2014. The main contributors to the deficit were animals feed at 34.4%, followed by sugars, sugar preparation and honey at 17.1%, meat and meat preparation at 14.7% and vegetables at 13.8%.

Employment and Productivity PerWorker.

Total employment in agriculture registered an upward trend with an average annual growth rate of 0.1%. The average annual growth of productivity per worker in the agro-food was at RM57,539 in 2014, an increase of 2.7% from RM51,672 in 2010. The increase in productivity was attributed to continuous skills training, better planting materials, adoption of modern technologies and improved farming techniques.

Income of Farmers.

In the food crop activities, income ranged from RM1,200 to RM2,700 per month in 2013. The differences in income were mainly attributed to planting intensity and availability of drainage and irrigation infrastructure which affected level of productivity.

Agricultural Land Use.

Total agricultural land is expected to increase by 1.9% in the Tenth Plan period. This is largely due to the expansion of oil palm and rubber plantations. Land use for agro-food activities is at 781,845 hectares in 2014 which comprises 10.7% of the total agricultural land.

Self-Sufficiency Level.

The SSL of the majority of agro-food commodities recorded positive increments supported by programs to increase food production under the food security initiatives in the Tenth Plan period. The increase in SSL was mainly contributed by increased productivity with the use of quality seeds, breeds and fries, wider adoption of technologies among farmers, establishment of new large-scale food production areas, improved extension services and better agronomic practices.

Investments and Financing.

Approved investments in agro-food for the period 2011-2014 recorded a total of 242 projects worth RM1.7 billion. The overall agriculture and agro-based financing from Agrobank, established to support the development of the agriculture sector, accounted for 10.1% as at end December 2014.

CHALLENGES (Economic Planning Unit 2015).

Low Productivity

- Increasing demands for food as well as scarcity of suitable agricultural land and resources underpin the need for higher productivity.
- **Supply of Quality Seeds, Breeds and Fries:**Inadequate local supply, use of uncertified seeds, high cost and dependency on imported quality seeds, breeds and fries have hampered the growth of the agro-food subsector.
- **Compliance to Standards.** The lack of awareness among farmers and buyers and low premium prices have led to the low rate of compliance to the Malaysian Good Agricultural Practices (MyGAP), which emphasises good agronomic and sustainable practices.
- **Use of Technologies.** The rate of adoption of new technologies is not prevalent except in the poultry industry. Among the main contributing factors include accessibility and adoption of cost effective farming technologies due to farm size, location and geographical constraints; dependency on foreign labor and lack of dedicated funds for farmers to adaptand upscale on developed technologies.
- **Agricultural Infrastructure**. Inadequate, dilapidated and poorly maintained agricultural infrastructure had affected production efficiency.

- **Biosecurity Measures**. Outbreak of diseases due to a lack of biosecurity measures, including poor pest and disease management as well as absence of early detection and warning systems. In the fruit industry, the papaya dieback disease has led to a significant drop in production from 45,990 metric tonnes in 2008 to 35,630 metric tonnes in 2012. The Early Mortality Syndrome among white shrimps in the aquaculture industry, caused by uncertified fries brought in illegally by unregistered farms, has affected shrimp production.

High Post-Harvest Loss

High post-harvest loss is prevalent in the paddy, fruits and vegetables industries. In 2013, the average post-harvest loss in agro-food was at 30%due to lack of good agricultural practices, inefficient harvesting machineries and technologies, poor storage facilities and logistics as well as lack of knowledge on post-harvest handling. Post-harvest loss has affected production, quality of produce, income of farmers and optimal use of resources.

Non-optimal Land Use

Limited arable land for food production has been one of the major constraining factors in achieving targets of food security initiatives. Despite this, it is estimated that a total of 120,000 hectares of agricultural landremains undeveloped. Challenges faced in utilizing idle land include difficulty in identifying land owners as well as scattered and uneconomic land size holdings.

Unorganized Marketing and Dependence on Middlemen

Marketing of agro-food has been a persistent issue among small farmers who are mainly unorganized and lack knowledge on market driven practices as compared to commercial farmers. As a consequence, small farmers mainly rely on middlemen in the marketing of their produce. On the average, fruit and vegetable farmers in Malaysia received between 41% and 45% of the retail price as compared to 65% in South Korea.

Ineffective Institutional Support

Lack of comprehensive institutional support by agricultural cooperatives and extension agencies in providing agricultural related services has affected the productivity and agility of the industry to respond to current market requirements.

Uncompetitive Workforce

Agricultural workforce comprised 1.6 million workers or 11.6% of the total workforce in 2014. Currently, 98.3% of the workforce comprises semi-skilled and unskilled workers due to lack of demand for qualified and trained workers as a result of the low level of mechanization and adoption of technology, small scale ventures and easy access to cheap foreign labor. In addition, lack of awareness and negative perception on the opportunities in agriculture, unconducive working environment, limited career advancement opportunities as well as low wages have caused locals, particularly the youth, to shun away from the sector. This further aggravates the issue of aging farmers in the sector. In 2013, 29.3% of the agricultural workforce was above 50 years old as compared to 27.3% in 2005.

Ineffective Knowledge Transfer and Lack of Priority Research

R&D in agriculture, which is largely undertaken by public agencies and universities, have low take up rates due to lack of market demand and insufficient promotion. Focus on priority research areas, particularly on pests and diseases, quality seeds, breeds and fries as well as animal feed, are needed to address disease outbreaks and high dependency on imported seeds and feeds.

Unfavourable Terms of Financing

Financial support for agricultural ventures is crucial, as they require high initial investments. Financial institutions offer limited products and unfavourable terms for agribusinesses.

Ineffective Broad-based and Input Driven Assistance

Currently, most agricultural assistance provided is broad-based and input driven. Subsidies for paddy cultivation including certified paddy seeds, fertilizers, herbicides and pesticides are provided annually based on hectarage, which amounted to RM2.2 billion in 2014. This form of assistance is ineffective as the same amount of inputs is provided irrespective of soil conditions, pests and diseases.

WAY FORWARD: ELEVENTH MALAYSIA PLAN, 2016-2020
(Economic Planning Unit 2015).

The agro-food subsector is expected to grow at 5.4% per annum with livestock, aquaculture and vegetable as the main contributors, while demand for food is expected to reach 14.8 million metric tonnes in 2020.During the Plan period, the agro-food subsector will be transformed into a high income and sustainable industry through innovative R&D and modernization initiatives. Emphasis will be given in ensuring food security and safety, increasing income of farmers and boosting productivity, particularly food commodities with low SSL. The targeted industries in the Plan period are paddy and rice, fruits and vegetables, ruminant and fisheries.

Macro Strategies

The macro strategies identified across the agro-food subsector will address common issues that hinder development and improvement in the productivity of the industry. In addition, these strategies will focus on improving the income of farmers, fishermen and livestock rearers, particularly the bottom 40% of the income group and drive modernization in the agro-food subsector. These strategies are as follows:

- Improving productivity and income of farmers, fishermen and rearers
- Building capacity of agricultural cooperatives and associations along the supply chain
- Promoting training and youth agropreneur development
- Strengthening institutional support and extension services
- Improving market access and logistics support
- Scaling up access to agricultural financing.

In achieving these objectives and strategies, it is imperative that effective planning, coordination and implementation of agricultural programs are carried out by all stakeholders.

REFERENCE

Babu, S.C., Gajanan, S.N. and Sanyal, P. 2014.*Food Security, Poverty and Nutrition Policy Analysis.Statistical Methods and Applications.*Second Edition. Elsevier, New York.

Economic Planning Unit (2013).www.epu.gov.my.

Economic Planning Unit.2015.Driving Modernization in Agro-food. www.rmk11.epu.gov.my.

Paul, B. 2013.Food Security in Malaysia.Challenges and Opportunities for Malaysia of Present and in 2050 for Maintaining Foods Security.University of Alberta.

ISBN 978-602-0860-10-7

Tey, Y.S. 2010. Review Article Malaysia's strategic food security approach. International Food Research Journal 17:501-507.

Third National Agricultural Policy 1998-2010.http://pmr.penerangan.gov.my/index.php/maklumat-kenegaraan/260-third-national-agricultural-policy-1998-2010-.html.

SAVING IRRIGATION WATER AND ENERGY WITH LASER LEVELING EQUIPMENT TO MITIGATE EFFECTS OF CLIMATE CHANGE AND TO ENSURE FOOD SECURITY [#]

PHAN HIEU HIEN, TRAN VAN KHANH, NGUYEN DUC CANH AND NGUYEN THANH NGHI [# V#]

Faculty of Engineering and Technology, *Center for Agricultural Energy and Machinery*
NÔNG-LÂM UNIVERSITY, Ho Chi Minh City, Vietnam
phhien1948@yahoo.com

ABSTRACT

Climate changes severely affect water shortage. To save irrigation water, laser-controlled field leveling technology has been applied in Vietnam from 2004 with the collaboration between the International Rice Research Institute and the Center for Agricultural Energy and Machinery, Nong Lam University, as a technology of precision agriculture to mitigate effects of climate change. It has been promoted in several provinces in Vietnam totaling more than 2000 hectares to demonstrate the benefits of laser field leveling. Results: irrigation water was saved 30 - 50% in leveled fields compared to unleveled fields, corresponding to saving 62% of energy from water pumping for irrigation. Other benefits of laser leveling included: seed saving (30%), fertilizer saving, labor saving for weeding control (70%), reduction of pesticide use. Total profit increase in yield and input saving was around US $260 per hectare per cropping season. Water saving leads to conserve natural soil and water resources and less use of fossil fuels which release greenhouse gases. Less use of water and energy through laser leveling shall mitigate the effects of climate change. The yield increase by 12% contributes to ensuring food security. Based on experimental data, the projection of laser leveling of 1 000 000 hectares of rice field in the Mekong Delta of Vietnam shall result in reducing the greenhouse gas emission by five million tons CO_2 in 10-year period, and the water saving is enough to compensate for 250 000 hectares if these areas are affected by the salinity which resulted from the climate change.

Keywords: Laser leveling, water saving, energy saving, climate change mitigation

INTRODUCTION

Vietnam is an agricultural country with 90.7 millions (M) inhabitants in 2014 of which 63 M are in rural households. Rice is the most important crop, cultivated on 80 % of the total farm area, and accounts for 85% of the country's food grain output. In 2014, Vietnam produced 44.8 M ton of paddy on 4.1 M ha of rice land, corresponding to 7.8 M ha of rice planting area. This total production is almost 6 times that of 1976, and 2.3 times that of 1990. The export of rice of 1.5 Mt in 1989 increased to 6- 7 Mt in the last 5 years. Vietnam is the world's second largest rice exporter in the past 10 years.

The Mekong Delta in Southern Vietnam (Fig.1), with 2.7 M ha of rice land, is producing 52% of Viet Nam total rice output. With only 20 % of the total population, this region has accounted for about 95% of Vietnamese rice export in the past decade. Average farm size is about 1 ha per household, the plot size is comparatively large, about 4000 m^2. In contrast, other agricultural regions in Northern and Central parts of Vietnam, farms are mostly 0.2- 0.5 ha, but divided into 4- 15 tiny plots of about 500 m^2 each; these regions produce only 48% of the total rice for 80% of the population.

Climate changes severely affect water shortage for agriculture in the Mekong Delta; each crop of rice cultivation use 22 000 m^3 of water per hectare and take 86% of the total water, only 14% is for industrial and domestic uses. Climate changes affect the Mekong Delta with the intrusion of saline water, which reduces the available water for irrigation, hence decreasing the cultivated area. This happened first in Bac-Lieu Province in 2009, and is most severe in 2016 with tens of thousands hectares affected by salinity in several provinces. The shortage of water by a prolonged dry season, and the contrast of heavy flood in the rainy season causing soil erosion, are traced to the effects of climate changes, and affect agricultural productivity.

To mitigate these effects, measures to increase the effectiveness of irrigation water are needed, which include: 1/ Planning of land use for each specific crop, and 2/ ***Saving of water***: Among several related recommendations, a basic measure is ***land reforming with laser-controlled field leveling*** (laser leveling **LLL**, for short), which not only saves water, but also save seeds, fertilizers, pesticides etc., or saving energy in general to mitigate the effects of climate changes.

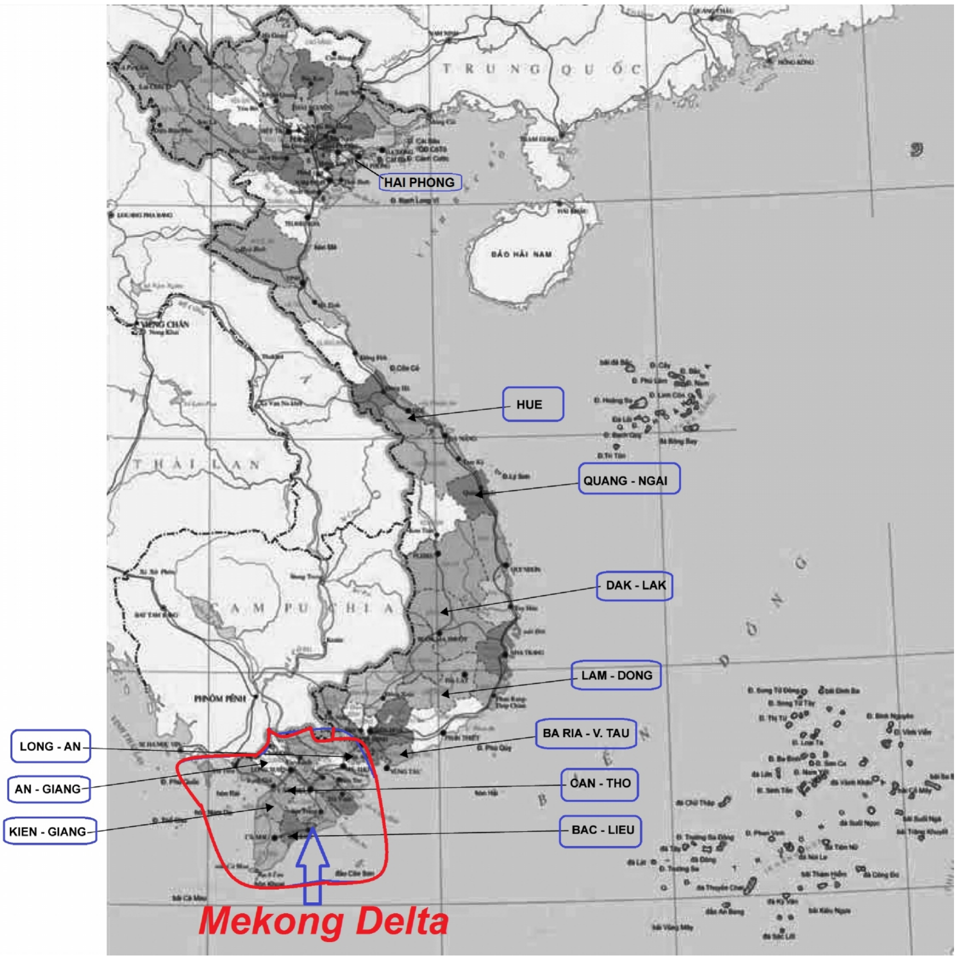


Figure 1. Map of Vietnam, with the Mekong Delta in the South, and the Provinces (boxed) where laser leveling has been operated.

This paper briefly describes the LLL utilization in Vietnam in 2004- 2015, the lessons learned, and suggests the future development direction for LLL in order to increase the rice productivity and economic return, while protecting the environment, reducing the *greenhouse gas emission*, as Vietnam has promised in the recent COP21 Paris Conference.

PRINCIPLE AND OPERATION OF LLL

The primary ***objective*** of laser leveling is to create a leveled field at a desired size (in most cases, merging several smaller fields) for ease of water management in crop cultivation, and for better mechanization.

Laser was a discovery of physics in late 1960's. The construction and operation principle of LLL are shown in Figures 2 and 3.

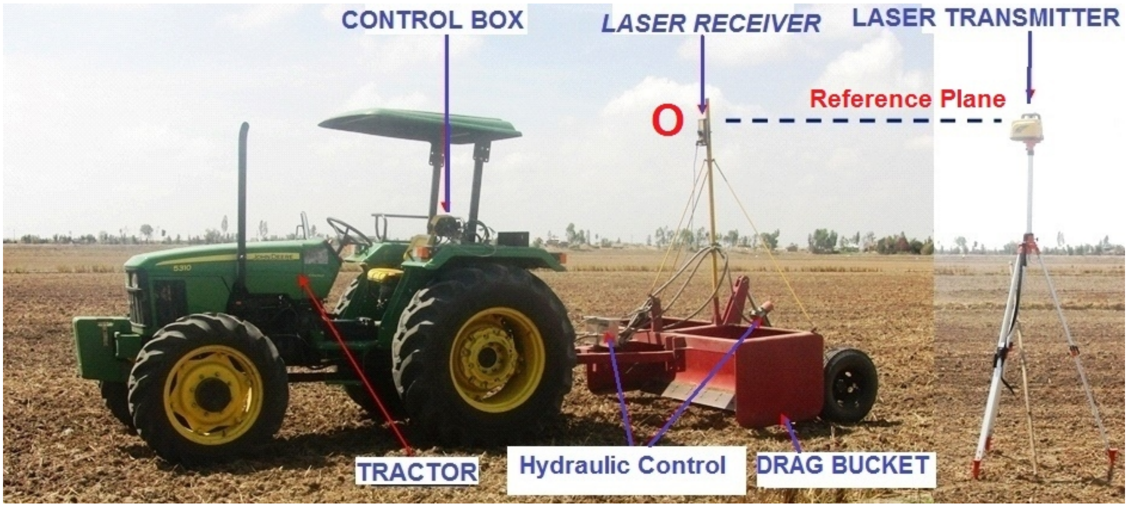
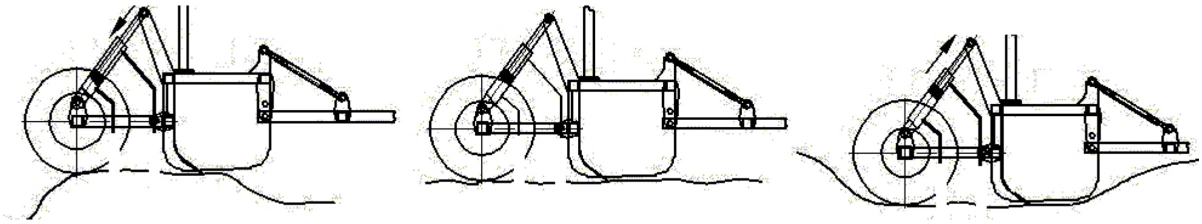


Figure 2. Laser-controlled equipment and the John Deere 5310 tractor (55 HP).

The laser rays are released by the laser *transmitter* in a horizontal plane, thus determines the altitude of the reference plane. The laser *receiver* mounted on the *bucket*, receives the rays and determines the altitude of the bucket blade relative to the reference plane, and relays the signals to the *control box* which processes the signals and actuates the *hydraulic cylinder* to lift or lower the bucket, so that the point **0** on the laser receiver is always on the reference plane, thus keeps the blade on a fixed horizontal plane too.



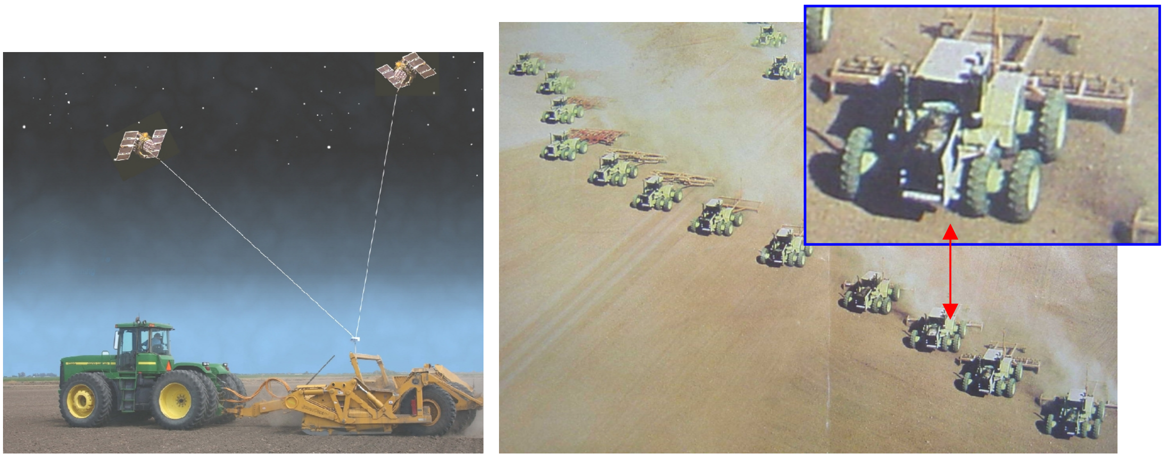
(a) (b) (c)

Figure 3. Three positions for the drag bucket: (a) Lowering and dragging soil at high spots; (b) Neutral at pre-set reference surface; (c) Lifting and releasing soil at low spots

Note that LLL is ***not*** *land preparation*, ***not*** *tillage* which is usually done *every* crop season. Rather, LLL is ***land reforming*** and ***improvement of the infrastructure*** which in theory is done once for ever. In practice, the field should be re-leveled after 4-5 years, which is called "re-wiped" by some farmers in Vietnam, meaning a minor maintenance. The misunderstanding comes from traditional leveling in which partial leveling is done every season while the field is still locally uneven.

APPLICATION OF LASER LEVELING IN THE WORLD

Leveling of crop lands by LLL is a widely used technology in developed agriculture such as the United States, Japan, Australia, etc., (Figures 4 and 5). The rice yield of 9 ton/ha in California is on the fields with 99% laser-leveled.India and China have applied LLL recently. In particular, India has promoted LLL very fast: in 2004 the first laser unit was applied; in 2011 about 7000 farmers owning 10 000 units, and they have plan to level one million hectares (Ferrer 2011).



(a) (b)

Figure 4. (a) Laser levelers in the United States, and (b) Australia (Source: John Deere Co.)

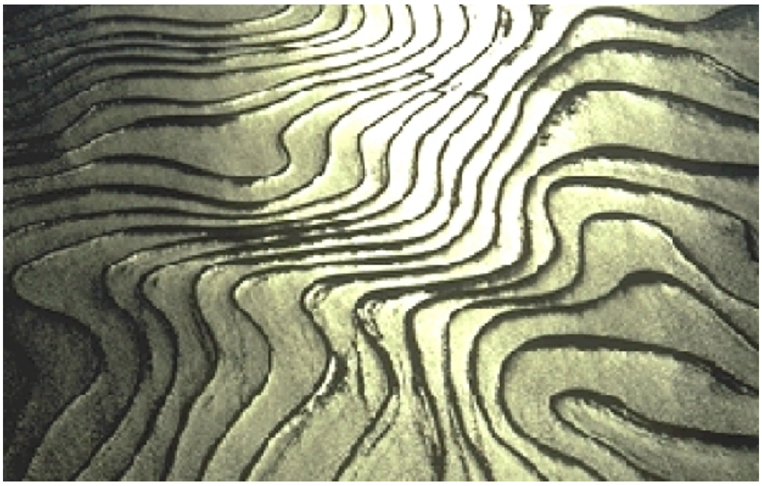


Figure 5. Laser-leveled rice fields in California, with a yield of 9 ton/ha

Experiments at Uttar Pradesh of India in 2005-2007 with the rice-wheat rotation resulted in yield increase by 7%, irrigated water decrease by 10- 14%, and increase of farmers' profit by US $145 per hectare annually (Jat et al 2009).

Pakistan acquired the first laser set in 2005, quickly reached 2000 sets in 2009 and 10 000 sets in 2014 (Sharma 2014 cited OFWM Punjab Pakistan); there one million hectares have been laser-leveled, out of the total of 17 million ha for 5 main crops (rice, wheat, corn, cotton, and sugarcane). Similar to India, the Pakistani Government subsidized 50% of the equipment purchase (the price of one laser set is about US$10 000).

APPLICATION OF LASER LEVELING IN VIETNAM

Timelines

Results of LLL application in Vietnam have been reported elsewhere (Phan H.Hien et al 2007, Phan H.Hien 2012, IRRI 2012, Mendoza 2013, Phan H.Hien et al 2015), and summarized as follow:\

In ***2004***, LLL technology was transferred from International Rice Research Institute (IRRI) to the Center for Agricultural Energy and Machinery (CAEM), a research unit under the Nong-Lam University - Ho Chi Minh City (**NLU**), Vietnam.

In ***2005***, experiments on LLL were done on 12 ha of the Bac-Lieu Seed Center, and in ***2006***, on 4 ha at An Giang Province, also on 30 ha in Lam-Dong Province in the Highlands (Fig.1) where 350 small plots of 500- 1000 m^2 were merged into 30 plots of 5000-10000 m^2 each.

From then, with the continued support of IRRI, laser leveling has been promoted widely. In ***2009***, two training workshops were conducted for key extension staff of 40 Provinces, each workshop with demo operation of LLL on 3 hectares. More than 10 local TV stations documented and broadcasted on LLL technology. Published materials (leaflets and book chapters) on LLL are available for extension workers.

In ***2010***, the Vietnamese Ministry of Agriculture &Rural Development (MARD) has officially recognized that laser leveling is a technological advance, that is, to be encouraged for promotion throughout the country.

In ***2013***, a National Seminar on LLL was organized in Long-An Province (of Mekong Delta) for 70 participants, who are Directors of MARD’s various Departments, and of the Ministry of Science and Technology, of the Provincial Departments of Agriculture, and Extension Centers.

In ***2014***, LLL is in the list of equipment eligible for support with investment and loan privileges from various banks.

Latest activities up to ***2015*** have been LLL transfer to farmers in the Provinces of An-Giang, Long-An, Ba Ria-VungTau, Hai Phong with the government support ranging from 30 to 100% of the equipment price.

LLL has been developed along the successful mechanization models in the Mekong Delta, namely through the contractors' system, wherein the poor farmers hired the service from richer contractors. To date, 22 LLL sets are used for contracting (08 by private farmers and 14 by state agencies). Trimble, a leading US laser leveling equipment manufacturer, selected a dealer [1] for Vietnam, Laos, and Cambodia. Research institutes and universities are only for technical support. It is foreseen that with more extensive contractors' service, other world-leading LLL manufacturers such as Leica, Komatsu etc would enter the local market.

To date in Vietnam, more than 2000 hectares have been laser-leveled, half of which has been in Long-An (Fig.1), with 6 laser sets by the Provincial Departments of Science, and of Agriculture in the "*Large Fields*" campaign (Fig.6), and one set by a private farmer who leveled 70 ha in 2015.

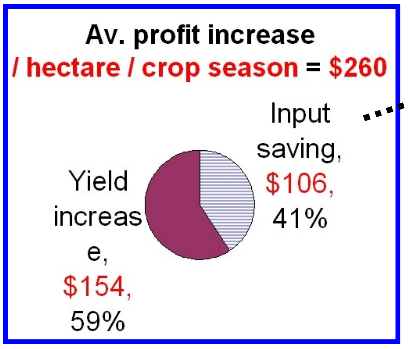
Figure 6. Four tractors with laser leveling equipment in a demo at Long-An, April 2012

The *Agricultural Competitiveness Program* from a World Bank loan has equipped 20 laser sets for cooperatives in 7 Provinces in the Mekong Delta; these units in 2015 have leveled about 200 hectares.

[1] Ideal Farming Corporation. Email: ngoc.nguyen@idealfarm.com.vn.
Tel: +84 907420006. Websites: **www.idealfarm.com.vn**

Technical and economic performance of laser leveling

Agronomic experiments were conducted 4 Provinces in the ***Mekong Delta***, and farmers' production in leveled fields were monitored. Typical benefits are summarized in Fig.7, which resulted from a survey in 2011 together with an IRRI Communication Specialist. Sixteen farmers were interviewed, who cultivated 5- 10 crop seasons after laser leveling; their land holding were in the range of 1- 150 ha (mostly 1.5- 4 ha). Farmers got a profit increase of US $260 per hectare per crop season, consisting of yield increase (averaged 0.62 ton/ha, range 0.38 - 1.0 ton/ha), and of reductions of input costs (water, fertilizer, herbicides etc).

(a)


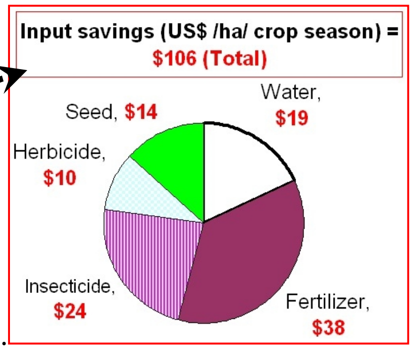
(b).


Figure 7. Economics of laser leveling
(from interviews of 16 farmer households in Bac-Lieu and An-Giang)

Details are as follow:

- Increase of rice yield by about 0.6 ton per hectare, which apparently contributes to ensuring food security.
- Saving of water, most visible to everyone; a field of 100 mm surface differential would require 100 mm of more water, that is more than twice the actual water need. Although the monetary value of water saving was only 18% (Fig 7b), it was the starting point for other savings.

Note that the *alternate wet-and-dry irrigation* (AWD) is recently recommended and contributes to saving water; each cubic meter of irrigation water yielded more kg of paddy, compared to normal flooded irrigation. This practice is best done on leveled fields to ensure uniform water level; thus LLL is a best companion of AWD.

- Saving of post-emergence herbicides on leveled field, only one pre-emergence herbicide application is needed as in unleveled fields; and about 70 % decrease of labor for weeding. More importantly, the decrease in using herbicides contributes greatly to environmental protection.

ISBN 978-602-0860-10-7

- Saving of sown seed, and saving of labor for re-planting missed seedlings at low spots.
- Saving of fertilizers, due to more uniform distribution on a leveled field.
- Reduction of pests, including less golden snails due to less levee areas for their shelter.
- More resistance to lodging (i.e. more upright plants); *this reduces post-harvest losses* when combine-harvesters are to be used. Harvesting of lodged rice crop, although feasible nowadays with current combine-harvesters (Fig.8), at the expenses of increasing the shattering loss to 6- 10%, compared to only 1- 2% for standing crop. A leveled grounds thanks to laser technology, with easier water control, helped in establishing standing crop, thus helped decreasing the post-harvest losses. Data from different combine-harvester contest as well from 50 ha of farmers' fields in An-Giang confirmed this reduction.

The loss reduction between the unleveled field with lodged plants and leveled field with standing crop, say 5% between 7% and 2%, is significant. For 1 million tons of harvested paddy, this corresponds to 50 000 tons worth of 12 million US$. At the household scale, assume a farmer with 8-ton harvest, but one-fourth is lodged, then 5% of 2 ton or 100 kg of loss is equivalent to about US $25.

Figure 8. Harvesting of lodged crop

For small-size rice farms in the ***Northern and Central Vietnam***, another benefit of laser leveling has been confirmed. Examples from two farms at Lam-Dong and Dak-Lak Provinces in pooling of tiny plots of 0.05- 0.1 ha into 0.5- 1 ha plots enabled the use of tractor-mounted seeders or combine-harvesters. The increase of total production is 5- 8% with the same agronomic practices, simply by removing unnecessary levees. For a rice area producing one million tons per year (similar to the Red River Delta of Vietnam) this means an annual production increase of up to 80 000 tons, quite sizable.

Figure 9: Destruction of levees for larger field size will increase the total production by 5- 8%

For ***economic calculations***, the laser leveling cost farmer-land owner pays to the service contractor in 2006 and 2016 is US $150- 350 per hectare, given that oil prices are similar in these two years; while the cost in 2013 was US $250- 600 due to higher oil price. About 90% of the cost are depreciation and fuel, or 45% for each component.

Versus a near maximum laser leveling cost of US 50/ha/crop (contracted fee of US $500 spreading over 10 crop seasons), the farmer who contracted in laser leveling can get a pay-back in one year or two crop seasons

Economic comparison can be made between LLL and traditional leveling. For a field surface differential of 20 cm, traditional leveling starts with *dry* leveling using big tractors of 50 HP or more and a drag board (Nguyen V. Khai 2013), but all depends on the driver's judgment; the cost is about US $130/hectare. Next, *wet* leveling is done with walking tractor or small 4-wheel tractor as the final tillage operation, and costs US $25/hectaret, for every crop season. This field can be comparatively leveled after 2 or 3 years of planting. Thus these costs for two years or 4 crop seasons are US $130 +25 + 25 + 25 + 25 = US $230, which is not cheap compared to LLL, and the benefits of a leveled field are not reaped right in the first year as in the case of LLL.

LASER LEVELING FOR SAVING WATER AND ENERGY, AND FOR ENVIRONMENTAL PROTECTION

Saving water and energy

Saving water is important for fighting against climate changes in the Mekong Delta with sea water intrusion and decrease of irrigation water.

Figure 10 illustrates how water is saved with a leveled surface. To suppress weed growth, the water level should be about 5 cm above the ground surface. To fulfill that condition with an original surface differential of 10 cm, the volume of water should be twice the volume required for a leveled surface. This was confirmed in practice through the reduction of pumping costs or through the fuel consumption for pumping, as reported by different collaborative experiments in An Giang and Bac Lieu.

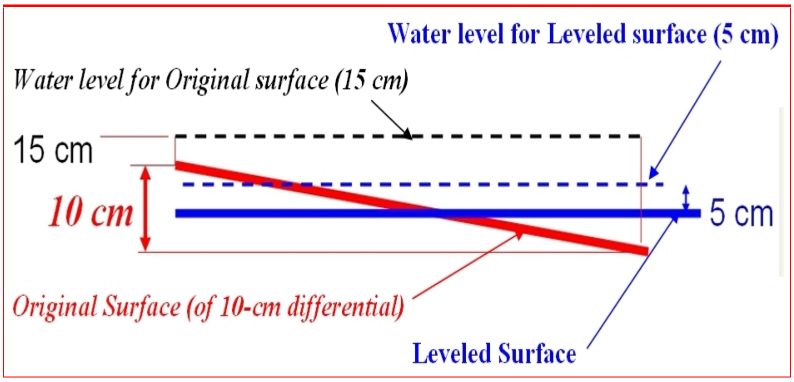


Figure 10. Schematic of how water is saved by 50% on leveled field

Mr. Nguyen Loi Duc of An Giang Province recorded the diesel for pumping on the 70 hectares of rice he cultivated, and came up with the following data: For the whole crop duration, he pumped 7 times. Before, with unleveled fields, he had used 4.0 liter/ha for each pumping. After leveling, he only used 1.5 liter/ha, or a saving of 63% on diesel cost. For 7 times of pumping, the difference was 7 * (4.0 – 1.5) = 28 – 10.5 = ***17.5** liter per hectare*.

The **direct energy saving** from fossil fuel as above can be converted in energy units, J or MJ. Each liter of diesel oil contains a heating value of 38.7 MJ; but for that liter to be at the processed state and available at the field site, some energy should be added to account for processing and transportation, the average value of which is 9.1 MJ (Kitani 1999). Thus one liter of diesel takes the value of 47.8 MJ (= 38.7 + 9.1). In the above case at An Giang, per hectare, the difference was between (28 * 47.8) MJ and (10.5 * 47.8) MJ or between 1338 MJ for unleveled field and *502 MJ for leveled field*. The energy saving was 836 MJ/ha due to laser leveling for a crop season.

The water requirement under flooded conditions, including direct evaporation, transpiration, percolation and transport losses is 10 mm or 100 m^3/ha-day, or 10 000 m^3/ha per crop season of 100 days (Chancellor 2002). For the pumping head of 1.0 m to 2.5 m (typical of the Mekong Delta of Vietnam), for a typical pumping efficiency of 50%, the energy needed is *200 to 500 MJ/ha*. Thus it seems that with the above data on a leveled field, the minimum energy for water requirement has been reached thanks to laser leveling.

The **indirect energy saving** can be calculated from other benefits resulted from laser leveling. For example in the above case of Mr. Duc, the saving per hectare thanks to leveled field is listed in Table 1:

Table 1. Saving of agricultural inputs per hectare

✓	80 kg of paddy seed (from 200 kg down to 120 kg).
✓	50 kg of all chemical fertilizers.
✓	04 liters of post-emergence herbicides, which was not used on leveled field, (only 2 liters of pre-emergence was needed as in other non-leveled fields)

Based on the unit price of these inputs (the currency VN \$ = Vietnam Dong), the total cash saving is VN \$1 990 000 or about US \$100. The value of the equivalent energy may be estimated by two ways. One is based on the monetary values of the inputs, comparing to the price of one liter of diesel oil, which was VN \$16 000 in 2008 and equivalent to 47.8 MJ. Thus the conversion of the above saving (VN \$1 990 000) is equivalent to 5 940 MJ, and is the energy of *124 liters* of diesel oil.

The other way to cross-check refers to published values (Kitani 1999): The unit energy value of paddy seed, urea fertilizer, and paraquat herbicide are 25, 78, and 450 MJ/kg respectively. Multiplied by the quantity in Table 1, the result is 7 700 MJ, or equivalent to the energy of *161 liters* of diesel oil.

Both ways of estimates gave discrepancies, of course as estimates. The implication is that, while the direct saving in pumping is 17.5 L/ha, *the indirect saving of other inputs* (whether equivalent to 124 or 161 L/ha) is *more impressive in magnitude*, which is at least 5 times compared to the direct energy.

Let's take 120 liter per hectare (or about 0.1 ton diesel per hectare), a low number of energy saving for both direct and indirect inputs, and assume about <u>*one half*</u> of the rice land of the Mekong Delta were laser-leveled (equivalent to planting 800 000 hectare per season), then the potential saving is 80 000 tons of diesel oil, worth about 64 million US\$ per crop or 128 million US\$ per year (assumed only 2 crops per year).

Envrironment protection

Saving water to compensate for the areas affected by saline water is significant. If 1 liter of diesel oil can provide 150 m^3 water, then the above fuel saving (17.5 liter/ha) corresponds to 2600 m^3 irrigation water, or about 25% of the water requirement for rice growth. In another word, laser leveling for 1 million hectares of rice land would provide enough water for 250 000 ha if these areas are affected by the intrusion of saline water.

Saving energy means *less greenhouse gases* (GHG) in order to protect the environment. In the recent Paris COP21's Conference, Vietnam promised to achieve *8% reduction of GHG*, in 2030 and if with further foreign supports, the reduction would be 25%. The 2030 GHG emission depends on different scenarios; for visualization we use 143 million tons CO_2 equivalent, which was the emission of Vietnam in 2012 (UNFCCC 2015), then 8% reduction is equal to ***12 million ton CO_2***. Measures to be adopted do not yet include laser leveling.

This 8% reduction can be partly fulfilled with LLL. A paper (P.H.Hien et.al 2015) used basic data on fossil fuel energy (MJ) needed to produce a unit (kg, liter) of different agricultural inputs (fertilizer, pesticide, machine etc.). Multiplied with the estimated saving of water, fertilizer, pesticide etc (which had been obtained from surveys in the Mekong Delta), and the total MJ is calculated back to the quantity of fossil fuel (kg) to produce these inputs. Hence the quantity and CO_2 reduction due to saving of the fossil fuel. Details are in Appendix 1.

Results: If LLL is done on 1 million hectares (out of the total of 4 million ha), then the reduction is *0.5 million ton CO_2* equivalent per year. For a Project with 4 years of preparation starting in 2016, then in 10 years 2020-2030, LLL would help reducing about ***5 million ton of CO_2***, a significant quantity compared to the promises that the Vietnamese Government aims up to 2030. This also serves as a rationale for seeking foreign support, in order to reduce 25% of the GHG.

LESSONS LEARNED FROM LASER LEVELING IN VIETNAM AND PROBLEMS AHEAD

In spite of proving benefits of LLL, the promotion of this technology is slow with only a total of 2000 ha have been leveled, quite negligible compared to the fast progress of India and Pakistan, which had the same starting point in 2004. Reasons follow:

- High investment, US $10 000 for the laser set, not including the tractor. But this is not the main factor, because combine-harvesters costing US $25 000 each are purchased by thousands of farmers in the past 8 years.

- The annual working time is short. LLL needs to work on dry soils in order to get the precision ±1.5 cm (15 mm); while on wet muddy soils the tractor tyres sink to 7- 12 cm. In the Mekong Delta with 2 or 3 crop seasons per year, the "iddle" time for the land (meaning time for operating LLL) usually is less than 2 months. Thus the equipment investors would reckon on the pay-back period. The case is different with the combine-harvester, the annual working time is at least 3 months, or more.

- Without awareness on LLL benefits, farmers are reluctant to hire the contracting service or do not know where to hire; while contractor are reluctant to invest in the equipment for fear of lacking customers. This is a <u>vicious circle</u> to be broken down.

- The problem of very small-sized fields (in Central and Northern Vietnam) is not technical, as NLU has good experience in leveling and enlarging the fiels of 40 ha in three Provinces of these regions. Problem is land consolidation by pooling scattered plots into larger plots for the same owner. The farmer-owner usually think that these scattered fields are more fertile with his/her life-long care. How to re-allocate the harvest quantity from the pooled plot compared to previous scattered plots?

- Delay in the support policy. The fast development of the combine-harvester in 2007-2010 has been with the Government focus support of 30% of the equipment purchase or waive of interest for three years. In contrast, similar support with LLL equipment only started in early 2014, just as a "normal" equipment among 40 other items.

- Awareness of the problem. The above 2000 ha of LLL demonstration are tiny bright spots among the immense 4 million ha of the country, or just 0.05%. <u>*All*</u> farmers and agencies who <u>*actually*</u> applied the LLL are happy with its benefits. But the majority who have not applied this technology are still indifferent, skeptical, or even refuting upon pure reasoning.

The ***proposed solutions*** for the above constraints are as follow:

a) Government's support in terms of loans and interest rate etc., as applied with combine-harvesters. The aim is to establish a contractor-service system. If it is not possible to support for 50% of equipment purchase price, as in India or Pakistan, then a minimum level of 30% is required to show the importance of the technology.

b) More extension activities such as demonstration, training, trial fields etc., with a partial contribution of the farmer-benefitiary, besides the Government's budget.

When the above vicious circle between users and contractors are cut off, the operating time for the equipment may increase, due to moving and working at different places with different growing dates. The trend is similar to what happened with the combine-harvester; it was estimated in 2009 that 20000 combine units are needed for the Mekong Delta; actually in 2014 the market is almost saturated with 10000 units due to competition among contractors moving around.

c) The demo fields are in parallel with appled research comparing LLL with traditional method withoutLLL. These culmulative facts would "spill out" and contributing to more awareness for more adoption of the technology.

d) The problem of land consolidation by pooling scattered plots can be solved with current modern GIS technology to ensure that no farmer loses a single square meter. A careful multi-step path would eventually meet farmers' need to get higher productivity on new larger fields.

e) The awareness of all, from high-level staff to village extension workers and direct farmers, on the importance of LLL in the future Vietnamese agriculture cannot be over-emphazised. The managers may visit succesful appication sites in the USA, Autralia, India etc. Farmers need to visit succesful demo sites in Vietnam.

It should be also aware of the *short opportunity* that oil prices drop to a low record of under US $50/barrel. LLL needs much diesel fuel (of about 45% of the total cost), so actions are needed as early as possible to grasp this opportunity. The land reforming would be much higher in the future as fossil fuels cannot keep as cheap as today.

Climate changes shown through the intrusion of saline water is inflicting heavy damage to the agriculture of the Mekong Delta. Saving water is not merely reducing pumping cost, but saving of a natural resource which is no longer infinite as before. The construction of hydro-dams in the far upper stream of the Mekong River is a great danger to the peoples in the Lower Mekong River. Our people should fight against that "lasso tie" of being deprived of water, with all measures possible, including laser leveling. LLL meets the 4 basic requirement for crop production: ***Water***, *Ferlilizer*, *Care*, and *Seed*, all include the agricultural modernization and mechanization aspects such as producing more yield and more food. With 1 million hectare laser-leveled, there would be enough water saving in case 250 000 ha are intruded by saline water, and concurrently would reduce the GHG emissions significantly in line with Vietnam's commitment in the recent Paris COP21 Conference. It is timely now to start with land reforming-consolidation, *10 years from now would be too late* with ten of millions small parcels (even smallr than today with subdividing land to younger generations) and more water deficit due to more fierce intrusion of saline water. We need to preserve and explore wisely this natural resource, water, with a seemingly simple work as laser land leveling.

ACKNOWLEDGEMENT

For the successful results of laser leveling in Bac Lieu, An Giang, and Lam Dong Provinces from 2005 to 2010, the authors acknowledge the active contribution / support / participation of the following:

- Dr J. Rickman and Dipl.Ing Martin Gummert, the International Rice Research Institute.
- Dr. Nguyen Huu Huan (deceased) Plant Protection Department (Ministry of Agriculture and Rural Development).
- Managers and staff of the Departments of Agriculture of Bac-Lieu, An-Giang, Long-An Provinces, of Southern Seed Company, Ho Chi Minh City.
- Other staff of the Center for Agricultural Energy and Machinery, and the Faculty of Engineering (Nong-Lam University): Mr. Nguyen Van Xuan, Dr. Nguyen Van Hung.
- Farmers in the Provinces of An-Giang, Bac-Lieu, Dak-Lak, Long An, who pionnered to apply the LLL efficiently.

The continued financial supports from both IRRC and the ADB-IRRI Post-harvest Project in promoting LLL from 2004 to 2013 are gratefully acknowledged.

The initiatives of the Long An Department of Science-Technology, and Long An Department of Agriculture (DARD) in 2012, and Can-Tho DARD in 2013 for the "pilot large field" campaign, in which LLL was the first step of implementation, are highly appreciated.

REFERENCES

Bouman, B. A. M., H. Hengsdijk, B. Hardy, P. S. Bindraban, T. P. Tuong, and J. K. Ladha. 2002. *Water-wise rice production* (pp. 25-26). International Rice Research Institute, Philippines.

Chancellor W.J. 2002. *Energy Flow Relationships in Asian Rice Systems*. Paper presented at 2002 ASAE Annual International Meeting /CIGR XVth World Congress.

Ferrer B. 2011. *Even grounds*. Rice Today Vol. 10, No. 2 <http://irri.org/knowledge/publications/rice-today/special-reports/science-shorts/even-grounds?print=1&tmpl=component >

Fluck R.C. & C.B. Baird. 1980. *Agricultural energetics*. AVI Publ. Co., Connecticut, U.S.A.

General Statistical Office of Vietnam (GSO). 1996. *Annual statistical data 1995*. (and *1997, 2005, 2011, 2013* for corresponding published years 1998, 2006, 2012, 2014). Statistics Publishing House, Ha-Noi.

IRRI. 2012. *Laser leveling: Rice fields in South-east Asia*. Video clips downloaded from: http://www.youtube.com/watch?v=6Dl3_V1XfnM

Jat M.L., P. Chandna, R. Gupta, S.K. Sharma and M.A. Gill. 2006. *Laser land leveling: a precursor technology for resource conservation*. Rice-Wheat Consortium Technical Bulletin Series 7. India: Rice-Wheat Consortium for the Indo-Gangetic Plains. 48p.

Kitani O. (Ed.). 1999. *CIGR Handbook in Agricultural Engineering*. Am. Soc. Agr. Engineers. (CIGR = Congrès International du Genie Rural).

Mendoza T.L. 2013. *Laser Guided Dreams*. Rice Today October-December 2013, pp.28-29, & <http://books.irri.org/RT12-4_Laser.pdf >

Nguyen Lơi Duc. 2012. *Role of laser leveling in the establishment of SD Company*. Proceedings of a ADB-IRRI Seminar at Can Tho City, Vietnam, 7-8 /3 /2012.

Nguyen Van Khai. 2013. *Field leveling as popularly practiced in the Southern Mekong Delta*. Proceedings of the Seminar "Laser land leveling” at Tan-An City, 15-16 / 3 /2013

Phan Hieu Hien, T. V. Khanh, N. D. Canh, N. T. Nghi, N. V. Xuan. 2015. *Application of high technology to reduce the GHG emissions*. Proceedings of a Seminar at An-Giang Province, December 2015.

Phan Hieu Hien. 2012. *Laser land leveling in Vietnam, a first assessment*. Paper presentated at the "Lessons Learned Workshop" of the ADB-funded Postharvest Projects and the IRRC Postproduction Workgroup, held at IRRI, Los-Banos, 22-24 May 2012.

Phan Hieu Hien, Tran Van Khanh, Nguyen Duc Canh, Pham Duy Lam. 2007. *Application of laser-controlled equipment for leveling rice fields in Viet Nam*. Proc. International

Workshop on Agricultural and Bio-systems Engineering (IWABE), 11-13 December 2007, Nong Lam University, Ho-Chi-Minh City, Viet Nam

Rickman J. 2002. *Land leveling: a reference guide*. IRRI, Philippines.

Sharma M.K. 2014. *SPL Technologies India since 2002*. Presentation at the Trimble's Asia Regional Meeting, 2 September 2014.

To Phuc Tuong. 2007. *Alternate Wetting and Drying Irrigation (AWD): a technology for water saving in rice production*. Presentation at the Crop Cutting Ceremony, Bangladesh, 14-5-2007.

UNFCCC (UN Framework Convention on Climate Change). 2015. *UNFCCC Country Brief 2014: Viet Nam*. < http://newsroom.unfccc.int/unfccc-newsroom/vietnam-submits-its-climate-action-plan-ahead-of-2015-paris-agreement/ >.

Appendix: CALCULATIONS OF THE GREENHOUSE GAS EMISSION (CO_2 EQUIVALENT) THANKS TO LASER LEVELING

Basic data

(Source: Fluck & Baird 1980, Kitani (Ed) 1999

- Heating value of 01 liter of ***diesel*** is 38.7 MJ; however, it is about 47.8 MJ when using a liter of diesel, including energy for processing and transportation (9.1 MJ/liter).
- Similarly, energy of 01 kg of coal is 32.6 MJ, consisting of 30.2 MJ heating value + 2.4 MJ for transportation = 32,6 MJ
- Energy for irrigation: Data was computed from using the quantity (liter) of diesel or equivalent fuel to irrigate.
- Energy in chemical fertilizers: listed in the following table

Type	Processing, MJ /kg	+ Packaging and Transportation	= Total, MJ/kg
N	69.5	8.6	78.1
P_2O_5	7.6	9.8	17.4
K_2O	6.4	7.3	13.7
Note: For Mixed fertilizer, add 1.1 MJ/kg of energy for mixing.			

Urea fertilizer contains 46% N, thus 1 kg is converted to 78,1 * 0,46 = 35,9 MJ/kg

DAP fertilizer (diammonium phosphate) contains 18% N and 46% P_2O_5,
thus, total energy of 1 kg = 78,1 * 0,18 + 17,4 * 0,46 + (1,1 mixing) = 23,16 MJ /kg

NPK fertilizer (16-16-8) with number indicating the % of N - P_2O_5 - K_2O,
thus, total energy of 1 kg = 78,1 * 0,16 + 17,4 * 0,16 +13,7 * 0,08 + (1,1 mixing)
= 16,38 MJ /kg

- ***Chemicals for crop protection*** : The amount of chemicals for crop protection is not so much, we may assume that total energy of 1 kg is about 300 MJ/kg (on the high side).
- ***Seed***: energy for seed production = 17- 25 MJ/kg, average value = 21 MJ/kg (compared to commercial paddy of 13 MJ/kg).

Data on reduction of input materials in Mekong Delta

#1: Water: Reduction of 18 liter/ha, data from farmers in Bac Lieu, Long An, and An Giang. For example, 70 ha of Mr. Nguyen Loi Duc in An Giang (2012), 7 water applications for whole cropping period: Fuel consumption for all applications is 28 liter/crop and 11 liter/crop for before leveling land and after leveling land, respectively

#2: Fertilizer:

Sources from three Extension Centers (2010). Unit: ***kg /ha***

Fertilizer	Can Tho	Long An	Dong Thap	Average	Rounded	Reduction of **15%** =
Urea	100	150	165	138	140	21
DAP	100	50	135	95	100	15
NPK	100	100	91	97	100	15
Potassium	60	80	93	78	80	12

#3: Chemicals for crop protection:

Reduction of 2 kg of post-emergence herbicide due to leveled land

#4: Seed:

Reduction of 40 kg/ha (for example from 150 kg/ha down to 110 kg/ha) due to leveled land, no need for re-transplanting.

#5: Others: Equipment

Reduction of time in using machine in the field means saving energy in manufacturing and fuel consumption, for exaample: :

a) Combine-harvester: Fabrication of 1 kg needs 116 MJ. The machine mass is 1800 kg and used for 3000 hrs, thus 1 hour of use spends 116 * 1800 / 3000 = 70 MJ. If the operation time is reduced by 0.5 hr, this is equivalent to 35 MJ.

b) Due to more efficient operation on leveled land, the fuel consumption is reduced by 2 liter/ha (observed from combine contests 2009-20110), which is equivalent to 47.8 *2 = 95 MJ

Thus, total reduction: 35 + 95 = 130 MJ /ha /crop season.

CO_2 emission from burning 1 ton of coal

From the ultimate analysis, assumed the percentage of C is 82%, that is,

1 kg of coal contains 0.82 kg of carbon C.

Combustion equation:	C	+	O_2	$\rightarrow$	CO_2
	12 kg			$\rightarrow$	44 kg
Thus,	0.82 kg			$\rightarrow$	0.82 *44 /12 = 3 kg

Burning 1 liter of diesel fuel with higher carbon percentage produces more CO_2 than that for burning 1 kg og coal. For simplicity, we assume it is similar. :

1 kg of coal of 1 liter of diesel $\rightarrow$ ***3 kg*** $\boldsymbol{CO_2}$

Summarized table

	Items	Value	Reduced by	Converted to MJ/ha	Fossil fuel, **F** kg/ha	**kg CO_2 /ha (=F *3)**
#1	Irrigation water	47.8 MJ/liter of diesel	18 liter/ha	860	18.0	**54**
#2	Fertilizer: Application rate		(Reduced by 15%)			
	Urea: 140 kg/ha	35.9 MJ /kg	21 kg/ha	754	15.8	**47**
	DAP: 100 kg/ha	23.2 MJ /kg	15 kg/ha	348	7.3	**22**
	NPK(16-16-8): 100 kg/ha	16.4 MJ /kg	15 kg/ha	246	5.1	**15**
	Potassium: 80 kg/ha	13.7 MJ /kg	12 kg/ha	164	3.4	**10**
#3	Herbicide	300 MJ /kg	2 kg/ha	600	25.1	**75**
#4	Rice seed	21 MJ /kg seed	40 kg/ha	840	17.6	**53**
#5	Combine-harvester etc	47.8	3 kg/ha	143	3.0	**9**
			TOTAL	3 956	83	**248**

01 ha /crop, reduction of 248 kg ≈ 0.25 ton of CO_2;

01 ha /year with 2 crops, reduction of 0.5 ton CO_2;

01 million ha /year, reduction of 0.5 million ton of CO_2;

01 million ha /10 years reduction of 5 million ton of CO_2

 ISBN 978-602-0860-10-7

THE ROLE OF *Saccharomyces cerevisiae* AS MODIFICATION AGENT ON THE CASSAVA STARCH

[1]*MARIA ERNA KUSTYAWATI, *AZHARI RANGGA AND *SRI SETYANI

(*Dept of Post Harvest Technology, Faculty of Agriculture University of Lampung).
Jl.S.Brojonegoro No.1 Bandar Lampung, Indonesia
([1]Corresponding author, email:maria.erna@fp.unila.ac.id)

ABSTRACT

Saccharomyces cerevisiae is group of yeast in food categorized in GRAS. It possesses several of extracellular and intracellular of enzymes beneficial to the tapioca modification. Tapioca has low characteristic of pasting properties that its use in food production was narrow. Modified tapioca could be defined as change of its physical, biochemical, or microbiological properties for the better purpose. The introduction of yeast *Saccharomyces cerevisiae* in to the cassava starch suspension was investigated in order to evaluate its potential in modifying pasting and physicochemical properties of the starch. *Saccharomyces cerevisiae* at the various concentrations was inoculated into cassava starch suspension and incubated at room temperature (30^{o}C) in facultative aerobic condition for 24, 48, 60 and 72h. The growth of *Saccharomyces cerevisiae* was monitored; the pH and starch granules were evaluated. The result showed that there was sign of erosion to the structure of cassava starch granules of the inoculated starch and of which could result in the change of its pasting properties. However, the growth of *Saccharomyces cerevisiae* was not in high counts which indicated non-optimally growth. It could have been lacking of growth factor, nutrition, or the presence of another microbe as competitor. Thus, the investigation on the present of lactic acid bacteria involved in the fermentation of the cassava starch suspension was needed.

Key words: *modification, S.cerevisiae, tapioca, pasting properties*

INTRODUCTION

Cassava is considered as low quality of raw substances in protein, minerals, and vitamin contents. This drawback characteristic of cassava affected its low price as raw fresh materials. Processing cassava to produce dried cassava chips, tapioca, ethanol, liquid sugar, sorbitol, monosodium glutamate, and modified cassava flour have been done by some researches. Several researchers have focused on fermenting cassava with additional nutrients for improving the quality of cassava flour (Uboh and Akindahu, 2005). However, a challenged method to improve its properties has been attracting most scientists. One of the techniques was modification of physical, chemical, and pasting characteristic of tapioca starch by fermentation with the use of starter culture. Fermenting cassava with addition of with mixed cultures *Lactobacilus plantarus, Saccharomyces cerevisiae,and Rhizopus oryzae* produced the cassava flour having protein increased and reduced starct content (Gunawan *et al*., 2013). However, the production of tapioca starch with the fermentation by the use of *Saccharomyces and Lactobacillus plantarum* has been neglected.

Saccharomyces cerevisiae has been associated with human beings for more than 6000 years, due to its use in food production, baking, wine and beer making. Potable and industrial ethanol production constitutes the majority of use of *S. cerevisiae* in biotechnological applications. However, baker's yeast also plays an important role as a model organism in the field of biochemistry, genetics and molecular biology. Baker's yeast can also be used as host organism for novel production of some industrially relevant chemicals. *Saccharomyces cerevisiae* has a very important role as a starter in the fermentation of various foods and beverages known as brewer's yeast, distillers yeast, and baker's yeast, and has been studied by several researchers (Kurtzman and Fell, 1998). In Indonesia, the use of yeast to produce traditional foods and fermented foods has not been so entrenched in comparison to fungi such as *Mucor spp, Rhizopus spp, Penicillium spp and Aspergillus spp*, or the use of lactic acid bacteria *Lactobacillus casei, L lactis, A.xylinum, A aceti,* due to lack of knowledge in the utilization and engineering yeast as a starter or as an agent in the fermentation process. Yeast has amylolytic properties in starch degradation that is capable for producing the enzyme amylase. Amylolytic yeast may have potential use in the food products as they contribute to the desired flavor (Romano *et al.,* 2002). The role of amylolytic yeast in producing ethanol and yeast biomass from starch, as well as for producing beverages and foods with low carbohydrates have much to do, for example in fermented rice, production of amylase in fermentation of sticky rice, and cassava tape (Ardhana and Fleet, 1989; Fleet, 2001). Yeast great potential and is still very necessary, especially in food diversification through a fermentation process to produce a new type of food or modification of existing products with better nutritional value, as well as aroma and texture adapted to the people's will. Baker's yeast has a great potential as a catalysts in organic chemistry owing to ease of handling, broad substrate acceptability and production of enzymes belonging to different *classes. S. cerevisiae* may be used in dry and pressed form, as raw yeast or lyophilized biomass and is capable of catalyzing many reactions in water or in organic media.This study was conducted to monitor the growth of *S.cerevisiae* co-inoculated during fermentation to produce modified tapioca starch, and to investigate the structure change of starch granule.

MATERIAL AND METHODS

Materials

White cassava tubers (Manihot utilisima var Kasetsart) were obtained from the Institute for Agricultural Research and Technology (BPTP) Bandar Lampung, pure culture of *Saccharomyces cerevisiae* was purchased from the culture collection of Gadjah Mada University, broth Malt Extract broth (Difco,USA), Malt Extract Agar (Difco), saline (0.85 % NaCl), oxytetracycline and chloramphenicol, and reagents for chemical analysis were obtained from Sigma Chemicals Company (St.Louis, MO).

Tapioca starch fermentation

The fermentation process was carried out by submerged fermentation method. Briefly, 100 mL of extracted cassava slurry was placed into a 500 mL flask. To the flask was added 150 mL distilled water containing V1% and V2% of *S.cerevisiae*. The flask was covered by cotton to create an anaerobic condition. The mixture was fermented at room temperature (30±2^{o}C) for different time (24, 48, 72, and 96, hours). After wards, solid and liquid phases were separated immediately by vacuum filtration. The solid phase was dried in oven blower at 50^{o}C to get the moisture content of 12-14% and designated as modified tapioca starch.

pH analysis

The pH of filtrate obatained from the fermentation was determined by the pH meter.

Microbiological analysis

One mL of sample was taken from the flask and serially diluted to 10^{-4} with sterile distilled water into the test tubes. One mL of diluted sample was spread plated into petridishes with designated media, then was incubated at 29±2^{o}C for 24-48h.

RESULT AND DISCUSSION

Microbial growth

Submerged fermentation of co-culturing *S. cerevisiae* without any additional nutrients was applied in this study. Microbial growth is defined as microbial population which is increasing of the quantity cellular and structure of organisms. The growth pattern of *S. cereviseae* on cassava fermentation is shown in Figure 1. Four phases were detected, such as adaptation phase (lag phase), growth phase (exponential phase), static phase (stationary phase), and mortality phase (death phase). The growth rate of *S. cereviseae* V2 was significantly faster than those of *S. cereviseae* V1. *S. cereviseae* growth has entered to stationary phase at fermentation time of 24 h. Moreover, the period of stationary phase both of *S. cereviseae* growth were achieved at about 48 h. It was found that addition of nutrient to the tapioca startch fermentation significantly affected the growth of *S. cerevisiae*. No other study was found regarding the microbial growth of *S. cereviseae* on tapioca starch submerged fermentation. The increase of yeast count in the control sample without addition of *S.cerevisiae* could be due to the growth of wild yeasts or yeast contaminants which was presence during fermentation.

ISBN 978-602-0860-10-7

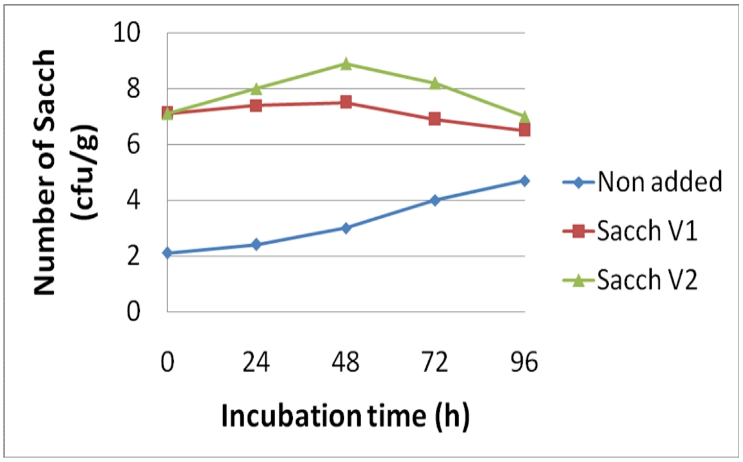


Figure. 1. Effect of incubation time on the number of *S.cerevisiae*

pH change

pH is one of the most important factors for maximizing growth of microorganisms, which was also found to be true for fermentation temperature. When co-inoculation *S. cereviseae*, on cassava fermentation without pH control, the pH profile decreased with time could have been as a result of more latic acid production and accumulation. On the other hand, it was noted that pH of addition with *S. cereviseae* (V1% and V2%) slightly increased from 4.1 to 4.9 (at *S.cerevisiae* V1) and to 4.4 (*S.cerevisiae* V2) within fermentation temperature studied at 30ºC (Figure 2). The addition of nutrient slightly increased the pH of the substrate due to the degradation of nutrient by *S.cerevisiae* and the cell biomass containing nitrogenous source. These results agree with previous works that the optimum pH levels for addition of *S. cerevisae* were from 3.5 to 6.0 and temperature levels were from 20 to 40°C (Manikandan and Viruthagri, 2010; Polyorach *et al*., 2013).

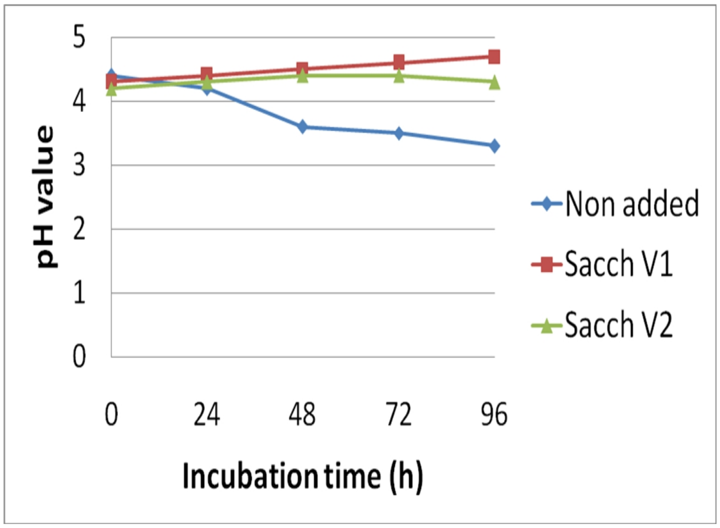


Figure. 2. Effect of incubation time on the pH of slurry tapioca starch

The change of granule

Figure 3 showed the granules of the native tapioca starch and tapioca starch fermented with *S.cerevisiae*. Hillum and lamellae of granules were noted in the native tapioca starch; whereas, there was signed of corrosion in the lamellae, and hillum was disrupted in the fermented tapioca starch. This was an indication of changes in the pasting properties of fermented tapioca starch. The reasons beyond this process could have been the enzymatic activity of *S.cerevisiae* that hydrolyzed carbon backbone chain of the oligosaccharide in the starch. This study was agree with the research done by Kustyawati *et al*. (2013). No other study was found regarding the effect of fermenting tapioca starch with *S. cereviseae* on the granules.

The findings of the present study was that (1) the growth of *S. cerevisiae* was not in high counts which indicated non-optimally growth, (2) Granule erosion was significantly noted, (3) The investigation on the present of lactic acid bacteria involved in the fermentation of the cassava starch suspension was needed.

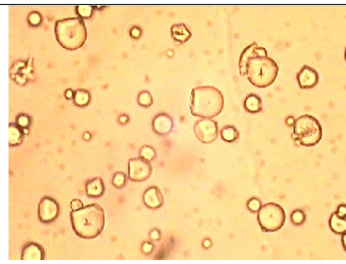
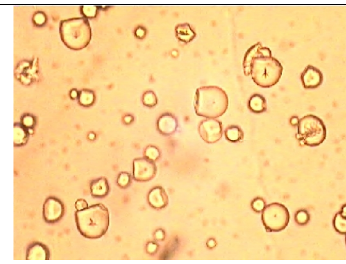
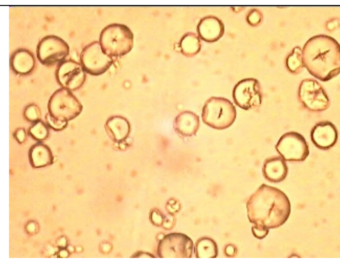
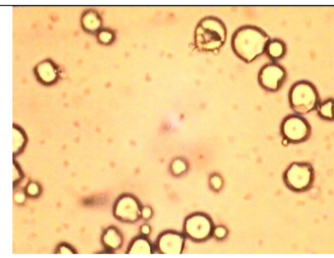
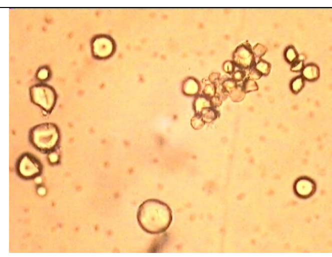
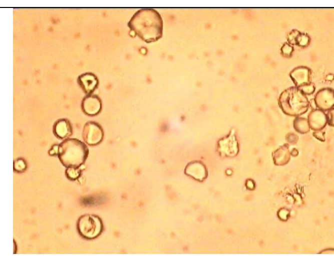
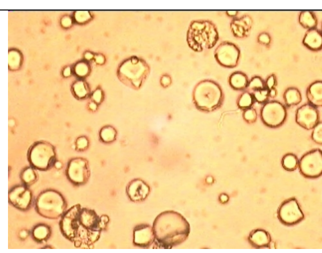
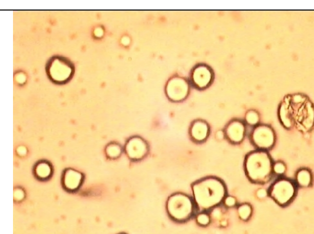
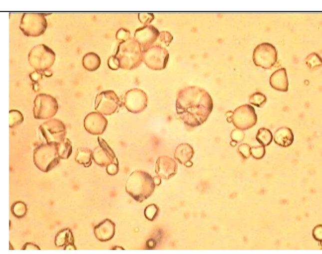
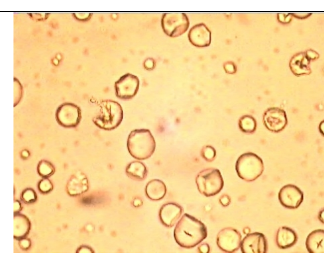
Fermentation time	*S.cerevisiae* co-inoculated	Without co-inoculated
0 h		
24h		
48h		
72h		
96h		

Figure 3. Effect of fermentation by the use of S.cerevisiae on the microscopic study of tapioca starch granule

ISBN 978-602-0860-10-7

ACKNOWLEDGMENT

This work was supported by a grant provided by the Institute of Research and Public Services (LPPM) University of Lampung, Indonesia, through the Grant Application (*Hibah Terapan*) 2016 with the project number of 418/UN/8/LPPM/2016.

REFERENCES

Ardhana, Made M., Fleet, Graham H. 2003. The microbial ecology of cocoa bean fermentations in Indonesia. International Journal of Food Microbiology 86:87–99

Fleet, G.H., 2001. Wine. In: Doyle, M.P., Beuchat, L.R., Montville, T.J. (Eds.), Food Microbiology Fundamentals and Frontiers. ASM Press, Washington, DC, pp. 747–772.

Gunawan, S., 1 Widjaja, T., 1 Zullaikah, S., 1 Ernawati, L., 1 Istianah, N., 1 Aparamarta, H.W. and 2 Prasetyoko, D. 2015. Effect of fermenting cassava with Lactobacillus plantarum, Saccharomyces cereviseae, and Rhizopus oryzae on the chemical composition of their flour. International Food Research Journal 22(3): 1280-1287.

Gunawan, S., Darmawan, R., Nanda, M., Setiawan, A.D. and Fansuri, H. 2013. Proximate composition of Xylocarpus moluccensis seeds and their oils. International Journal of Industrial Crops and Products 41: 107-112.

Kurtzman, C., Fell, J., 1998. The Yeasts—A Taxonomic Study, 4th ed. Elsevier, Amsterdam.

Kustyawati, M.E., Hayati, T. 2013. Effect of fermentation by Saccharomyces cerevisiae on the biochemical ckaracteristics of tapioca starch. AGRITECH ISSN 0216-0455 33(3):281-288.

Manikandan, K. and Viruthagiri, T. 2010. Optimization of C/N ratio of the medium and fermentation conditions of ethanol production from tapioca starch using co-culture of Aspergillus niger and Saccharomyces cereviseae. International Journal of Chemistry and Technology Resource 2: 947-955.

Oboh, G. and Akindahunsi, A.A. 2005. Nutritional and toxicological evaluation of Saccharomyces cereviseae fermented cassava flour. Journal of Food Composition and Analysis 18: 731-738.

Polyorach, S., Wanapat, M. and Wanapat, S. 2013. Enrichment of protein content in cassava (Manihot esculenta Crantz) by supplementing with yeast for use as animal feed. Emir. Journal of Agricultural and Food Chemistry 25: 142-149.

Romano, P., Fiore, C., Paraggio, M., Caruso, M., Capece, A. 2003. Function of yeast species and strains in wine flavour, Inter J of Food Microbiol. 86: 169– 180.

DESIGNING AND CONSTRUCTING OF SUN DRYING WITH SEMI-AUTOMATIC MOVING RACKS

TAMRIN* AND HENDRA SAPUTRA*

*Agricultural Engineering Department, Lampung University
Email:tamrin62@yahoo.com

ABSTRACT

Solar dryer is one type of dryers that uses direct or indirect solar energy to remove some of moisture from the products for preservation purposes. Direct solar dryer has some drawbacks primarily when used during rainy season because the drying products have to be move manually and quickly in order to avoid rehydration. Therefore in this paper we reported our study on designing and constructing prototype of solar dryer with semi-automatic moving racks. The result showed that our designed dryer was able to move the drying racks 10 times faster than those of manually moved.

Key word : moving racks, semi-automatic, solar dryer

INTRODUCTION

Drying of agriculture products using the heat from the sun and the natural movement of the air , known as sun drying method, is one of traditional methods that has been widely practiced especially in developing countries(Sachithananthan *et al*., 1985). Sun drying is one of preservation methods that is known for its convenient and lowest cost (Eyo, 1986). However, the products obtained through this drying system usually have lower quality due to contamination by dust, insects, birds, other pet animals and rain (Hii *et al*. , 2012; Sablani *et al*., 2002) .

Developing less expensive conventional drying technique that reduces losses and maintains the quality of the products is very important. Many researchers reported the usefulness of solar dryer for improving product qualities. Chakrabarti and Varma (1999) reported that traditional drying of fishes at ambient temperature caused spoilage very rapidly, whereas using solar dryer improved the fish quality. Hedge et al.(2015) reported that solar dryer that they designed has proven to improve the dried banana qualities.

Sun drying using the racks is also reported to increase the efficiency of drying. With water circulation, the rack system reduces fish drying time from three days to eight hours Sachithananthan et al.(1985) . A problem that may rise during sun drying of products using racks is when it is raining. In order to protect the product from getting wet because of the rain, the drying racks should be moved manually to a shelter. This activity is time consuming , therefore the aim of this study was to design and prototyping a solar dryer equipped with semi-automatically moving racks. In this dryer, the drying racks were connected with wheels to facilitate them to move semi-automatically. This type of dryer will reduce the time for moving the drying racks to the shelter so that the product could be protected from getting wet because of the rain.

Design Features of the Sun Drying with Rack:

The sun drying with rack (SDR) we designed was a dryer consisted of several drying racks that could move semi-outomatically. One of SDR was equiped with four wheels, a pair of rails, and a pair of rails place for the wheels. The drying racks could move by releasing the pin at the end of the racks. The initial energy used to move the SDR is a spring force. Spring was connected with the end rack with ropes. Once the pin is released, the racks will move to a rack shelf compilers. The next energy to move the rack is gravity force. more and more rack compiled, the greater the energy needed to pull the next rack. The SDR, sun drying, with semi-automatic moving racks is illustrated in Figure 1. .

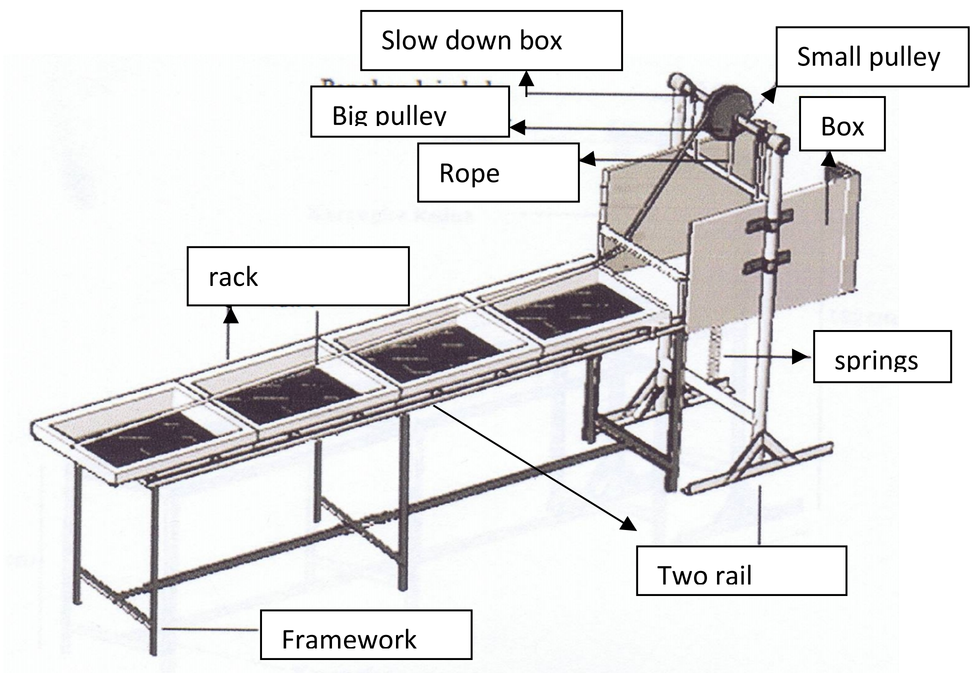


Figure . 1. Sun drying with semi-automatic moving racks

SDR design consideration

SDR was design based on engineering design. The design starts from the discovery of the problems faced in the drying of agricultural products. The problem may rise when the rain drops suddenly and force the worker to work hard collecting the drying racks containing products, move them to storage rooms or to shelters. Therefore, This work was done to improve the drying rack collecting system that could perform faster . There were several steps done to in designing this drying , included producing some of the images in the form of sketches, then select the sketch drawing that is considered could solve problems in sun drying . Image in question is an image of the dryer with a rack equipped with wheels. This equipment can be moved with a semi automatic.

During designing, there were several concepts to be considered such as equipment can quickly move product to temporary storages, can facilitate job in the drying, dried product can be protected from dirt, and the products could be able to return to sun drying easily

SDR component

SDR was made by drawing the main component parts. This equipment was assembled as in Figure 2.

Figure 2. Prototype a four rack-SDR

ISBN 978-602-0860-10-7

The main component of the SDR

The main components of SDR that was designed were consisted of a frame work, a box, pulleys, and springs. Those components were described in Figures 3 and 4.

1. Framework,

The Framework served as a place to attach all major components. The major components were composed of racks, ropes, boxes, springs and pulleys. Springs were used to control the moving box rate. Framework was also be used as a rail for a wheel that was attached to the rack, and each rack has four wheels.

2. Box

The box was used to compiled the racks. The box was placed inside the temporary warehouse, so the drying rack were sliding and arranged in the box , thus the drying racks containing the products will be kept of from rain and other dirt.

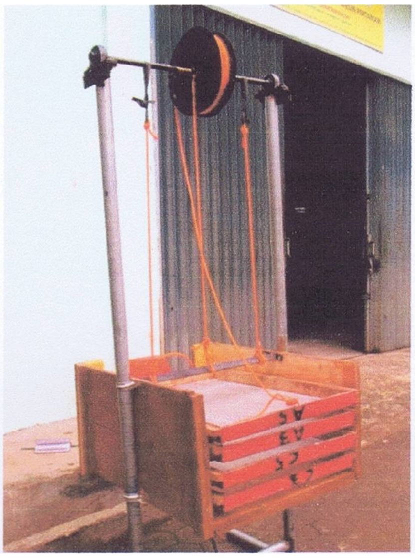


Fig. 3. Box, rack and pulley

3. Racks

The racks were used to spread out a product that will be dried. Wire netting was mounted on the bottom shelf. The use of wire netting will accelerate drying products, because air flow becomes faster. The rack wall was made of wood with a thickness of 2 cm in size of 40 x 60 cm.

4. Pulleys

There were two pulleys used, a large pulley and a small pulley. The large pulley was connected between the racks with rope and the small pulley was conneted by racks. Pulley diameter ratio (large pulley and small pulley) is a comparison of the speed of the movement of the racks and boxes or comparison of the heigh tof rack with the length of the rack. The the racks moved horizontally along the rail, then the box containing racks moved vertically.

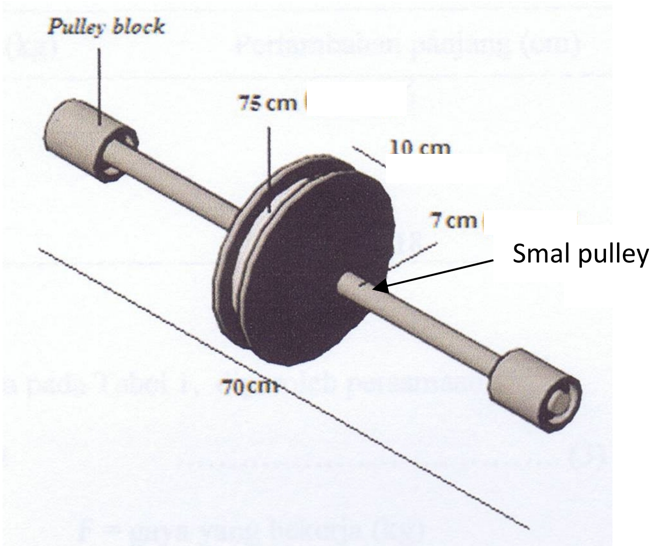


Fig. 4. Small pulley and big pulley

4. Springs

Springs used had two functions as an initial movement puller and as a tool to slow down the movement rate of the racks.

The SDR was designed and constructed base on compiling racks that could move or slide semi automatically. The movement of racks required several mathematical equations . they were:

1. Comparison of horizontal and vertical movement of the rack.

In the drying process, the rack in its position is pulled by a spring, but the rack does not move, because the rack is nailed. If the pin of rack is released, then the rack will move. The movement of the rack horizontally (V_r) as compared to the movement of the box (V_b) vertically. As follows

$$\frac{V_r}{V_b} = \frac{rack\,high}{rack\,long} = \frac{big\ pulley\ diameter}{small\ pulley\ diameter} \quad \text{...} \quad (1)$$

The movement of the rack horizontally also have relation to pulley diameter, because the speed of the movement of boxes and racks are linked by the amount of rotation pulley.

2. The tensile strength of the spring for initial movement

The strength of the spring is used to pull the initial movement of the rack to fight wheel friction, pulley friction and gravity force of boxes. Puller force equation of spring (F_{pu}) that is used is

$F_{pu} = F_r + F_p - W_b$ ....(2)

Where
F_r = Friction of rack wheel
F_p = pulley friction
W_b = box weight

Wheel friction force of rack relates to the mass of the product and the number of rack were formulated as follows

$F_r = \mu_s (W_p + W_r).N$ .... (3)

Where μ_s = static coefisein
W_p = product mass
W_r = rack mass

The value of frictional force (μ_s) was obtained from experiments

3. The power of springs to hold the movement of box

The strength of the springs to hold the movement of the box (F_h) was based on gravity force of box and rack and it was formulated as follows

$F_h = W_b + n \ W_r$ .... (4)

Where n = number of rack

4. Strength springs (F_s)

$F_s = k \ \Delta x$ .... (5)

Where k = coefisien springs
Δx = displacement

 ISBN 978-602-0860-10-7

Table 1. Design condition and asumption

item	Condition and asumption
1. Gravitation force	9,81 m/s²
2. coefisien pull springs	0,5 kg/cm
3. coefisien hold springs	0,75 kg/cm
4. Puller friction rack wheel	Be ignored

Table 2. Values of design parameter

item	Value	Data or equation use
1. Box mass	9 kg	Equation (2)
2. Rack mass unit	2 kg	Equation (3)
3. Static coefisien	0.1	Equation (3)
4. Number of rack	4	
5. Rack lenght	75 cm	Equation (1)
6. Rack high	7.5 cm	Equation (1)

Contruction of prototype SDR

The constructed SDR consisted of framework, rack, box, and pulley as shown Fig. 2. A framework was 375 cm long, 60 cm wide and 180 high. Part of the framework serves as a rail with a height of 80 cm from the surface. There were four rack that had wheels above the rails. The cabinet-shaped racks'size was 75 cm long, 60 cm wide and 7.5 cm thick. In the bottom of the rack were mounted wire netting. The capacity of each rack was 1-3 kg of products. Sling or rope was used to connect between the rack with a large pulley and also it was connected to the box with the small pulley. The box dimension was 60 cm long, 60 wide and 40 high.

At the time of compiling the rack on the box, the rate of movement of the rack horizontally was 10 times faster than the rate of movement of the box vertically. Comparison of the rate of movement was based on the size of the rack that was 75 cm long and 7.5 cm thick. At the time of the racks are arranged, then the box will go down as far as 7.5 cm, when one of rack was compiled. To compile four racks, then the box will go down as far as 30 cm.

Performance Test of SDR prototype

Tests was done to observe th time to compile the rack. Experiment was done on empty rack as well as loaded racks. In testing the performance, racks were loaded with either cassava crackers or soybeans, the tests were performed 5 times for each commodity. The time taken for compiling 4 racks were measured. The lenght of time required to compile the 4 racks neatly is shown in Table 3.

Table 3. The lenght of time required to compiling the rack perfectly (seconds)

No	Unloading	With loading	
		Grain of soy bean	cassava crackers
1	4.58	4.50	4.59
2	5.00	4.56	4.56
3	5.12	5.12	5.00
4	5.12	5.14	5.12
5	4.55	4.54	4.55
Average	4.87	4.77	4.76

The time required to compile the rack using the designed dryer were from 4.76 to 4.87 seconds. While the time required to manually compile rack was 47.82 seconds. Thus, the time used to compile the racks by using this equipment was 10 times faster. This equipment is promising to be used to handle the drying product when the rain drops suddenly , furthermore , it eases an operator in utilizing sun drying for agricultural products.

It was concluded that SDR was designed for accelerating the arrangement of rack to avoid rehydration of the drying products during sudden heavy rain. Time to move the racks with SDR was 10 times faster than manually. The dryer can be operated in any climatic conditions: on normal sunny days, as well as cloudy days. Based on the experimental study, it is concluded that the solar dryer with semi-automatic moving racks is suitable for drying of agriculture products, including marine products.

REFERENCES :

Chakrabarti, R and P.R.G..Varma, 1999. Halotolerant fungi in salted and dried fish at lower. Vishavatnam coast. Fishery Technology 26(1):26-31

Eyo, A.A. 1986. Significance of fish handling preservation and processing in the development of Nigeria inland fisheries with special reference to Kanji Lake. Fisheriessociety Nigeria: 3 annual conference proceedings.

Sablani, S., Rahman, M.S., Mahgoub, O. and ALMarzouki,A. 2002. Sun and solar drying of fishsardines. Proceedings of the international dryingsymposium Vol.C:1662 -1666.

Sachithananthan, K., Trim, D. M. and Spears, C. I.1985. A solar- dome dryer for drying fish. Proceedings of the FAO expert consultants of fish technology, In Africa Lusaka Zambia 329: 161 - 172.

Hedge, V.N., V. S. Hosur, S. K. Rathod, P. A. Harsoor and K. B. Narayana, 2015. Design, fabrication and performance evaluation of solar dryer for banana. Springer open journal. Energy, Sustainability and Society 5:23

Hii, C.L. S.V. Jangam, S.P. Ong. and A.S. Majumdar, 2012. Solar drying fudamental, application and innovation. TPR Gruop publication, Singapore.

A REVIEW OF VARIOUS MATERIALS AND LEVELS MODULE ON THAI PEPPER (*Capsicum frutescens* L.) IN VERTICULTURE PATTERN OF LEVELS MODULE

SITAWATI, AGUS SURYANTO AND EUIS ELIH NURLAELIH

Faculty of Agriculture, University of Brawijaya
Jl. Veteran Malang 65145, East Java, Indonesia
*E-mail: sitawati_fpub@yahoo.com

ABSTRACT

Verticulture on Thai pepper is a farming effort on narrow land as in urban area. The application of levels module verticulture is intended to obtain the combination of materials and efficient levels module, as well as to increase optimal productivity of Thai pepper (*Capsicum frutescens* l.) in Module Verticulture Pattern. Hypothesis of the research were (1) the application of module material, bamboo, that could absorb water and has better structural strength, and (2) the productivity may increase along with the increasing numbers of module. The research was conducted in Batu from June to September 2015. Design of the research was the Split Plot Design (SPD) with 3 replications. Treatment on the main plot was module or medium container as bamboo (M1), Styrofoam (M2), and PVC gully (M3). Treatment on sub plot is levels module as 3 levels (T1), 5 levels (T2), and 7 levels (T3). The observed variables of the research were height of plant, numbers of leaf, weight of yield (g/plant), and numbers of fruit. Results of the research showed that materials of module verticulture, such as bamboo, Styrofoam, and PVC gully, would provide identical micro environment for the plant growth resulting no significant difference on growth pattern and yield. Weight of yield per plant showed no significant difference on 3, 5, and 7 levels. However, weight of yield per area of plant increase 2 to 4-fold compared with weight of yield from 3 levels module.

Keyword: *Capsicum frutescens* L, Material and Levels Module, Verticulture

INTRODUCTION

Urban agriculture can be defined as agricultural activities, such as farming, animal husbandry, fishery, and forestry that locate inside the town or at the suburban in order to provide and fulfill consumption of the public in urban area. The implementation of urban agriculture can be brought into reality through utilizing abandoned and critical lands, utilizing Green-Open Space both private and public, optimizing yard and the application of verticulture and roof garden. In accordance with character of urban landscape that having limited land, better technological innovation of plant production, both food and non food, is required to fulfill the demand for foods.

The increasing numbers of population and developmental activities in all sectors have reduced the farming land (BAPPENAS, 2007). Agus and Ani (2005) reported that from 1999 to 2002, farming land conversion occurred in Java Island for about 107.48 ha and outside Java Island (274.73 ha), therefore, during the period of time, the farming land conversion in Indonesia was 141.28 ha per year. Up to 2014, it was presumed that farming land conversion has reached 100,000 ha each year (PERTANI, 2014). The decrease of farming land will directly affect on food security. The increasing demand for foods, which is not balanced out with the increasing production may threat public survival.

Limited land is one of obstacles in developing urban agriculture, therefore various efforts have been done to overcome such limited land, and one of them is verticulture. Implementation of such verticulture technique could increase numbers of plant on specific area from 3-10 folds, which depends on the applied model (Liu, 2005). In principle, verticulture is identical with farming on garden or flat land, but they are different in area of land use.

As in horizontal farming system, verticulture technique has also concerned with the spacing. According to Noverita (2005), verticulture enables to be applied on land of one meter square by more plants than on flat land with the same width. One of plants that support such verticulture technique is Thai pepper. Thai pepper posts high level of consumption in Indonesia, in which the demand for Thai pepper keeps increasing year-by-year, as supplement to other spices. So that planting Thai pepper in verticulture technique may increase the needs of Thai pepper for the public and economize on the household's needs by planting Thai pepper via verticulture technique at narrow yard, particularly in urban area.

Verticulture technique has some benefits, such as aesthetical value, providing micro environment that free of pollution, efficient in water use, can be applied on narrow space, the plant age is relatively short and quick-harvested and consumed, and the application of verticulture can be done by everyone and the farmer without exception. Results of the research by Sitawati *et al*. (2016a) showed that planting medium and materials of such verticulture may affect growth and yield of *pakchoy* due to different environment for optimal growth and yield of *pakchoy*. Besides that, both horizontal farming model and verticulture have identical effects on growth and yield of strawberry (Sitawati *et al*., 2016b). The application of verticulture by levels module is intended to obtain is intended to obtain the combination of materials and efficient levels module, as well as to increase optimal productivity of Thai pepper (*Capsicum frutescens* L.) in Module Verticulture Pattern. Hypothesis of the research include (1) the application of module material, bamboo, that could absorb water and has better structural strength, and (2) the productivity may increase along with the increasing numbers of module.

MATERIALS AND METHODS

The research was conducted in Batu from June to September 2015. The geographical location of the research is at 7°16′ North Latitude and 112°43' East Longitude. Equipments used in the research include ruler, camera of Nikon Coolpix AW100, Lux meter and Leaf Area Meter type LI – 3100, scales of NictVoor type PS 1200 and oven Memmert type 21037 FNR. Materials of the research included Thai pepper seeds, planting medium, coco peat and humus, *Phonska* fertilizer, as well as module materials that comprised of bamboo, Styrofoam, and PVC gully.

The research was done using the Split Plot Design (SPD) with 3 replications, in which the main plot is the medium container/Module, which are Bamboo (M1), Styrofoam (M2), and PVC gully (M3). Meanwhile, the sub plot is the Levels Module, as 3 levels (T1), 5 levels (T2) and 7 levels (T3). Each module was made of 1 m length and the volume of the planting medium was made as close s the gully module that has 12 cm width and 11 cm height, as well as 0.5 m^2 area wide.

The observed variables of the research included height of plant (cm), numbers of leaf, leaf area (cm^2), numbers of fruit, and weight of yield (gm). Data on results of the observation was analyzed by using F-test at level $\alpha = 0.05$, in order to find out any interaction or significant effect of the treatment. If any interaction or significant effect of the treatment were found, it would be continued with test between treatments using Least Significant Difference (LSD) at level $p = 0.05$.

RESULTS

Results of the research showed no interaction between materials and numbers of module. Separately, materials and numbers of levels module have no significant effect on variables of growth, such as: height of plant, leaf area at 60 dap, and numbers of leaf at 30 and 60 dap.

On variable of yield, such as weight of fresh fruit and numbers of fruit, they did not show any significant effect on materials and numbers of the module. Separately, materials of the module do not have significant effect on weight of yield and numbers of fruit. Meanwhile, levels module show significant effect on weight of yield and numbers of fruit. Results of the research showed that weight of yield by 3 levels module produced lower yield than the treatments by 5 and 7 levels module. Weight of yield by 7 levels module produced higher weight of yield than the treatment by 3 levels module. The results were also straightly proportional to numbers of fruit. Numbers of Thai pepper fruit by 7 levels module were higher than 3 and 5 levels module, in which numbers of fruit were lower on 3 levels module.

DISCUSSIONS

Results of the research showed that the treatment of materials, such as bamboo, Styrofoam, and PVC, have found no significant effect on variables of growth and yield of Thai pepper. It showed that materials of the module, such as Styrofoam, bamboo, and PVC have provided the same growth environment for growth and yield of the plant. In this case, micro-growth environment for those three materials of module have identical characteristics, such as humidity, micro temperature, light and growth space for the roots. All of these conformed to literature by Georgius (2001) who stated that variables of environment, which affect the plant growth, are temperature, light intensity, relative humidity, concentration of CO_2 and planting medium. Optimal temperature is determined by the involved process in utilizing assimilate of photosynthesis and distribution of dry matter to shoots, leaves, roots, and fruits. In order to control the plant growth, average temperature for more than a day or few days is more important than day/night of different temperature (De Koning, 1996). The same variables of growth were affected by radiation interception of all treatments. According to Wilson *et al*. (1992), when light became the limiting factor, a linear function occurred between light decrease as well as the growth, and on the contrary, 1% increase would increase the growth 1% on light below the light level up to 200 W/m^2.

Height of module does not affect light interception on Thai pepper as C3 due to the need of C3 is lower than C4. However, C3 grows by carbon fixation and usually grows well on area that has moderate light intensity, mild temperature, by concentration of CO_2 for about 200 ppm or higher, as well as abundant soil water. According to Gardner *et al*. (1991), the photosynthetic pattern of C3 was different from photosynthetic pattern of C4 and CAM (Crassulacean Acid Metabolism). In general, photosynthetic pattern of C3 is less productive than C4. In photosynthetic process, C3 has photorespiration that causes Carbon losses for about 20% in Calvin cycle as a result of light radiation. So that optimal production of C3 requires partial light (Sanger, 1998). C3 has low photosynthetic efficiency due to on C3, utilization of CO_2 has just 50% as a result of photorespiration, so that the photosynthetic efficiency is low. In general, C3 is presumed less productive than C4. One difference is on photorespiration, which is extremely active on C3. Photorespiration makes the plant increase its consumption of oxygen when C3 intercepts the radiation (Subbarao *et al*., 2005).

Different levels module showed significant effect on numbers of fruit and weight of yield. Different numbers of fruit and weight of yield in accordance with levels module are due to the verticultures increase along with the levels module by the same area width. So that it could increase the area of harvest on the same area. In verticulture, the area of harvest is affected by increasing levels, layout and model. By the same area width horizontal ($0.5m^2$), 3 levels Modulby vertical could produce 126.97 gr, 387.50 gr on 5 levels module and 692.17 gr on 7 levels module. Results of the research showed that levels module can be used as alternative model for urban farming in order to overcome food security at urban area. International Food Policy Research Institute (IFPRI) shows that poverty and lack of nutrients, which previously occurred at the suburban, have moved to urban area. Food scarcity in urban area is generally related food availability and disability of the poors to access safe and qualified, as well as sufficient foods. This trend implicates how the researcher and decision-maker try to find out new model and approach in order to overcome problems that relate to food scarcity and lack of nutrients at urban area(Rocha, 2000).

Moreover, verticulture have other benefits, such as fulfilling the need of nutrients for family and saving the household’s budget. Study by Alice and Foeken (1996) on Nairobi City, Kenya, showed that urban farming may increase food security, as reviewed from energy adequacy, protein consumption, and decreased numbers of children who had lack of nutrients. Study on urban farming at the yard in Philadelphia has found that low-income societies who have yards may save their expenses for foods $150 on average in each crop season (Pinderhughes, 2003). The use of bamboo, Styrofoam, and gully do not affect productivity, so that they can be applied in accordance with financial support, but PVC gully is preferred as seen from duration of appliance (life span) and aesthetics. Urban farming plays in reducing poverty, food security and overcoming problems that relate to garbage. Urban farming may guarantee the availability of fresh and nutritious foods, so that it will increase the availability of vegetables and fruits, as well as save 15-30 percent of the budget, which is expended for foods (*USDA Economic Research Service, 2003*).

Results of the research showed that materials of verticulture, such as bamboo, Styrofoam and PVC gully provided identical micro environment for the plant growth, so that no significant difference was found on yield and growth pattern. Weight of yield per plant was insignificant difference on 3, 5, and 7 levels module. Therefore, weight of yield per area of plant increased 2 to 4-fold in comparison with weight of yield on 3 till 7 levels module.

ACKNOLEDGEMENT

The writer would like to express her gratitude to Indonesia Directorate General of Higher Education for financial support to this research, Dewi Ratih and Fanin.

REFERENCES

Agus. F and Ani Mulyani. 2005. Judicious use of Land Resources for Sustaining Indonesia Rice. Indonesian Soil Research Institute. Bogor. Indonesia. International Rice Conference 2005. Bali. Indonesia. 12-14 September 2005.

Alice, M. and D. Foeken. 1996. Urban Agriculture, Food Security and Nutrition in Low Income Areas ofThe City of Nairobi, Kenya. African Urban Quarterly, 1996 11 (2 and 3) pp 170-179 © by African Urban Quarterly Ltd.

BAPPENAS, Badan Perencanaan Pembangunan Nasional (National Planning Board). 2007. The Plan of National Action on Food and Nutrition 2006 – 2010 (*Rencana Aksi Nasional Pangan dan Gizi 2006 – 2010*). National Planning Board. Jakarta.

De Koning, A. N. 1996. “Quantifying the responses to temperature of different plant processes involved in growth and development of glasshouse tomato” *Acta Hort.,*406: 99 - 104.

Gardner F.P., R.B. Pearce, and R.L. Mitchell. 1991. Physiology of Crops (*Fisiologi Tanaman Budidaya*). UI-Press. Jakarta.

Georgios, K. S. 2001. “Temperature control and energy conservation in plastic greenhouse” J. agric. Eng. Res.80 (3): 251-259.

Liu, W., Chen, D.K. and Liu, Z.X. 2005. High Efficiency Column Culture System in China. Acta Hort. 691, ISHS 2005.

Noverita, S. 2005. Effect of Concentration of Liquid Supplemental Fertilizer of Nipkaplus and Spacing on Growth and Production of Baby Kaylan (*Brassica oleraceae*L.) in Verticulture (*Pengaruh Konsentrasi Pupuk Pelengkap Cair Nipkaplus dan Jarak Tanam Terhadap Pertumbuhan dan Produksi Tanaman Baby Kaylan* (*Brassica oleraceae* L.) *Secara Vertikultur*). Journal of Research on Agricultural Science, 3(1): 21-29.

PERTANI. 2013. Each Year, 100 thousand Farming Lands are Lost (*Tiap Tahun 100 ribu Lahan Pertaian Hilang*). www.pertani.co.id Accessed on 28 March 2015.

Pinderhughes, R. 2004. Alternative Urban Futures: Planning for Sustainable Development in Cities throughout the World. Lanham, Boulder, New York, Toronto, Oxford: Rowman & Littleield Publishers.

Rocha, C. 2000. An Integrated Program for Urban Food Security: The Case of Belo Horizonte, Brazil. Department of Economics. Ryerson Polytechnic University. Toronto

Sanger, A. 1998. Mathematics for Biologists Part Biology. *Mathematics for Biologists.*

Sitawati, S. Heddy and A. Izhar. 2016a. Effect of Planting Medium and Materials of Verticulture on Growth and Yield of *Pakchoy* (*Brassica Juncea*L.) (*Pengaruh Media Tanam dan Bahan Vertikultur terhadap Pertumbuhan dan Hasil Tanaman Pakcoy (Brassica Juncea L.)*).

Sitawati, A. Nugroho and E. Priyambudi. 2016b. Effect of Farming Model and Application of P and K Fertilizer on Growth and Yield of Strawberry (*Fragaria*Sp.) (*Pengaruh Model Penanaman dan Aplikasi Pupuk P dan K pada Pertumbuhan dan Hasil Tanaman Stroberi (Fragaria Sp.)*). Journal of Crop Production. University of Brawijaya. Malang.

Subbarao, G.V., Ito, O. & Berry, W. 2005. Crop Radiation Use Efficiency and Photosynthate Formation-Avenues for Genetic Improvement, M. Pessarakli, Editor, Handbook of photosynthesis, (2nd ed.), Taylor and Francis, New York.

Wilson, J. W., D. W. Hand and M. A. Hannah. 1992. Light interception and photosynthetic efficiency in some glasshouse crops. *J. of Experimental Botany* 43(248): 363 - 373.

Table 1. Height of Thai pepper plant by treatments of different levels module and materials at 30 and 60 dap

Treatment	Height of plant (cm plant^{-1})	
	30 dap	60 dap
Bamboo	16.56	35.33
Styrofoam	15.42	40.89
PVCgully	17.76	35.92
LSD 5%	ns	ns
3 Levels	16.39	37.28
5 Levels	16.38	39.11
7 Levels	16.97	35.75
LSD 5%	ns	ns

Notes: number followed by the same letter at the same age shows insignificant difference based on LSD (Less Significant Difference) test of 5%. Dap = day after planting

Table 2. Leaf area of Thai pepperplant by treatments of different levels module and materials at 60 dap

Treatment	Leaf Area
Bamboo	937.65
Styrofoam	1613.14
PVCgully	1167.13
LSD 5%	ns
3 Levels	3616.46
5 Levels	3712.66
7 Levels	3824.6367
LSD 5%	ns

Notes: number followed by the same letter at the same age shows insignificant difference based on LSD (Less Significant Difference) test of 5%

Table 3. Numbers of leaf on Thai pepper plant by treatments of different levels module and materials at 30 and 60 dap

Treatment	Numbers of leafs	
	30 dap	60 dap
Bamboo	10.94	20.64
Styrofoam	11.67	28.86
PVCgully	11.50	23.47
LSD 5%	ns	ns
3 Levels	11.72	23.08
5 Levels	10.75	26.72
7 Levels	11.64	23.17
LSD 5%	ns	ns

Notes: number followed by the same letter at the same age shows insignificant difference based on LSD (Less Significant Difference) test of 5%. Dap = day after planting

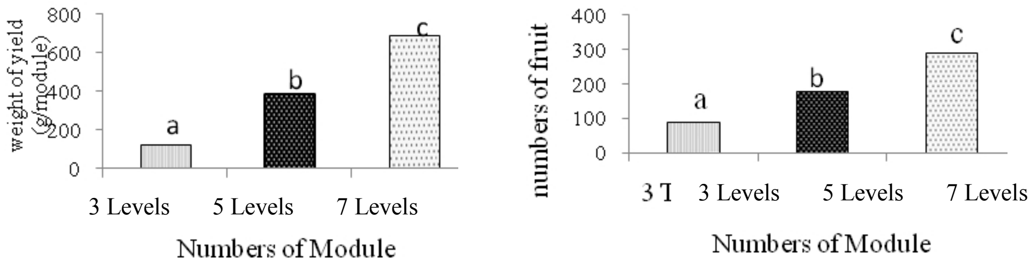


Figure 1. Weight and numbers of yield by different levels module and different materials of module

ECONOMIC ANALYSIS OF SMALL RUMINANT MIXED FARMING TO THE FARMER'S INCOME IN YOGYAKARTA-INDONESIA

TRI ANGGRAENI KUSUMASTUTI

Faculty of Animal Science Universitas Gadjah Mada, Yogyakarta, Indonesia,
Email : triaksp@yahoo.co.id

ABSTRACT

Mixed farming of small ruminants is one of the main models of Integrated Farming System is widely applied in developing countries because of the role of small ruminants, especially goats has the potential to alleviate poverty in rural areas. The purposes of this study was to measure the income of farmers comes from integrated crops and livestock system. The location selected in Sleman district which is a center for the breeding and milking production of ettawa crossbred goats in Yogyakarta. Collecting data purposively farmers as much as 71 respondents . To determine the revenue share mixed farming systems analyzed descriptively. The results showed that the highest income comes from Ettawa Crossbred goat IDR 3,628,149 / month (55.42%), forestry namely sengon (Albizia chinensis) and mahoni (Swietenia mahagoni) IDR 1,372,922 / month (20.99%), forage king grass (Pennisetum purpupoides) and Calliandra (Calliandra haematocephalus) IDR 893.305 / month (13.66%), plantation namely Salacca zalacca and coconut (Cocos nucifera) IDR 640. 671 / month (9.79%), and food crops are cassava (Manihot utilissima) IDR 5556 / month (0.08%). Therefore, considering the farm accounted for the highest share of the income of goat especially doe farmers hence the need for additional scale farmer's income.

Keywords: mixed farming, income, Integrated Farming System, Ettawa Crossbred goat

INTRODUCTION

Production systems integrating crops and livestock have potential for providing additional ecosystem services from agriculture by capturing positive ecological interactions and avoiding negative environmental outcomes, while sustaining profitability (Sulc and Franzluebbers, 2014). Development of livestock using integration patterns in plantations (palm oil, coffee, cocoa, palm) has very good prospects; while in the whereas goat -sallaca can serve as a producer of compost (Dwiyanto *et al*., 2004). Manure was the second reason stated for keeping small ruminants. Farmers use sheep and goat manure as fertiliser for their fruit trees and paddy fields. (Budisatria *et al*., 2007). Mixed farming provides a range of products, and enables farmers to diversify risk from a single commodity (Devendra, 2011). Mixed crop-livestock systems, combining livestock and cash crops at farm level,- are considered to be a good way to achieve sustainable intensification of agricultural systems (Ryschawy *et al*., 2012 , Hendrickson et *al.,* 2008). In Java mixed farming adapted to the seasons and topography. Integration goats and corn crops in the lowlands as well as the legume in the highlands, while in the rainy season and the dry season is dominated grasses are rice (Budisatria *et al*., 2010).

MATERIAL AND METHOD

The location selected in Sleman district which is a center for the breeding and milking production of ettawa crossbred goats in Yogyakarta. Collecting data census farmers as much as 71 respondents in the hamlet Kemirikebo,Village Girikerto. Descriptive analysis was used to explain the characteristics of the respondents, the income share mixed farming systems from forestry, grass, plantation, crop , and livestock obtained from the tabulation of questionnaires.

RESULTS AND DISCUSSION

Based on the research results, judging from the characteristic of respondents, including productive farmers age (48.42 years) and business experience has been effort hereditary (16:11 years). The mean level of similar high school education (39.44%) influence on non-formal education that followed, in particular relating to the implementation of the feed and waste treatment technologies. Both of these technologies are indispensable to the integration of crop-livestock systems (Table 1)

The results showed that the highest income comes from livestock with Ettawa Crossbred goat ownership of 8.54 head or 1.06 UT . Forestry namely sengon (Albizia chinensis) and mahoni (Swietenia mahagoni), each with the number of trees as much as 11 465 and 1532 trees and the selling price of IDR 450,000 / tree IDR 1,372,922 / month/farmer (20.99%). Forage namely King grass (Pennisetum purpupoides) and Calliandra (Calliandra haematocephalus) with average area 19500m^2 and 35945m^2, the selling price of IDR 700 / kg, IDR 893.305 / month/farmer (13.66%). Plantation namely Salacca zalacca and coconut (Cocos nucifera) with the number 45 975 and 257 trunks of trees, the sale price IDR 5000 and 3500 / kg IDR 640. 671 / month / farmer (9.79%), and food crops are cassava (Manihot utilissima) with a total production of 3945 kg / year and the selling price of IDR 1200 / kg , IDR 5556 / month /farmers (0.08%).

Table 1. Characteristics of respondents

Component	value
Age (year)	48.42 ± 15.10
Business experience (year)	16.11 ± 10.49
Formal education (%)	
No School	22.54
Elementary School	26.76
Junior High Schools	9.86
High Schools,	39.44
Colleges	1.41
Family members (person)	1.16 ± 0.51
The main job (%)	
On farm	46.48
Non farm	15.49
Non formal education (%)	
Feed technology	33.80
Artificial Insemination	4.22
Animal health	4.22
Waste treatment	11.27

Table 2. Average income from crop-livestock integration system

kinds of plants	Income (IDR/ month / farmer)
Crops (Cassava)	5,556.34
Total	5,556.34
Plantation	
Salacca zalacca	513,981.07
Cocos nucifera	126,690.14
Total	640,671.21
Forage	
Pennisetum purpupoides	308,566.90
Calliandra haematocephalus	584,739.08
Total	893,305.99
Forestry	
Albizia chinensis*	1,211,091.55
Swietenia mahagoni*	161,830.99
Total	1,372,922.54
Livestock	3,628,149

Note : *crop harvested at an average age of 5 years

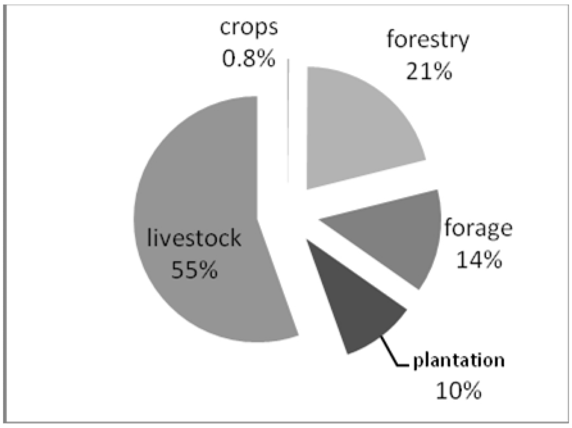


Figure 1. The percentage of income from crop-livestock integration

Farmers raise goats for milking and breeding ie.54.29% and 45.71% of milk production and for breeding. Average milk production of 0.81 liters / head / day with an average ownership of doe lactation 4 head or 12:18 UT (Table 3).

Table 3. Potential income from the livestock system

Kind		Average(IDR/month)
Cash	sale of goat	1.627.876
	fertilizer sales	13.515.73
	sales of milk	464.323.9
	Total	2.105.715
Non cash	the added value of doe	303.169
	the added value of kid	165.845.1
	Total	469.014.1
Total Revenue		182.805.783

The highest costs incurred namely the purchase goats. This is because the respondents have a primary job as a trader of goat and goat owned are often used for livestock contests so often buy superior breeding stock. Fees are calculated from labor forage farmers when looking for forage with the calculation of wages of agricultural workers in the hamlet Kemirikebo is IDR 50.000,00 / day with an effective working hours to 6 hours. Land leases in the village group system IDR 10.000,00 / year / plots. Land lease forage is IDR 100,00 / m^2 / year and the average land area of 938,57m^2 (Table 4).

Table 4. The total cost from the livestock system

Expenses	Average (IDR/month)
Variable cost	
purchase goats	932.335,7
purchase of equipment	3.236,143
capital interest	49.550,7
renting male goat	6.631,45
feed concentrates	242.618,7
forage	428.281,5
supplement	4.696,24
drugs	4,894,6
family labor	98.591,51
labor affairs	37.464,79
mortality	100.939
Total	1.909.240
Fixed cost	
land leases	2.369,71
depreciation tool	3.843,04
depreciation cage	46.067,88
Total	52.280,64
Total cost	4.961.520

Based on the results of research, income comes from the highest integration system of factory farming. Therefore, to increase the total revenue from the integration of crop-livestock systems in addition to increasing the number of lactation doe are also necessary to increase socialization as a breeder of dairy cattle rearing system so that the income from milk production can be optimized

REFERENCES

Budisatria, I.G.S., Udo, H.M.J., Eilers, C.H.A.M., van der Zijpp, A.J., 2007. Dynamics of small ruminant production: a case study of Central Java.Indonesia. Outlook Agric. 36, 145–152.

Budisatria, I.G.S., Udo, H.M.J., Eilers, C.H.A.M., Baliarti, E., van der Zijpp, A.J., 2010. Preferences for sheep or goats in Indonesia. Small Rumin. Res. 88,16–22.

Diwyanto, D.Sitompul, I. Manti, I-W Mathius dan Soentoro. 2004. Assessment Systems

Integration Business Development Oil Palm-Cattle. Proceedings of the National Workshop on Systems Integration Oil Palm- Cattle. Agriculture Department Bengkulu collaboration with the Provincial Government and PT Agricinal.

Devendra, C. 2011. Integrated Tree Crops-ruminants Systems in South East Asia: Advances in Productivity Enhancement and Environmental Sustainability. Asian-Aust. J. Anim. Sci. 24 (5): 587 – 602

Gujarati, D.N. 2003. Basic Econometrics. Fourth Edition. Published by McGraw-Hill Printed in Singapore

Hendrickson JR, Hanson JD, Tanaka DL and Sassenrath GF 2008. Principles of integrated agricultural systems: introduction to processes and definition.Renewable Agriculture and Food Systems 23, 265–271.

J. Ryschawy, N. Choisis, J. P. Choisis, A. Joannon and A. Gibon .2012. Mixed croplivestock systems: an economic and environmental friendly way of farming? J. Animal, 6: 1722 – 1730

Sulc, R.M. and A.J. Franzluebbers, 2014. Exploring integrated crop – livestock systems in different ecoregions of the United States. Europ. J. Agronomy ,57 (2014) 21–30.

OXYGEN SATURATION OF LAMBS DURING ESTROUS CYCLE WITHIN DIETS WITH DIFFERENT CATION AND ANION RATIO

FARIDA FATHUL[1)] AND ENDANG LINIRIN WIDIASTUTI[2)]

[1)]Animal husbandry Dept., Faculty of Agriculture – The University of Lampung –
Jl. Prof Dr. Sumantri Brojonegoro 1, Bandar Lampung 35145, Indonesia,
[2)] Biology Dept., Faculty Math and Sciences - The University of Lampung –
Jl. Prof Dr. Sumantri Brojonegoro 1, Bandar Lampung 35145, Indonesia, elwidi@yahoo.com

ABSTRACT

Estrous cycle is known consumed much energy than normal state of many rumens. The oxygen consumption for generating this energy could be accounted by determining the oxygen saturation, in which diets affected for improving effectiveness of oxygen saturation. Different diets with different ratio of cation and anion was assigned for this study. Five different cation and anion ratio diets were given to the lambs which already experienced with pregnancies, they were -28, -18, 0, + 14 and +32 mEq (of dietary cation and anion different/DCAD), each was replicated by 3. Group A (-28 mEq) were given normal diet with 0.230 g S + 0.446 g Cl, group B (-18 mEq) were given normal diet with 0.230 g S + 0.286 g Cl, group C (0 mEq) were given normal diet with 14.259 g S, group D (+14 mEq) were given normal diet only, group E (+32 mEq) were given normal diet with 0.235 g Na + 0.523 g K. Randomized groups were assigned for this study and ANOVA was used to analyze the collecting data such as blood pH, pCO_2, pO_2 and percentage of Hb O_2. Data was collected before and during estrous states. The result indicated that in most of groups, the pH as well as pCO_2 increased significantly during estrous, while the pO_2 and percent of Hb-O_2 decreased. Different ratio of cation and anion did not show any significant different among groups.

Key words: DCAD, blood, pH, oxygen,

INTRODUCTION

Modern livestock likely depend on the development of biotechnical and biotechnological methods which are playing the mayor roles in order to get more meat and more milk production. In the term of getting more meat, many livestock are depended in the female offspring. It is believed that vaginal fluid might affect the sex ratio of offspring (Pratt, *et al*, 1987), therefore manipulating the vaginal fluid may produced more female or male depend on what they need for. If the vaginal fluid close to basic more male offspring would be delivered, unlike with acidic fluid more female offspring would be delivered.

Cation-Anion in diets plays important roles in osmotic pressure, nerve function, metabolism etc. Even some of activities/animal performance needs more cation-anion intake, such as during parturition and lactation, beside their need on energy supply through metabolism. During that period of activities, for sure, the need of oxygen to bind to hemoglobin is high enough and plays a major role in succeed of their performances. In addition to it, different cation-anion on dietary (DCAD) affected the acid base of blood (Stewart, 1983). Related to major issues above, the study was conducted to determine the effect of differences in cation anion in diets on energy metabolism through hemoglobin-oxygen binding and pH of blood which is important for further possibility to change the sex ratio of newly born lambs of Domba Garut var. Therefore, we would like to evaluate **how the differences in cation-anion on diets affect the oxygen concentration in blood?**

MATERIALS AND METHODS

The study was conducted in Nutrition Lab of Animal Husbandry Faculty of Bogor Agriculture Institute (IPB) and Laboratory of Rehabilitation Unit (URR) – Dept. Veterinary, Bogor Agriculture Institutes (IPB). Animal diet consisted of 65 days-Haway corn leaves, padi peels, cassava, corn meals, coconut and soy beans remnants, fish oil, minerals: Zn SO_4, Na_2CO_3, K_2CO_3, $CaCL_2$, and $CaSO_4$. For worm preventive, the lambs/animals were given some medicinal substances provided by Nova Laboratories Sdn. Bhd. Sungai Pelek Sepang, Malaysia: *Vita vet* injectable solution and Alben 10% as oral suspension. Hormone was also delivered which was 0.3 g of progesterone EAZI-BREED™ (CIDR®). Other materials used were cotton, alcohol, jelly (mix of 30.0 g carboxymetilcelulosenatrium, 100.0 g glicerol 85.0%, and 1000 ml renset vand metilparahydroxybenzoat 0.1%), glicerol, milique water, aquades. 15 ewes (*Ovis aries*) from Garut-West Java were used as sample animals with their average body weight of 22 − 36 kg.

Equipments used for this study such as food and drinking plates, buckets, O-Haus analytic balances with accuracy of 0.001 g, capacity of 2 kg, 10 kg, 100 kg. Tools for mixing the feed, syrink, venoljект, vacuum tube lithium heparin 7 ml, micropipet ependorf (1.5 and 2.0 ml), plastic material, apron, speculum, CIDR setting aplicator, cortex, centrifuge (with 2500 rpm), Radiometer ABL 700 Series.

Methods: As already mentioned in other paper, this research used basic animal dietary with 15.0% crude protein based on Wodzicka-Tomaszewska *et al*. (1991). In order to determine the diet content, Proximate Analysis was applied to all animal diet and done in Laboratorium Pusat Antar Universitas (PAU) IPB. While, mineral analysis of Na, K, Ca, Mg, P was conducted in Nutrition Lab of Animal Husbandry Faculty of Bogor Agriculture Institute (IPB) and for Cl and S was done in Bogor – Center of Soil Research (Puslitan – Bogor). *Dietary cation-anion different* (DCAD) was calculated based on Na, K, Cl, and S content of the total animal basic dietary. DCAD formula was generated by Tucker *et al*. 1992 and as follow:

DCAD (mEq)= (Na+K) – (Cl+S) (mEq/100 g BK diet)

Therefore, the DCAD number was +14 mEq/100 g of dry diet.

The treatment groups based on the cation-anion balance from basic dietary then was modified with addition of cation or anion to modified diet become 28, -18, 0, dan +32 mEq. The diet composition, amount of mineral added, and the nutrition content of treatment diets could be seen in Tabel 1.

Acclamation was performed for the sample animals by giving mix dietary for approximately 2 months. Each animal was randomly placed in metabolic cages and was fed and drink *ad libitum* twice a day at 07.00 am and 14.00 pm. To prevent sample animals from infecting worms, they were given 10% suspension of Alben as much as 2 ml/anima, a week prior acclamation time.

Data Collection:

1. First data collected when the animals found nonpregnant was for their body weights. Then, they were fed-drink *ad libitum* and the amount of diets was determined and given for the next day.
2. At the 7th day, sample animals were syncronized for their estrous cycle using EAZI-BREED™ CIDR® (implanted in vagina and was made for 13 day).

3. At the 13th day prior feeding period, blood was collected from Vena Jugularis, to determine blood parameters before estrous.
4. At the 13th day after implantation of CIDR, the CIDR was taken out from vagina of each animal.
5. At the 1st and 2nd day after CIDR was taken out, estrous condition of animals was observed and blood was collected from Vena Jugularis, for 2 – 3 ml, heparinized, centrifuged and analyzed for blood pH, gassous partial pressures and Hb-O_2 (oxygen saturation) - before and during estrus using Radiometer ABL 700 series.

Tabel 1. Dietary composition: mineral and nutrient content of treatment diets*

Criteria	DCAD treated diets (mEq/100 g dry diet)				
	-28	-18	0	+14	+32
Dietary composition (% dry weight of basic diet)					
Corn leaves	35.000	35.000	35.000	35.000	35.000
Padi peels	6.000	6.000	6.000	6.000	6.000
Cassava	9.500	9.500	9.500	9.500	9.500
Corn meals	18.500	18.500	18.500	18.500	18.500
Coconut remnant	7.000	7.000	7.000	7.000	7.000
Soy beans remnant	22.000	22.000	22.000	22.000	22.000
Fish oil	2.000	2.000	2.000	2.000	2.000
Minerals (g/kg dry weight of basic diet)					
Zn SO_4	0.124	0.124	0.124	0.124	0.124
$CaSO_4$	9.881	9.881	9.700	-	-
$CaCl_2$	6.974	4.965	-	-	-
Na_2CO_3	-	-	-	-	4.015
K_2CO_3	-	-	-	-	5.202
Nutrient Content (% dry weight)*					
Dry weight**	89.300	89.300	89.300	89.300	89.300
Ash**	8.118	8.118	8.118	8.118	8.118
Crude Protein**	15.003	15.003	15.003	15.003	15.003
Crude Lipid/fat**	5.118	5.118	5.118	5.118	5.118
Crude Fiber**	14.733	14.733	14.733	14.733	14.733
Nitrogenless extraction **	57.028	57.028	57.028	57.028	57.028

note:
* This table is also used by another article (Fathul and Widiastuti, 2016)
** = Analyzed by Laboratorium Pusat Antar Universitas (PAU) IPB

Treatment dietary of the research as follow:
1. A (-28 mEq) = basic diet added with 14.375 mEq (0.2300 g S) and 27.884 mEq (0.4461 g Cl)
2. B (-18 mEq) = basic diet added with 14.375 mEq (0.2300 g S) and 17.884 mEq (0.286 g Cl)
3. C (0 mEq) = basic diet added with 14.259 mEq (0.2281 g S)

4. D (+14 mEq)=basic diet only
5. E (+32 mEq)= basic diet added with h 10.21 mEq (0.235 g Na) and 7.531 mEq (0.5232 g K)

Data Analysis

All the collected data were analyzed by using ANOVA followed by LSD at 5% level in SPSS -17 program.

RESULTS AND DISCUSSIONS

Different cation-anion dietary (DCAD) on the blood parameters could be seen in Table 2. Basically, DCAD did not show any differences in blood gaseous parameters.

Tabel 2. The effect of different cation-anion dietary on oxygen saturation

Groups	Blood Gases Variables	pH X + SEM	pCO_2 X + SEM (mmHg)	pO_2 X + SEM (mmHg)	Hb-O_2 X + SEM (%)
Estrous	A	7.37 ± 0.01	38.00 ± 6.22	37.47 + 5.82	68.10 ± 9.32
	B	7.37 ± 0.03	40.47 ± 7.42	37.10 + 2.11	68.70 ± 4.33
	C	7.40 ± 0.01	40.89 ± 3.41	34.44 + 7.23	63.67 ± 14.58
	D	7.36 ± 0.03	44.93 ± 5.98	36.07 + 4.56	65.37 ± 9,85
	E	7.40 ± 0.00	39.63 ± 1.61	42.37 + 4.03	77.10 ± 4.26
	X_{ABCDE}	**7.38 ± 0.02**	**40.77 ± 5.11**	**37.47 ± 5.09**	**68.59 ± 9.21**
Non-estrous	A	7.41 ± 0.00^b	34.53 ± 4.98	43.67 ± 5.30	78.83 ± 5.45
	B	7.42 ± 0.01^b	36.37 ± 2.70	40.60 ± 3.62	76.13 ± 4.12
	C	7.48 ± 0.03^a	35.0 ± 6.09	43.87 ± 8.52	80.47 ± 8.17
	D	7.37 ± 0.05^b	43.20 ± 4.86	40.27 ± 6.65	71.93 ± 9.97
	E	7.38 ± 0.05^b	40.83 ± 6.12	47.38 ± 9.34	79.6 ± 8.53
	X_{ABCDE}	**7.41 ± 0.05**	**38.17 ± 5.49**	**43.15 ± 6.49**	**77.39 ± 7.14**

[a,b] Superscript at the means in the same column indicated significantly different LSD at 5%

However, DCAD affected the blood pH from non-estrous groups, increasing in cation or anion did change the blood pH, but not during estrous groups. The blood pH of all groups were still in normal range which was 7.35 – 7.45 (Anstey, 2005; Story *et al*, 2004). This acid-base of the blood was very crucial during animal performance, like those in parturition or lactation or even during determining the sex of offspring (Pratt *et al*, 1987). DCAD during lactating in cattle like cows affected the acid-base of the blood (Hu and Murphy, 2004).

Oxygen pressure in blood was greater in non estrous period as well as the percentage of hemoglobin-oxygen binding, reaching above 77%. This indicated that prior estrous, physiologically, the animals need to serve and provide more energy. Estrus or known as heat is energy consumable. However, reproductive efficiency in most ruminant, like sheep, depended on food resource accessibility as well as status of energy of each animal (Sejian *et al*, 2010). Naqvi *et al* (2013) indicated also that enhanced nutrition (by concentrating supplementation prior to breeding) used as a tool to increase ovulation rate and overall reproductive efficiency.

From the data we can see that DCAD which was in more basic, (diet with + 14 mEq) seemed increase in oxygen pressure in the blood, both in period of estrous and non estrous reached 42.37 – 47.38 (mmHg). Increasing the blood oxygen pressure could be accounted for the use of cation on diet, such as sodium and potassium to enhance the ability of blood to absorb more oxygen, in which then increase the percent of hemoglobin binding, above 77%. It is well known that these two cations were playing in major role in nerve function and other muscle contraction, beside their function in acid-base of body fluids.

We can conclude that different cation – anion ratio on diets did not give any significant different in blood gaseous, pCO_2, pO_2 and HB-O_2. However, the oxygen saturation reached up to 77% prior estrous period. The DCAD affected only those in phase before estrous (non estrous), the pH was affected either by increase/decrease in cation-anion ratios on diets.

REFERENCES

Anstey, C.M. 2005. Comparation of three strong ion models used for quantifying the acid-base status of human plasma with special emphasis on the plasma weak acids. *J Appl Physiol* 98:2119–2125.

Hu, W., M. R. Murphy. 2004. Dietary Cation-Anion Difference Effects on performance and Acid-Base Status of Lactating Dairy Cows: A Meta-Analysis. J. Dairy Sc. 87:2222-2229.

Naqvi, S. M. K., V. Sejian, and S.A. Karim. 2013. Effect of feed flushing during summer season on growth, reproductive performance and blood metabolites in Malpura ewes under semiarid tropical environment. Trop. Anim. Health Prod 45:143–148 DOI 10.1007/s11250-012-0185-2.

Pratt, N.C., U.W. Huck, R.D. Lisk. 1987. Offspring sex ratio in hamsters is correlated with vaginal pH at certain times of mating. *Behav Neural Biol* 48:310−316.

Sejian, V., V.P. Maurya, S.M.K. Naqvi, D. Kumar, and A. Joshi. 2010. Effect of induced body condition score differences on physiological response, productive and reproductive performance of Malpura ewes kept in a hot, semi-arid environment. Journal of Animal Physiology and Animal Nutrition, 94(2), 154-161.

Stewart PA. 1983. Modern quntitative acid-base chemistry. *Can J Physiol Pharmacol* 61:1444−1461.

Story, D.A., H. Morimatsu, R. Bellomo. 2004. Strong ions, weak acids and base excess: a simplified Fencl-Stewart approach to clinical acid-base disorders. *J. Anaesthesia* 92(1):54−60.

Tucker, W.B., Hogue, J.F., Waterman, D.F., Swenson, T.S., Xin, Z., Hemken, R.W., Jackson, J.A., Adams, G.D., Spicer, L.J. Sulfur should be included when calculating the dietary cation-anion balance of diets for lactating dairy cows. Animal Science Res. Rep., Oklahoma State Univ., Stillwater; 1992 (Pages 141–150).

Wodzicka-Tomaszewska M, I.K. Sutama, I.G. Putu, T.D. Chaniago. 1991. *Reproduksi, Tingkah laku, dan Produksi Ternak di Indonesia.* Diterbitkan atas kerjasama Direktorat Jenderal pendidikan Tinggi dan International Development Program of Australian Universities and Colleges. Jakarta: Gramedia Pustaka Utama.

DIFFERENCE OF CATION AND ANION DIETS ON LEUCOCYTES DIFFERENTIATION OF LAMB DURING ESTROUS CYCLE

FARIDA FATHUL[1)] AND ENDANG LINIRIN WIDIASTUTI[2)]

[1)]Animal husbandry Dept., Faculty of Agriculture – The University of Lampung –
Jl.P. Dr. Sumantri Brojonegoro 1, Bandar Lampung 35145, Indonesia,
farida.fathul@gmail.com
[2)] Biology Dept., Faculty Math and Sciences - The University of Lampung –
Jl. P. Dr. Sumantri Brojonegoro 1, Bandar Lampung 35145, Indonesia, elwidi@yahoo.com

ABSTRACT

Blood status of rumen is important to determine physiological conditions; especially those are in estrous cycle. It is also known that diets affect the blood status of rumens, therefore this study was determined to evaluate leucocytes differentiation of lamb during estrous cycle given different cation and anion ratio on their diets. Five different cation and anion ratio diets were given to the lambs which already experienced with pregnancies, they were -28, -18, 0, + 14 and +32 meq (of dietary cation and anion different/DCAD), each was replicated by 3. Group A (-28 meq) were given normal diet with 0.230 g S + 0.446 g Cl, group B (-18 meq) were given normal diet with 0.230 g S + 0.286 g Cl, group C (0 meq) were given normal diet with 14.259 g S, group D (+14 meq) were given normal diet only, group E (+32 meq) were given normal diet with 0.235 g Na + 0.523 g K. The blood variables were determined before and during estrus, they were the number of red blood cells (RBC/cells-mm^{-3}), Hb content (g %), hematocrit (%), and the leucocytes differentiation (leucocyte, monocyt, lymphocyt, eosinophil /cells mm^{-3}). ANOVA was applied to analyze the collecting data with α 5%, followed with LSD at α 5%. The result indicated that decreasing the cation on diet affected on lowering of RBC and Hb of the blood ($p \leq 0.05$) before estrus, while during estrus there was no significant different among blood variables.

Key words: Cation/anion, leucocytes, differentiation, lamb

INTRODUCTION

Different cation and anion ratio on diet affect metabolism of animals, especially mammalian which undergo estrous cycle. This different cation and anion ratio on dietary is known improving the acid and base balance in which then effect the milk yield and feed intake (Hu and Murphy, 2004). Beside that cation and anion play important role in many physiological activities, such as nerve function including hormone release, muscle contraction, etc.

Hematological parameters of ruminants particularly for goats and sheep are influenced by the biological condition of the animals themselves, such as age and sex (Egbre-Nwiyi *et al*, 2000). In which age and sex are correlated each other, particularly for the female that undergo estrous cycle. Therefore, this study was also try to evaluate any changes in blood/hematological parameters of the female lambs related to estrous and non estrous periods at given different cation and anion ratio on dietary.

MATERIALS AND METHODS

Materials: The study was conducted in field work, Nutrition Lab of Animal Husbandry Faculty of Bogor Agriculture Institute (IPB) as well as in Lab of Rehabilitation Unit (URR) – Dept. Veterinary, Bogor Agriculture Institutes (IPB). Animal feed consisted of 65 days-Haway corn leaves, padi skin, cassava, corm meals, coconut and soy beans remnants, fish oil, minerals: Zn SO_4, Na_2CO_3, K_2CO_3, $CaCL_2$, and $CaSO_4$. Some medicinal substances provided by Nova Laboratories Sdn. Bhd. Sungai Pelek Sepang, Malaysia, *Vita vet* injectable solution, were also given, as well as Alben 10% as oral suspension for worm preventive. Hormone was also given, 0.3 g of progesterone EAZI-BREED™ (CIDR®). Others were cotton, alcohol, jelly (mix of 30.0 g carboxymetilcelulosenatrium, 100.0 g glicerol 85.0%, and 1000 ml renset vand metilparahydroxybenzoat 0.1%), glicerol, milique water, aquades. For animal sampels were used 15 ewes (*Ovis aries*) from Garut-West Java with average body weight of 22 − 36 kg.

Equipment used for this study food and drinking plates, buckets, O-Haus analytic balances with accuracy of 0.001 g, capacity of 2 kg, 10 kg, 100 kg. Tools for mixing the feed, syrink, venolject, vacuum tube lithium heparin 7 ml, micropipet ependorf (1.5 and 2.0 ml), plastic material, apron, speculum, CIDR setting aplicator, cortex, centrifuge (with 2500 rpm), Radiometer ABL 700 Series.

Methods: This conducting research used basic animal diet need with 15.0% crude protein based on Wodzicka-Tomaszewska *et al*. (1991). Proximate Analysis was applied to all animal diet and done in Laboratorium Pusat Antar Universitas (PAU) IPB. Mineral analysis of Na, K, Ca, Mg, P was conducted in Nutrition Lab of Animal Husbandry Faculty of Bogor Agriculture Institute (IPB) while Cl and S was done in Bogor – Center of Soil

Research (Puslitan – Bogor). *Dietary cation-anion different* (DCAD) was calculated based on Na, K, Cl, and S content of the total animal basic diet with formula generated by Tucker *et al*. 1992, as follow:

DCAD (meq)= (Na+K) – (Cl+S) (meq/100 g BK diet)

From this calculation the DCAD number was +14 meq/100 g of dry diet.

The treatment groups based on the cation-anion balance from basic diet then was modified with addition of cation or anion to form 28, -18, 0, dan +32 meq. The diet composition, amount of mineral added, and the nutrition content of treatment diets could be seen in Tabel 1.

Tabel 1. Diet composition, amount of additional mineral and nutrient content of treatment diets

Criteria	DCAD treated diets (meq/100 g dry diet)				
	-28	-18	0	+14	+32
Diet composition (% dry weight of basic diet)					
Corn leaves	35.000	35.000	35.000	35.000	35.000
Padi peels	6.000	6.000	6.000	6.000	6.000
Cassava	9.500	9.500	9.500	9.500	9.500
Corn meals	18.500	18.500	18.500	18.500	18.500
Coconut remnant	7.000	7.000	7.000	7.000	7.000
Soy beans remnant	22.000	22.000	22.000	22.000	22.000
Fish oil	2.000	2.000	2.000	2.000	2.000
Minerals (g/kg dry weight of basic diet)					
$ZnSO_4$	0.124	0.124	0.124	0.124	0.124
$CaSO_4$	9.881	9.881	9.700	-	-
$CaCl_2$	6.974	4.965	-	-	-
Na_2CO_3	-	-	-	-	4.015
K_2CO_3	-	-	-	-	5.202
Nutrient Content (% dry weight)*					
Dry weight*	89.300	89.300	89.300	89.300	89.300
Ash*	8.118	8.118	8.118	8.118	8.118
Crude Protein*	15.003	15.003	15.003	15.003	15.003
Crude Lipid/fat*	5.118	5.118	5.118	5.118	5.118
Crude Fiber*	14.733	14.733	14.733	14.733	14.733
Nitrogenless extraction *	57.028	57.028	57.028	57.028	57.028

note:
* = Analyzed by Laboratorium Pusat Antar Universitas (PAU) IPB

Treatment diets of the research were:

1. A (-28 meq) = basic diet added with 14.375 meq (0.2300 g S) and 27.884 meq (0.4461 g Cl)
2. B (-18 meq) = basic diet added with 14.375 meq (0.2300 g S) dan 17.884 meq (0.286 g Cl)

3. C (0 meq) = basic diet added with 14.259 meq (0.2281 g S)
4. D (+14 meq)= basic diet only
5. E (+32 meq)= basic diet added with h 10.21 meq (0.235 g Na) dan 7.531 meq (0.5232 g K)

The animals were acclimated with mix diets for almost 2 months. Each animal was randomly put in metabolic cages and was fed and drink twice a day at morning (07.00 am) and afternoon (02.00 pm) *ad libitum*. A week later animals were given 10% suspension of Alben for worm preventive, 2 ml/animal.

Collecting data:

1. Data first collected when the animals were found nonpregnant for their body weights. They were fed-drink *ad libitum* and the amount of diets was determined and given for the next day.
2. At the 7th day, estrous cycle of animals were syncronized by using EAZI-BREED™ CIDR® (implantation in vagina was made for 13 day).
3. At the 13th day prior feeding period, blood was collected from jugularis vine, to determine blood parameters before estrous.
4. At the 13th day after implantation of CIDR, the CIDR was taken out from vagina of each animal.
5. At the 1st and 2nd day after CIDR was taken out, estrous condition of animals was observed and blood was collected from jugularis veins, for 2 – 3 ml and analyzed for the red blood cells (RBC), pack cell volume (PCV), Hemoglobin (Hb) and white blood cells (WBC), as well as their WBC differentiation. Blood collection followed methods presented by Jones and Allison (2007).

Data Analysis

All the collected data were analyzed by using ANOVA followed by LSD at 5% level in SPSS -17 program.

RESULTS AND DISCUSSION

Effect of diets with different cation-anion ratio on blood parameters could be seen in the Table 2. Even though there was no statistical significant different among groups of different cation-anion ratio on diets for RBC, PCV, Hb, and WBC. There was decrease in RBC but increase in WBC during estrous. Meanwhile, the percentage of hemoglobin (Hb%) did not affected by different in cation-anion ratio of diets. All the blood parameters lay within the normal number of blood cells (Kramer, 2000), in which the RBCs ranging from 8 – 18 10^6 cells/mm^3, PCV 22 – 38, and Hb 8 – 12 (g %).

Table 2. The effect of different cation-anion on diet in blood parameters

Groups / Blood Parameters		RBC (10^6)cells/mm^3	PCV (%)	Hb (g %)	Leu/WBC (10^3) cells/mm^3
Estrous	A	11.56 $\pm$ 3.43	36.83 $\pm$ 5.77	11.33 $\pm$ 0.41	8.05 $\pm$ 1.33
	B	11.25 $\pm$ 1.57	34.92 $\pm$ 3.16	10.6 $\pm$ 1.22	9.22 $\pm$ 1.71
	C	10.77 $\pm$ 1.26	32.92 $\pm$ 0.88	9.8 $\pm$ 0.88	16.82 $\pm$ 10.33
	D	8.58 $\pm$ 1.16	33.0 $\pm$ 3.5	10.13 $\pm$ 0.42	19.68 $\pm$ 18.2
	E	9.57 $\pm$ 3.77	34.58 $\pm$ 4.84	10.47 $\pm$ 1.89	13.97 $\pm$ 4.58
	X_{ABCDE}	10.34 + 0.62	34.45 + 0.77	10.39 + 0.26	
Non-estrous	A	12.29 $\pm$ 0.29	34.92 $\pm$ 2.13	11.27 $\pm$ 0.61	7.63 $\pm$ 3.36
	B	11.50 $\pm$ 0.76	34.75 $\pm$ 4.13	10.8 $\pm$ 1.51	6.46 $\pm$ 1.05
	C	10.28 $\pm$ 0.92	30.58 $\pm$ 1.23	9.60 $\pm$ 0.53	9.11 $\pm$ 1.48
	D	11.79 $\pm$ 1.21	33.67 $\pm$ 5.35	10.13 $\pm$ 1.03	8.13 $\pm$ 4.07
	E	11.69 $\pm$ 1.84	31.92 $\pm$ 2.27	10.13 $\pm$ 0.61	8.91 $\pm$ 5.68
	X_{ABCDE}	11.51 + 0.30	33.17 + 0.86	10.47 + 0.28	

Increase in RBC of non-estrous groups could be accounted for preparation of estrous cycle, while fluctuation in WBC of each groups was not fully understood, but it likely to be affected by stress level of each animal, even though they were kept them in normal state and were acclimated in metabolic cages. In order to understand this phenomenon, the differentiation of the WBC was determined and can be seen in Table 3.

Given different cation-anion ratio on diets did not show any significantly different for differentiation of WBC in estrous groups, unlike those in non-estrous groups. However, both groups indicated that percentage of lymphocytes was the highest among other WBC differentiation. Different cation-anion ratio on diets affected the WBC differentiation of non-estrous groups. The percentage of neutrophils was far less in group given ration cation-anion +32 meq (E group) compared to others, but the number of lymphocytes was far more than others ($p<0.05$).

Tabel 3. Differentiation of leukocytes on different diets with different cation-anion ratio

Groups Leucocytes Diff		Neutophils (%)	Lymphocytes (%)	Monocytes (%)	Eosinophils (%)
Estrous	A	39.00 ± 7.80	49.00 ± 3.00	3.33 ± 1.55	8.67 ± 5.50
	B	28.67 ± 8.02	51.00 ± 7.00	4.33 ± 1.53	16.00 ± 7.93
	C	30.00 ± 6.57	52.00 ± 7.00	3.00± 1.73	15.00 ± 3.00
	D	49.00 ± 34.22	34.67 ± 24.3	6.00 ± 6.00	10.33 ± 5.51
	E	37.33 ± 15.27	44.00 ± 16.64	3.67 ± 3.79	15.00 ± 5.29
	X_{ABCDE}	36.80 ± 4.43	46.13 ± 3.49*	4.07 ± 0.80	13.00 ± 1.46*
Non-estrous	A	31.33 ± 15.04^{ab}	56.33 ± 10.12^{b}	7.00 ± 3.00	5.33 ± 3.05^{b}
	B	32.33 ± 17.39^{ab}	53.00 ± 9.64^{b}	6.00 ± 2.60	8.33 ± 5.51^{b}
	C	35.33 ± 8.38^{ab}	54.67 ± 8.08^{b}	5.00 ± 1.70	5.00 ± 2.00^{b}
	D	42.67 ± 0.58^{a}	50.33 ± 20.50^{b}	4.33 ± 1.53	15.67 ± 0.58^{a}
	E	14.33 ± 5.51^{b}	80.33 ± 3.06^{a}	4.37 ± 2.08	4.33 ± 1.16^{b}
	X_{ABCDE}	31.20 ± 3.50	58.93 ± 3.88	5.33 ± 0.57	7.73 ± 1.30
Normal [1]		30 – 48	50 – 70	0 – 4	1 – 8

^{a,b} *Superscript at the means in the same column indicated significantly different LSD at 5%*
[1] Normal number based on Kramer, 2000
* Different at 5% between estrous and non estrous groups.

The number of neutrophils is likely affected by pathogen, like those in bovine in which the neutrophils of bovine mammary glands increased in cell numbers when *S. dysgalactiae* were injected to them (Blagitz *et al*, 2015). Since there was no infectious pathogen applied to these animals study, therefore, the normal number of neutrophils was gained for all of treatment groups, except the E group. Different cation-anion ratio on diet might be sufficient to control the neutrophils number. Meanwhile, the lymphocytes number was the highest among other WBC differentiation. It is known that lymphocytes are responsible for both humoral and cellular immunity, and in form of antibodies and in form of receptors of any antigen. The highest cation-anion ratio on diet seemed able to increase the production of lymphocytes in non estrous groups, but not during estrous. It seemed that production of lymphocytes was necessary prior estrous period. Seemingly, readiness of immunity of the female animals/lambs should be happened to ensure the breeding process. All treatment groups had the lymphocytes in nora, range based on Kramer (2000). Only those in group E, the lymphocytes number was above the normal. No explanation could be generated for this effect. However, given different cation-anion ratio on diet (DCAD) with +32 mEq seemed affected in more alkaline, and might affect the dry matter intake of animals, just like those in Holsteins cows (Chan *et al*, 2005) and improved the amino acid availability for protein synthesis (Wildman, 2007), therefore the number of lymphocytes reached much greater than other treatment groups. Beside that, the production of WBC in lambs or goats is affected by certain minerals which absorbed in bone marrow and also by sex differences, in which male goats have higher lymphocyte number of cells as compared to females, while the females have a higher neutrophil number of cells as compared to the males (Tambuwal *et al*., 2002; Daramola *et al.*, 2005).

When the sample animals were grouped from the estrous cycle, the number of eosinophils for both estrous and non estrous groups was significantly different. This could happen since the eosinophils work to fight bacterial or parasitic infectious as well as being produced to response with allergic. The estrous cycle then might affect this differences in cell numbers, even though both groups had number of cells still in normal range (Kramer, 2000) and no pathogenic particles

Based on the results we can conclude that the different cation-anion ratio on diet affected on the number of neutrophils and eosinophil and the increase in ratio cation-anion on diet of 32 mEq decreased in the number neutrophils but increased in the number of lymphocytes before estrous.

REFERENCES

Blagitz, M.G., F. N Souza, C. F Batista, Luis Fernando F Azevedo, Nilson Roberti Benites, Priscilla Anne Melville, Soraia A Diniz, Marcos X Silva, João Paulo A Haddad, Marcos Bryan Heinnemann, Mônica M O P Cerqueira and Alice M M P Della Libera (2015). The neutrophil function and lymphocyte profile of milk from bovine mammary glands infected with Streptococcus dysgalactiae. Journal of Dairy Research, 82, pp 460-469. doi:10.1017/S0022029915000308.

Chan, P.S., J.W.West, J.K. Bernard, J.F. Fernandez. 2005. Effect of Dietary Cation-Anion Differences on Intake, Milk Yield and Blood Component of the Early Lactation Cow. J. Dairy Sci. 88:4384-4392.

Daramola, J.O., A.A. Adeloye, T.A. Fatoba, A.O. Soladoye. 2005. Haematological and biochemical parameters of West African Dwarf goats. Livestock Research for Rural Development, 17, Art. 95. Retrieved January 19, 2011, from http://www.Irrd.org/Irrd.org/Irrd17/8/dara 17095. htm. 3:05 pm.

Egbe-Nwiyi, T.N., S.C. Nwaosu and H.A. Salami. 2000. Hematological Values of Appararently Healthy Sheep and Goats as Influenced by Age and Sex in Arid Zone of Nigeria. Afr. J. Biomed. Res. Vo. 3:109-115.

Hu, W., M. R. Murphy. 2004. Dietary Cation-Anion Difference Effects on performance and Acid-Base Status of Lactating Dairy Cows: A Meta-Analysis. J. Dairy Sc. 87:2222-2229.

Jones, M.L., R.W. Allisdon. 2007. Evaluation of the Ruminant Complete Blood Cell Count. Vet. Clin. Food Anim. 23:377-402

Kramer, J.W. 2000. Normal hematology of cattle, sheep, and goats. In Feldman BF, Zinkl, JG, Jain, NC, editors. Schalm's Veterinary Hematology, 5th Edition. Philladelphia-Lippincott. Williams & Wilkins. Pp. 1075-84.

Tucker, W.B., Hogue, J.F., Waterman, D.F., Swenson, T.S., Xin, Z., Hemken, R.W., Jackson, J.A., Adams, G.D., Spicer, L.J. Sulfur should be included when calculating the dietary cation-anion balance of diets for lactating dairy cows. Animal Science Res. Rep., Oklahoma State Univ., Stillwater; 1992 (Pages 141–150)

Tambuwal, FM, B.M. Agale, A. Bangana. 2002. Haematological and biochemical values of apparently healthy Red Sokoto goats. Proceeding of the 27th Annual Conference of the Nigerian Society for Animal Production, Federal University of Technology, Akure, *Nigeria*. pp. 50-53.

Wildman, C.D., J.W. West., and J.K. Bernard. 2007. Effect of Dietary Cation-Anion Difference and Dietary Crude Protein on Performance of Lactating Dairy Cows during Hot Weather. J. Dairy Sci. 90: 1842-1850.

Wodzicka-Tomaszewska M, I.K. Sutama, I.G. Putu, T.D. Chaniago. 1991. *Reproduksi, Tingkah laku, dan Produksi Ternak di Indonesia.* Diterbitkan atas kerjasama Direktorat Jenderal pendidikan Tinggi dan International Development Program of Australian Universities and Colleges. Jakarta: Gramedia Pustaka Utama.

EFFECT OF SIGER RICE FROM CASSAVA ON BLOOD GLUCOSE LEVEL AND THE PANCREAS IN MICE INDUCED ALLOXAN

SUBEKI[1], WISNU SATYAJAYA[1], MURHADI[1] AND ERWIN YULIADI[2]

[1]Department of Agricultural Product Technology, Agriculture Faculty, University of Lampung. Jl. S. Brojonegoro No. 1 Gedung Meneng – Bandar Lampung 35145
[2]Department of Agrotechnology, Agriculture Faculty, University of Lampung. Jl. S. Brojonegoro No. 1 Gedung Meneng – Bandar Lampung 35145
Email:bekisubeki@yahoo.com

ABSTRACT

Siger rice is a term to mention the product which resemble grains of rice that is processed by cassava. Siger rice is good to be consumed by diabetic's sufferer, because it has low glycemic index and rich dietary fiber. This research aims to know the effect of giving the siger rice on blood glucose level and the pancreas in mice induced alloxan. This research was conducted using a completely randomized design with 3 repetitions. This research used 27 mice which were divided into 9 groups. Each group consisted of three mice. Each group was fed with a different composition of siger rice. Then, the mice were maintained up to 28 days and given feed and drink *ad libitum*. The data were analyzed with Tuckey and followed by analysis of variance (anova) to obtain prediction error variance and to find out if any differences between treatments. The results from anova were then analyzed using least significant different (LSD) at 5% level. The results showed that giving of siger rice effect to decrease in blood glucose levels of mice. Giving siger rice III with composition siger rice:corn starch (30:35) decreased blood glucose level returned to normal 114.67 mg/dL on day 14 and improved performance of the pancreas.

Key words: alloxan, blood glucose, cassava, pancreas, siger rice

I. INTRODUCTION

Rice is one of the most important crops and a primary food source for more than half of the world's population (Dong et al., 2013). Rice supplying as much as half of calories of the world population (Abbas et al., 2011). Southeast Asia's consumers eat large quantities of rice. Most rice is consumed as fully milled white rice that is steamed or cooked in water and served in a bowl at a meal in the home or at restaurant (Baldwin et al., 2012). However, the population of rice consuming countries continue to grow and it is estimated that we will have to produce 40% more rice in 2030 (Khus, 2005).

Dependence on rice as a staple food of Indonesia is not matched by domestic rice production. From Indonesia statistic data in 2010, rice consumption achieves 34 million tones per year. In 2011, Indonesia imported 2.75 million tones (BPS, 2013). In 2019-2021 Indonesia will deficit 3,009 million tones of rices (Abdullah and Adhana, 2011). It proves that Indonesia does not have national food endurance. An effort is needed to supply food needs, thus reaching a solution which is food diversification. But the culture of Indonesian people who consume rice three times a day can be difficult to be changed. So an alternative food that resembeles rice as the main food is needed and contain almost the same nutrition as paddy rice. Siger rice is one of the alternatives that can be developed to substitute the paddy rice.

Siger rice is artificial rice that is produced from cassava with extruder method. Siger rice is made from cassava flour by mixing materials with adding 50% water to the mixture to form clumps, granulating mixture into rice using a extruder with single screw, evaporating grains for 24 hours at temperature of 60 °C and drying until the moisture content reaches below 10%. Siger rice product can be cooked using a minimal amount of water with one time the volume of rice.

Siger rice contains high carbohydrates. There is a considerable variation in bioavailability of carbohydrates among different foods though a higher percentage of carbohydrates in most human diet which is digested and absorbed in the small intestine. It has been suggested that diets containing large amounts of rapidly digestible carbohydrates may be elevate glucose level in blood, which is crucial for diabetics (Jenkins *et al.* 1988). Glycemic index (GI) has been developed for classification of foods containing carbohydrates, which provides quantitatively comparing the blood glucose responses following ingestion of equivalent amounts of digestible carbohydrates from different foods. It has been suggested that low GI foods have beneficial effects in the management of diabetes and high GI foods are crucial as they rapidly elevate glucose concentration in blood (Jenkins et al., 2008; Brouns et al., 2005).

Studies have shown that the digestibility of starch is partly attributed to the inherent properties of starch including crystallinity, granular structure, and amylose:amylopectin ratio. Therefore, the type of crop and variant process play an important role in determining the rate

 ISBN 978-602-0860-10-7

of digestion of their starch (Paes et al., 2008). This study was aimed to determine the effect of siger rice on blood glucose level and the pancreas in diabetic mice induced by alloxan.

II. METHODOLOGY

2.1. Method

This study was conducted in a completely randomized design with 3 replications. The study was conducted using 27 mice (*Mus musculus*) (strain BALB/C, male, 24 days old, weight 19-23 g) obtained from Lampung veterinary Medical Center. Mice were divided into 9 groups. Each group consisted of three mice. Each group was fed with different compositions of siger rice. Mice maintained up to 28 days and were given feed and drink *ad libitum*. The data were analyzed with Tuckey and followed by analysis of variance (anova) to obtain prediction error variance and to find out if any differences between treatments. The results from anova were then analyzed using least significant different (LSD) at 5% level.

2.2. Preparation of Cassava Flour

Cassava (variety of manggu, 8 months) was obtained from Way Kandis – Bandar Lampung. Cassava was peeled its skin and cleaned using water to remove impurities. The clean cassava was then sliced and soaked in water for 72 hours. Every day the water for soaking cassava was changed with clean water. After soaking, the cassava was dried in oven at 60 °C for 1-2 days. The dried cassava was grounded by using a grinding machine and sieved with the size of 60 mesh to get cassava flour. The cassava four was then processed into siger rice. Preparation of cassava flour can be seen in Figure 1.

Cassava
(10 kg)
- Peeling
- Washing
Clean cassava
Slicing
Soaking
(water, 72 hours)
- Filtering
Drying
(Oven, 60^{o}C)
Grinding
Sieving
(60 mesh)
Cassava flour

Figure 1. Preparation of cassava flour

2.3. Preparation of Siger Rice

Cassava flour 1 kg was mixed with 250 mL of water. The mixed cassava was steamed with a temperature of 90 ^{o}C for 5 minutes. The gelatinized cassava flour was then subjected to extruder (temperature 80^{o}C, RPM screw 2000, speed 10 kg/h) to form grains. The grains of siger rice were then dried in an oven (memmert) at a temperature 60^{o}C for 24 hours. Siger rice obtained was tested in animal experiments. Preparation of siger rice can be seen in Figure 2.

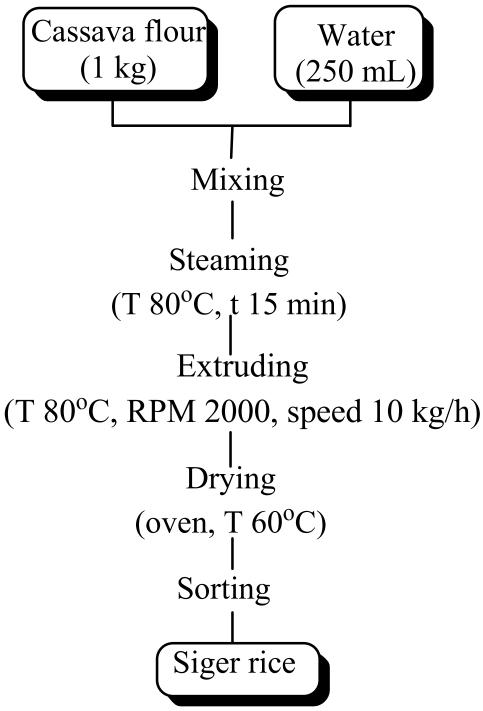


Figure 2. Flow chart of siger rice production

2.4. Introduction of Alloxan Dose

Preliminary test was conducted to establish the effectiveness of a dose of alloxan in inducing diabetic mice. Furthermore, mice were randomly divided into 4 groups with each treatment as shown in Table 1.

Table 1. Distribution of the preliminary test of alloxan dose

No	Groups	Number of mice	Treatment
1	Alloxan dose -1	3	Alloxan dose 140 mg/kg bw
2	Alloxan dose -2	3	Alloxan dose 160 mg/kg bw
3	Alloxan dose -3	3	Alloxan dose 180 mg/kg bw
4	Alloxan dose -4	3	Alloxan dose 200 mg/kg bw

Mice (*Mus musculus*) (strain BALB/C, male, 24 days old, weight 19-23 g, and non-diabetic mice) obtained from Lampung Veterinary Medical Center were adapted for 3 days in the animal laboratory testing in the Department of Agricultural Product Technology, Faculty of Agriculture, Lampung University. Each mouse was given feed and drink *ad libitum*. After the mice were adapted for 3 days, all mice were tested for their blood glucose level. Then the mice were given appropriate treatment in Table 1. After the treatment, the mice were given feed and drink *ad libitum*. On day 7, blood glucose levels were observed. Effective dose causing hyperglycemia (high blood glucose) but does not cause the death of mice was selected for the primary research.

2.5. Siger Rice Feeding Experiment

In the current study used 3 control groups, namely normal control, negative control and positive control and six groups of treatment with siger rice different composition. Normal control was done to determine blood glucose levels in non-diabetic mice and given a standard feed. Negative control was done to determine blood glucose levels in diabetic mice and given standard feed. Positive control was done to determine blood glucose levels in diabetic mice and given drug of glibenclamide and standard feed. While, siger rice groups were done to determine the effect of siger rice in decreasing blood glucose levels and performance of the pancreas in mice. Each group consisted of 3 mice. Determination of the number of test animals and division treatment group are presented in Table 2. While, the siger rice composition can be seen in Table 3.

Table 2. Determination of the number of test animals and division treatment group

No	Group	Number of mice	Treatment
1	Normal control	3	Healthy mice + standard feed
2	Negative control	3	Diabetic mice + standard feed
3	Positive control	3	Diabetic mice + glibenclamide 4,5 mg/kg bw + standard feed
4	Siger rice Composition I	3	Diabetic mice + Siger rice Composition I
5	Siger rice Composition II	3	Diabetic mice + Siger rice Composition II
6	Siger rice Composition III	3	Diabetic mice + Siger rice Composition III
7	Siger rice Composition IV	3	Diabetic mice + Siger rice Composition IV
8	Siger rice Composition V	3	Diabetic mice + Siger rice Composition V
9	Siger rice Composition VI	3	Diabetic mice + Siger rice Composition VI

Table 3. Various compositions of siger rice as feed mice

Composition (g/100 g)	Treatment						
	Standard	I	II	III	IV	V	VI
Corn	65	55	45	35	25	15	5
Siger rice	0	10	20	30	40	50	60
Casein	20	20	20	20	20	20	20
Soybean oil	9	9	9	9	9	9	9
Mineral mix	4	4	4	4	4	4	4
Vitamin mix	2	2	2	2	2	2	2
Total	100	100	100	100	100	100	100

The blood was taken via the tail vein and blood glucose levels measured using glucose meter (accu-chek). A drop of blood from the tail vein is checked by touching and holding the test strip opening to the drop until it has absorbed enough blood to begin the test. Test result can be seen on the monitor screen of accu-chek. All groups except normal control were given alloxan to make into diabetes. Siger rice was given to mice every day *ad libitum* for 28 days. Measurement of blood glucose levels was done every week on days 1, 7, 14, 21, and 28. After 28 days in experiment, mice were turned off by decapitation. Pancreas of mice were removed and fixed with buffer formalin. The pancreas was made culture preparation for histology test. Implementation research can be seen in Figure 3.

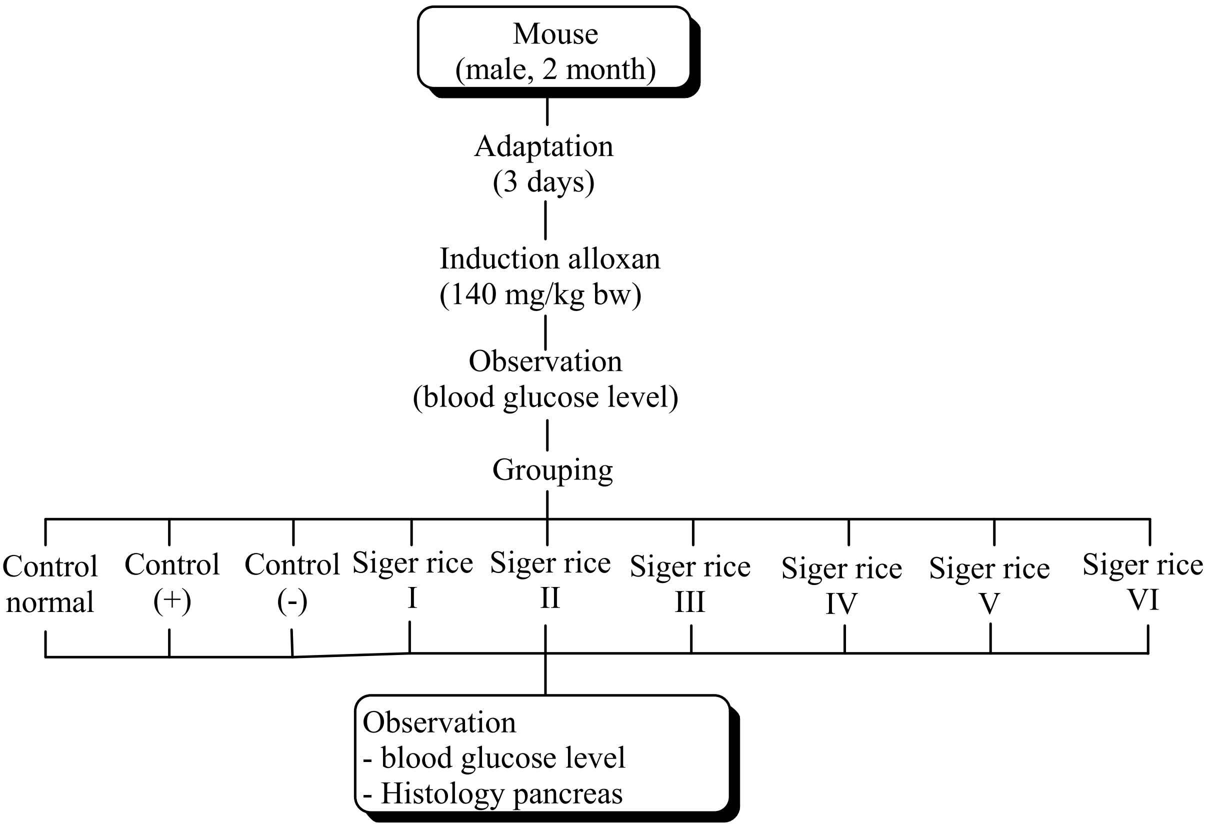


Figure 3. Administration of siger rice in mice induced by alloxan

III. RESULTS AND DISCUSSION

3.1. Introduction of Alloxan Dose

Preliminary test was carried out to determine the effective dose of alloxan that can cause diabetes in mice. The blood glucose levels of the mice after being given various doses of alloxan can be seen in Table 4.

Table 4. Preliminary test of alloxan dose

Alloxan Dose (mg/kg bw)	Blood glucose level (mg/dL)		Number of mice	Number of live mice
	Before induced alloxan	After 7 days induced alloxan		
140	152	307	3	3
160	148	200	3	2
180	145	141	3	1
200	150	-	3	0

180 dose showed two dead rats and live rats with a blood glucose level 5

Based on Table 4 that alloxan dose of 140 mg/kg bw led to three mice have diabetes with blood glucose levels an average of 307.33 mg/dL and no dead mice. A dose of 160 mg/kg bw caused 2 mice have diabetes with an average blood glucose of 200 mg/dL and 1 dead mouse. A doses of 180 mg/kg bw caused 2 dead mice and 1 live mouse with blood glucose level of 141 mg/dL. While, the dose of 200 mg/kg bw caused 3 dead mice. The dose of alloxan to be used in the main study is the dose that causes diabetes in mice but did not cause the death of the mice. A person is said to have diabetes if blood glucose levels greater than 200 mg/dL and fasting blood glucose level higher than 126 mg/dL (FKUI, 2006).

The appropriate dose to induce mice to be diabetic was the dose 140 mg/kg bw with blood glucose levels of 307.33 mg/dL. Administration of alloxan can cause hyperglycemia in mice. Alloxan is one of the substances diabetogenic, especially to the β-Langerhans cells. The compounds of Alloxan enter into β-Langerhans cells and bind to the cell membrane. Alloxan produces free radicals that damage the membrane cells. The presence of free radicals in cells will damage DNA molecules and other cell components and eventually leading to death of the cells (Nugroho, 2006). β-Langerhans cell damage caused the body can not produce insulin and increased blood glucose level (Ali, 1981).

3.2. Antidiabetic Siger Rice

Blood glucose levels of mice before were inducted alloxan between 140-155 mg/dL. One day after being induced alloxan showed blood glucose level in mica between 578,67-597,33 mg/dL. A decrease in blood glucose levels in mice given siger rice treatment can be seen in Figure 4. Results of analysis of variance indicated significant effect between control and mice given siger rice on decreasing blood glucose levels. Further test results of BNT in decline blood glucose levels can be seen in Table 5.

Table 5. Average blood glucose levels in mice at various time of observation

Treatment	Blood glucose level (mg/dL)						Inter-cept	Slope	r2
	Before induced alloxan	After induced alloxan							
		1 day	7 days	14 days	21 days	28 days			
Control	140	108.00b	108,00c	86,33b	88,33c	74,33c	111,2	-1,283	0,881
Control (+)	151	596,33a	430,33a	105,00b	104,67b	103,67c	539,5	-19,12	0,789
Control (-)	147	597,33a	564,67a	419,67a	378,00a	342,67a	605,7	-10,23	0,932
Siger rice I	148	580,67a	384,33a	147,33b	148,33b	187,67b	500,2	-14,82	0,705
Siger rice II	155	583,00a	146,67b	126,00b	125,33b	77,00c	422,1	-14,82	0,581
Siger rice III	146	597,00a	467,00a	114,67b	100,00c	85,33c	561,4	-20,32	0,821
Siger rice IV	152	578,67a	299,67a	64,33b	69,67d	92,67c	468,1	-17,40	0,708
Siger rice V	144	596,00a	273,67a	108,00b	108,67b	109,00c	472,7	-16,45	0,697
Siger rice VI	152	597,33a	448,00a	238,00ab	83,67c	99,00c	576,1	-19,92	0,913

Description: The number followed by the same letters in a row means significantly different at 5% level.

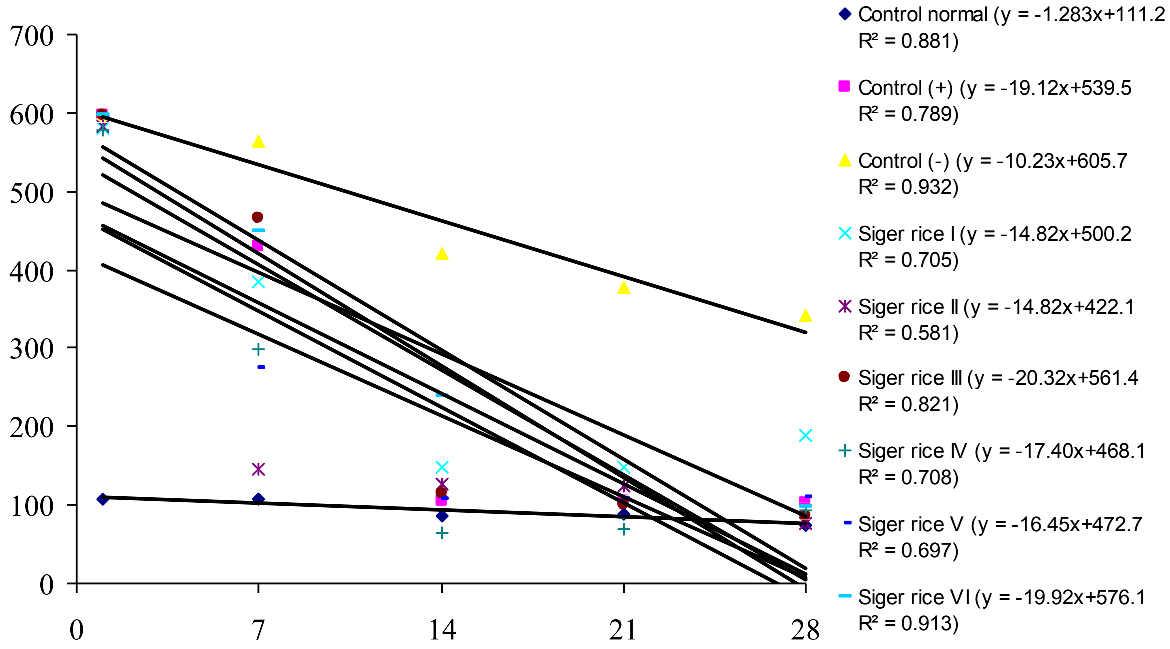


Figure 4. A decrease in blood glucose levels of mice were given rice siger

The results of LSD test on day-1 showed the positive control, negative control, and siger rice I to IV significantly different from control mice. On 7th day showed significantly different from the normal control with the positive control, negative control as well as siger rice I, III, IV, V, and VI, but not significantly different with siger rice II. On the 14th day showed normal control significantly different from the positive control, siger rice I, II, III, IV, and VI, but significantly different from the negative control. On the 21st day showed normal control were significantly different with the negative control and siger rice I, but not significantly different from the positive control, siger rice II, III, IV, V, and VI. On the 28th day showed significantly different from normal control, negative control, and siger rice I, but not significantly different from the positive control, siger rice II, III, IV, V, and VI.

Based on the results of measurements of the average blood glucose level in normal control obtained slope of -1.283 which the blood glucose is below 200 mg/dL from day 1 to day 28. The positive control obtained slope of -19.12 where a decline in glucose level from day 1 until 28. A decrease in blood glucose levels to normal occured on the 14th day. This is because the administration of glibenclamide may increase insulin secretion from β-Langerhan cells (Sarfaraz et al., 2012). The negative control obtained slope of -10.23 where blood glucose levels are still high during the time of observation. High levels of blood glucose were caused by administration of alloxan that can inhibite the production of insulin in β-Langerhan cells (Karan et al., 2012).

In the siger rice I obtained slope of -14.82 which occurred a decrease in blood glucose level from day 1 to 28. Decreased glucose levels back to normal occurred on the 14th day. In siger rice II obtained slope of -14.82 where a decline in glucose blood level occurred from day 1 to 28. A decrease in blood glucose levels to normal occurred on the 7th day. In the siger rice III obtained slope of -20.32 where a decline in blood glucose occurred from day 1 to 28. A decrease in blood glucose levels to normal may occur on the 14th day. In the rice siger IV obtained slope of -17.40 where a decrease in blood glucose levels occurred from day 1 to 28. A decrease in blood glucose levels to normal may occur on the 14th day. In the rice siger V obtained slope of -16.45 which a decrease in blood glucose level occurred from day 1 to 28. A decrease in levels of blood glucose occurred on the 14th day. In the siger rice VI obtained slope of -19.92 where a decline in glucose blood levels occurred from day 1 to 28. A decrease in blood glucose levels to normal occurred on the 21st day.

Based on the results of this study indicated that after being induced alloxan had increased blood glucose levels more than 200 mg/dL in mice. Retnaningsih (2001), stated that one day after being induced alloxan showed increasing of blood glucose levels in mice. Alloxan is one of the compound that has capability to inhibit the secretion of insulin from pancreas. A decline blood glucose levels in mice treated by siger rice was observed in each week. The best treatment was composition of siger rice III having slope decrease in blood glucose greater than other composition.

Cassava flour and water having a low glycemic index (GI) of 40,12 (Itam et al., 2012). Glycemic index value categorized into three namely GI low (<55), GI medium (55-70), and high GI (> 70). Factors that affect GI of food include fiber content, comparison amylose and amylopectin, digestibility of starch, fat and protein levels, and processing methods (Gumus et al., 2014).

Cassava flour have crude fiber content of (1.38-3.20%). High crude fiber of food can be used as a functional food to decrease blood glucose level (Janick, 2011). In general, high crude fiber content contributes to a low GI value. Crude fiber improves glycemic response by reducing rate of glucose absorption in small intestine (Cherbut et al., 2004).

The cassava products can be considered good sources of resistant starch (0.56 to 1.1%) which make them beneficial products to the gastrointestinal tract (Pereira dan Leoneh, 2014). The high resistant starch in siger rice supposedly formed during the drying process after steaming. Some studies suggest that resistant starch have significant implications for human health. Resistant starch fraction passes on to the colon, where it is fermented by the microorganisms producing mainly short chain fatty acids. Due to this fact, resistant starch has functional properties and positive effects on diabetes. Resistant starch in siger rice is the most important since their formation is a result of food processing. The amylose content, temperature, physical form, the degree of gelatinization, cooling, and storage affect its contents (Nugent, 2005; Sajilata et al., 2006).

The glycemic index (GI) is an important parameter of food quality which compares the hyperglycaemic effect of a tested meal with pure glucose (Jenkins et al., 2008). The GI is a measure of the food power to raise glucose concentration after a meal. Foods with carbohydrates that break down quickly during digestion and release glucose rapidly into the bloodstream tend to have a high GI. Siger rice with carbohydrates of crude fiber and resistant starch that break down more slowly, releasing glucose more gradually into the bloodstream, tend to have a low GI. A lower glycemic index suggests slower rates of digestion and absorption of the carbohydrates and may also indicate greater extraction from the liver and periphery of the products of carbohydrate digestion (Jenkins et al., 2008; Brouns et al., 2005). A lower glycemic response usually equates to a lower insulin demand and may improve long-term blood glucose control and blood lipids (Atkinson et al., 2008).

3.3. Histology of Pancreas

Analysis of pancreas histological is done to see the damage the pancreas of mice after being given siger rice. According to Lenzen (2008), there are four phases after being induced alloxan. A first transient hypoglycaemic phase of up to 30 min starts within time of alloxan injection. This short-lived hypoglycaemic response is the result of a transient stimulation of insulin secretion, as documented by an increase in the plasma insulin concentration. The underlying mechanism is a temporarily reduced consumption and increased availability of ATP caused by blockade of glucose phosphorylation through glucokinase inhibition. The second phase starts with an increase in the blood glucose concentration, 1 h after administration of the alloxan, and a decrease in plasma insulin. This first hyperglycaemic phase, which usually lasts 2–4 h, is caused by inhibition of insulin secretion leading to hypoinsulinaemia. During this phase the β-Langerhans cells show the following morphological characteristics: intracellular vacuolisation, dilation of the rough endoplasmic reticulum, decreased golgi area, reduced secretory granules, and insulin content, and swollen mitochondria. The third phase, again a hypoglycaemic phase, typically occurs 4–8 h after the injection of the alloxan and lasts several hours. It may be so severe that it causes convulsions, and may even be fatal without glucose administration, in particular when liver glycogen stores are depleted through starvation. This severe transitional hypoglycaemia is produced by the flooding of the circulation with insulin as a result of alloxan-induced secretory granule and cell membrane rupture. Pancreatectomy prevents this phase. In addition to the morphological changes seen in the first phase, the beta cell nuclei are pyknotic.

The fourth phase is the permanent diabetic hyperglycaemic phase. Morphologically, complete degranulation and loss of β-Langerhans cells integrity is seen within 12–48 h. siger rice administration in mice induced by alloxan can improve damaged β-Langerhans cells. Mice with diabetes after being induced alloxan can be seen in Figure 5.

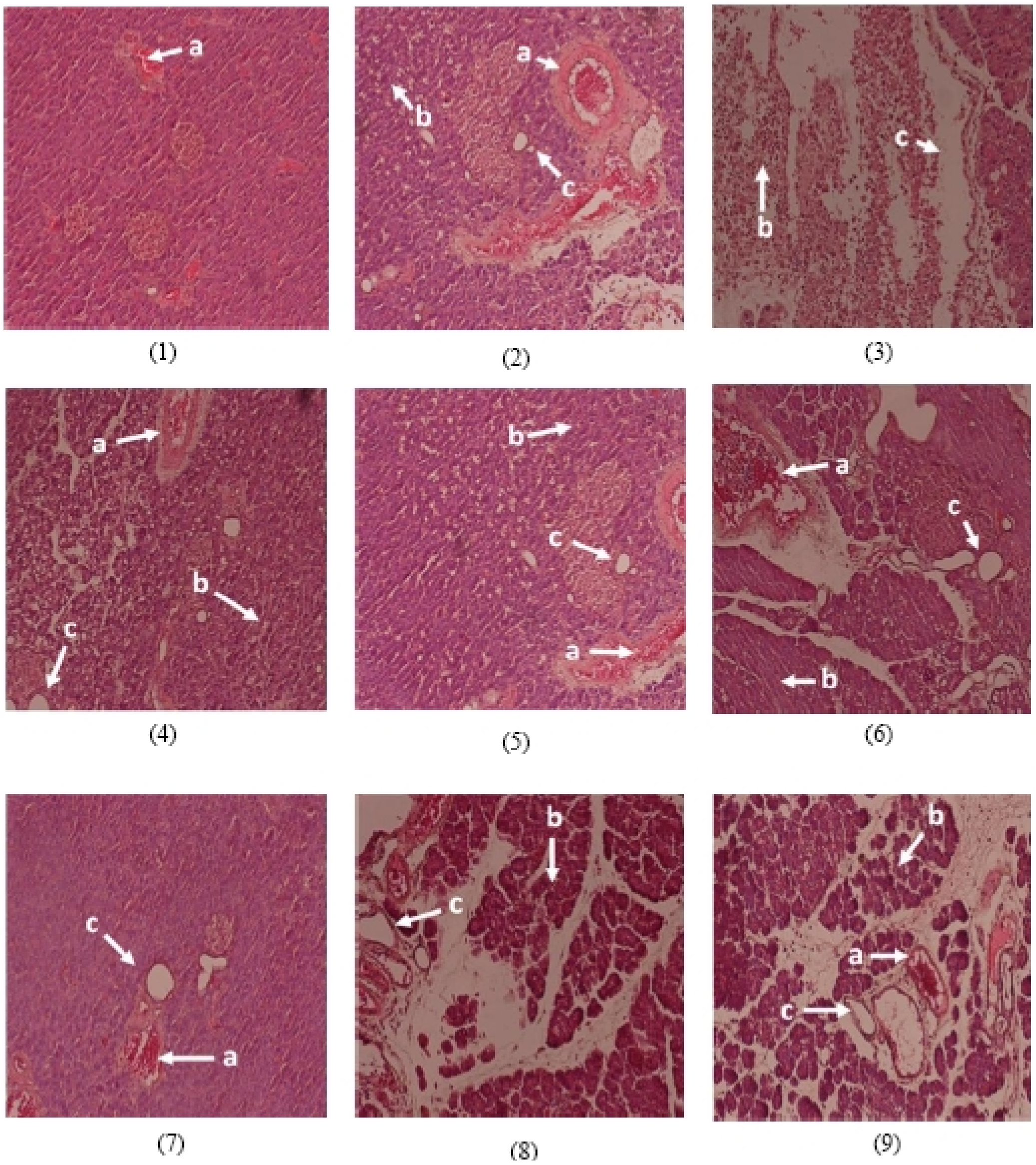


Figure 5. Histology pancreas of mice after 28 days of treatment (1) healty mouse, (2) control positive, (3) control negative, (4) siger rice I, (5) siger rice II, (6) rice siger III, (7) siger rice IV, (8) siger rice V, (9) siger rice VI, (a) bleeding in the β-Langerhans cell, (b) the vacuole in acinier cell, (c) focal nekrosa in β-Langerhans cell

In the normal control indicates the amount of blood and excess mucus in the pancreas, but it did not spoil the β-Langerhans cells and pancreas of mice. For the positive control shows mild bleeding and does not damage the β-Langerhans cells. Treatment of siger rice I to VI indicates the number of blood and excess mucus part of the pancreas, and there are cavities on the walls of the pancreas, but the β-Langerhans cells are not too damaged. In contrast to the negative control treatment showed severe damage on the vacuole in a cell of acinier and focal nekrosa in β-Langerhans cell. Damage to the pancreas of mice is caused by alloxan injection. Alloxan has capability to destroy β-Langerhans cells thereby inhibiting the secretion of insulin.

Mechanism of alloxan on pancreatic damage occurs by the formation of reactive oxygen compounds that form superoxide radicals via the redox cycle. Through a redox cycle will form hydroxyl very reactive which cause damage β-Langerhans cells quickly (Lenzen, 2008). Additionally, alloxan interfere with the oxidation process of cells by expenditure calcium ions from mitochondria resulting in a disruption of homeostasis which causes the death of pancreas cells (Nugroho, 2006).

The majority of islet cells is formed by β-Langerhans cells which are responsible for producing insulin. Depletion of β-Langerhans cells will therefore result in insulin deficiency which will lead to a disorder in carbohydrate metabolism with a resultant hyperglycaemia. In this study, alloxan which selectively destroy β-Langerhans cells of the islet was used to induce diabetes. Insulinitis and loss of β-Langerhans cells were observed which may be seen in diabetes. insulinitis is evidenced by bleeding in the β-Langerhans cell, the vacuole in a cell acinier, and focal nekrosa in β-Langerhans cell in and around the islet. Islet cells of mice treated with siger rice has regenerated considerably suggesting the presence of stable cells in the islets with the ability to cause regeneration of pancreatic β-Langerhans cells. This also suggests that the siger rice has the ability of inducing the quiescent cells to proliferate to replace the lost cells.

The findings of the present study well demonstrated that (1) giving siger rice showed effect to the decrease in blood glucose levels mice. (2 giving siger rice III with composition of siger rice:corn starch (30:35) decreased blood glucose levels returned to normal 114.67 mg/dL on day 14.

ACKNOWLEDGEMENTS

The authors wish to thank for the financial support provided from Hibah Bersaing 2015 grant by the Ministries of Research, Technology, and Higher Education of Indonesia (KEMENRISTEK DIKTI) Indonesia.

REFERENCES

Abbas, A., S. Murtaza, and S. Aslam. 2011. Effects of Processing on Nutritional Value of Rice (*Oryza sativa*). *World Journal Medical*. 6(2): 68-73.

Abdullah, A. and S. Ito Adhana. 2006. Estimate of Rice Consumption in Asian Countries and the World Toward 2050. Ttory University.

Ali, N. 1981. Diabetes and You: a Comprehensive, Holistic Approach. England (UK):Rowman dan Littlefield Publishers, Inc.

Atkinson, F.S., K. Foster-Powell, J.C. Brand-Miller. 2008. International Tables of Glycemic Index and Glycemic Load Values. *Diabetes Care* 31(12): 2281–3.

Baldwin, K., N. Childs, J. Dyck, and J. Hansen. 2012. Southeast Asia's Rice Surplus. United State. Department of Agriculture. Report No.RCS-12I-01.

BPS. 2013. Data Sosial Ekonomi 2013. pp 35.

Brouns, F., I. Bjorck, and K.N. Frayn. 2005. Glycaemic Index Methodology. *Nutritional Research and Review* 18(1): 145–71.

Cherbut, C., S.B. Des Varannes, M. Schnee, R. Martine, J. Galmiche, and J. Delort-Laval. 1994. Involvement of Small Intestinal Motility in Blood Glucose Response to Dietary Fibre in Man. *British Journal of Nutrition*. 71: 615-685.

Dong, W., J. Chen, and L. Wang. 2013. Impacts of Nightime Post-anthesis Warming on Productivity and Grain Quality in East China. *Crop Journal*. 2: 63-69.

Fakultas Kedokteran Universitas Indonesia. 2006. *Hidup Sehat dengan Diabetes: Sebagai Panduan Bagi Penyandang Diabetes dan Keluarganya Serta Petugas Kesehatan yang Terkait*. Editor: Soewondo P. Penerbit FKUI. Jakarta.

Gumus, H. Y. Akdevelioglu, and S. Bulduk. 2014. Determination of Factors Effected Dietary Glycemic Index in Turkish University Students. *European Journal of Educational*. 3 (1): 1-7.

Itam, E.H, A.H. Itam, M.O. Odey, R. Ejemot-Nwadiaro, M.E. Asenye, N.N. Ezike. 2012. Effect of Processing Method on the Glycemic Index of Some Carbohydrate Staples (*Manihot esculanta, Ipomoea batata* and *Dioscorea rotundata*) in Both Normal and Diabetic Subjects. *Annals of Biological Research*. 3(12):5507-5510.

Janick, J. 2011. Tropical Root and Tuber Crops. Horticultural Reviews, 12: 157–196, Jisha, S., Padmaja G. and Sajeev, M. S. 2010. Nutritional and Textural Studies on Dietary Fiber-enriched Muffins and Biscuits from Cassava-based Composite Flours. *Journal of Food Quality*. 33: 79–99.

Jenkins, D.J., C.W. Kendall, G. McKeown-Eyssen. 2008. Glycemic Index: Overview of Implications in Health and Diseases. *Journal of Applied Nutrition.* 300(23): 2742–53.

Karan, S.K., S.K. Mishra, D. Pal, and A. Mondal. 2012. Isolation of β-sitosterol and Evaluation of Antidiabetic Activity of *Aristolochia indica* in Alloxan-induced Diabetic Mice with a Reference to *In-vitro* Antioxidant Activity. *Journal of Medicinal Plants Research*. 6(7): 1219-1223.

Khus, G. 2005. What It will Take to Feed 5.0 Billion Consumers in 2030. *Plant Molecular Biology*. 59: 1-6.

Lenzen, S. 2008. The Mechanisms of Alloxan- and Streptozotocin Induced Diabetes. *Diabetologia*. 51(2) 216–226.

Nugroho, A.E. 2006. *Hewan Percobaan Diabetes Melitus*. Patologi dan Mekanisme Aksi Diabetogenik. *Biodiversitas.* 4: 378-382.

Nugent, A. P. 2005. Health Properties of Resistant Starch. *Nutrition Bulletin*. 30(1): 27-54.

Paes, S. S., I. Yakimets, and J.R. Mitchell. 2008. Influence of Gelatinization Process on Functional Properties of Cassava Starch Films. *Food Hydrocolloids*. 22(5):788-797.

Pereira, B.L.B and M. Leonel1. 2014. Resistant starch in cassava products. *Food Science and Technology*. 34(2): 1-5 .

Retnaningsih C., Z. Noor, and Y. Marsono. 2001. Sifat Hipoglikemik Pakan Tinggi Protein Kedelai Pada Model Diabetik Induksi Alloxan. *Jurnal Teknologi dan Industri Pangan* 12: 141-146.

Sajilata, M. G., R.S. Singhal, and P.R. Kulkarni. 2006. Resistant Starch: a Review. *Comprehensive Reviews in Food Science and Food Safety*. 5(1): 1-17.

Sarfaraz, M.D., P. Venubabu, D. Hiremath, and S.G. Prakash. 2012. Mucoadhesive Dosage form of Glibenclamide: Design and Characterisation. *International Journal of Pharma and Biosciences.* 2(2): 162-172.

PHYSICOCHEMICAL CHARACTERISTICS OF CASSAVA STARCH PRODUCED BY ITTARA - A SMALL SCALE TAPIOCA INDUSTRY : A Case Study at PD Semangat Jaya , Lampung

SITI NURDJANAH[1)], UDIN HASANUDIN[1)], NETI YULIANA[1)] ,
AND DESY SILVIANTI[2)]

[1)] Department of Agroproduct Technology , Faculty of Agriculture, University of Lampung, Jalan Soemantri Brojonegoro No.1, Bandar Lampung, Indonesia 35145.
[2)] Industrial Technology Vocational High School (SMTI) Lampung, Jalan Jendral Sudirman No 43. Bandar Lampung, Indonesia.
E-mail: nurdjanahnurdjanah@gmail.com

ABSTRACT

Cassava is very potential crop grown on marginal lands. It has great productivity, which in Lampung , most of the cassava roots are used for tapioca production. PD Semangat Jaya is one of small scale tapioca industry at Lampung. This industry still uses traditional technology in processing the starch, and the properties of the starch have never been characterized. Therefore the objective of this study was to evaluate the physico-chemical properties of the starch produced by this industry. Based on its distance for settling during extraction process, the starch was categorized into three grades, Grade I, grade II and grade III. Parameters evaluated were, the starch pH, whiteness, moisture, ash, starch, and amylose contents, and pasting properties. The data obtained from three replications were analyzed analyzed descriptively. The results showed that the pH, whiteness, moisture, ash, starch, and amylose contents of starch grade I were 4.1; 77.1; 7,87%; 0.17%; 79.3%; and 34.96%. Whereas for grade II were 4,25; 75.1; 8,1%; 0,22%; 72.38%; and ; 34.97% . The similar contents for grade III were 4,1; 65.7; 8.04%; 0.27%; 77.08% and 31.47% . These results revealed that chemical contents analyzed were in compliance with SNI. For the pasting properties, it was found that the maximum viscosity for grade I, II and II were 968.5 BU; 831.5 BU; and 688.5 BU. The paste instability (breakdown) for grade I, II, and III were 614.5BU; 512 BU; and 327.5 BU. The setback viscosity for grade I, II, and III were 191 BU; 181 BU; and 91 BU. These indicated that the starch granules in each grade has different structure , different functionality and therefore further study is needed.

Keywords: cassava, ITTARA, Lampung, pasting properties, starch.

INTRODUCTION

Cassava (*Maninot esculenta* Crantz), originated from South America, is a perennial woody shrub with tuberous roots . The world production of was estimated as 262 585 742 tonnes with the top producers being Nigeria, Indonesia, Brazil, and Thailand (FAO, 2014). Cassava's planting and harvesting time is flexible, therefore, is available all year around and thus make it a reliable crop for food security.

Cassava grown in Indonesia, includes Lampung , is mainly for tapioca production. Lampung Province is one of major tapioca production center . The tapioca industries in Lampung area consisted of modern industries as well as small scale traditional industry called ITTARA (Industri Tapioka Rakyat). One of ITTARA survivor is PD Semangat Jaya which is located at Pesawaran District. PD Semangat Jaya , so far, uses a series of traditional technique includes peeling outer skin, washing, rasping, pressing, settling and sun-drying of the starch slurry in tapioca production. However the effects of traditional settling and sun-drying on the physic-chemical properties of the tapioca have never been reported. Therefore, this paper reports some physicochemical properties of the tapioca processed traditionally.

MATERIALS AND METHODS

Materials

Raw material used for thus study was starch grade I, grade II and grade III produced by PD Semangat Jaya. Grade I was starch originated or taken from settling area which has the distance of 0-30 m, grade II was 30-60 m , and grade III was 60-90 m from the fresh starch slurry inlet after being settled for 15 h. Whereas the tapioca with commercial brand was bought from local market.

Chemical composition of tapioca

The chemical compositions were analyzed using methods described in AOAC, (2005) with the number of method description as follows: ash (Method 923.03), moisture (Method No 925.10) and starch (Method No 945.37). The amylase content was determined using method described by Juliano (1971).The pH was measured in triplicate using a pH meter (Jenway 3330, UK). Tapioca whiteness was determined using a Powder Whiteness Tester Model C 100, Kett Electric Laboratory.

Determination of amylose content

The amylose content was determined using amylose-iodine complex procedure as described by Juliano (1971). The value of samples and amylose standard absorbance were obtained at 620 nm using a spectrophotometer (Shimadzu UV-1700, Tokyo). The plot of samples absorbance against pure potato amylose standard curve was used to calculate the amylose content of the samples.

Determination of pasting properties

The pasting properties of tapioca samples were determined using Brabender Micro Viscoamylograph (Brabender OHG, Duisburg, Germany). Ten grams (dry basis) of flour samples was suspended in 100 ml of distilled water to obtain 10% suspension w/w. Then the suspension was transferred into the bowl of Brabender, heated from 35°C to 95°C at a rate of 1.5°C/min and kept for 20 min at 95°C. Then it was cooled down to 50°C at a rate of 1.5°C/min and held at 50°C for 20 min. Parameters measured were beginning of gelatinization, peak viscosity, temperature at maximum viscosity, breakdown and setback viscosity.

Statistical analysis

The data of starch proximate, amylose content and pasting properties were taken from 3 replications, and reported in average with standard deviation.

RESULTS AND DISCUSSION

The results of physical content and chemical compositions of the tapioca was summarized in Table 1, and discussed as follows:

pH Value

The pH of the tapioca was between 4.11 and 4.43. The commercial brand tapioca had the highest pH among other samples. This could be caused partly by the different the settling technique used by the manufacturer. ITTARA uses 15 h to settling the starch slurry and then it was sun-dried, whereas the commercial brand uses a vertical dryer machine . The length of settling time affected the pH. The longer the settling, the lower the pH. This phenomena could be caused by the growth of lactic acid bacteria . The growth of lactic acid bacteria (LAB) are dominant during all stages of cassava fermentation and contribute to the development of characteristic properties such as taste, aroma, visual appearance, texture, shelf life and safety. Spontaeous fermentation is also important because it removes considerable amounts of cyanide and produces antimicrobial compounds including organic acids, hydrogen peroxide, and other active low molecular weight metabolites and bacteriocins (Adams and Nicolaides, 1987; Holzapfel, 2002).

Whiteness

The desired starches for commercial purposes should be high value for whiteness. The whiteness of grade 1 grade 2 grade 3 and commercial brand starches was slightly different. They were between 65.7-77.1, whereas the commercial brand starch, as a reference, was 93.3. Different distance of settling tank resulted in small difference in whiteness. The longer the distance resulted in less whiteness value of the starch. This was probably due to the longer the distance had caused higher amount of pigments, polyphenol oxidase and phenolic compounds attached to the starch granule during reaching the settling area. These compounds are easily undergo denaturalization or browning during starch isolation and drying process, lead to inferior starch color (Chen, 2003).

Moisture and Ash Content

The moisture content of the starches were 7.87 % (grade I) to 8.04% (grade III), while this content for commercial brand was 9.05%. These moisture contents were slightly different but meet the National Standard Industry. The ash content of grade I, II, and III starches were 0.17%, 0.22% , and 027%. This results indicated that the longer the distance of settling area from the slurry inlet , the higher the ash content. This phenomena is probably caused by the contribution of low density materials, mainly non -starch polysaccharides materials , together with starch flowing and settling into the further settling areas. The higher ash content indicates less purity of the starch (Thao and Noomhorm, 2011).

Starch and Amylose content

Starch contents of grade I,II, and III were between 72.38% and 79.3%, whereas that of commercial brand was 90%. These values meet the National Standard Industry. The lower content of grade II and grade III was probably attributed to impurities originated from non-starch polysaccharides bound to starch granules.

Amylose contents of grade I,II, and III were between 31.47% and 34.97%, whereas that of commercial brand was 25.87%. The variation in amylase content was attributed to difference of distance of settling areas. Settling area up to 60 m did not affect the amylase content, but further distance (60 m – 90 m) caused decreased in amylase content, while that of commercial brand was much lower (25.87%). These amylose contents were slightly higher compared to those of reported by Richard et al.(2001) which was between 13.6%-23.8%, Moorthy at al.(2002) which ranged from 22.6% to 26.2%.

Tabel 1. Physical characteristics and chemical content of tapioca PD Semangat Jaya and commercial brand

Physical and Chemical Composition	Tapioca			
	Grade I	Grade II	Grade III	Commercial brand
pH	4.11±0.11	4.25±0.17	4.11±0.11	4,43±0,04
Whiteness	77.1± 0.1	75.1±0,15	65.7±0,2	93.3±0,1
Moisture	7.87±0.4	8.11±0.15	8.04±0.01	9.05%±0.1
Ash	0.17%±0,01	0.22%±0,002	0.27%±0,01	0.30%±0.02
Starch	79.3±5.00	72.38±12.05	77.08±7.05	90%±4.05
amylose	34.96±0.53	34.97±0.35	31.47±0.40	25.87%±0.65

All values are mean of three replications followed by standard deviation

Pasting properties

The pasting properties of the starch produced by ITTARA and commercial brand are summarized in Table 2.

The start of gelatinization temperature for grade I,II and III starches ranged from 72.9°C (grade I starch) to 74.9 °C (grade III starch), while this temperature for commercial brand only was about 67.7°C. These results were higher than the results reported by Richard et al.(1991) and Moorthy et al.(1992) in which reported that temperature of cassava starches varied from 60.11°C to 72.6°C . The differences in the start of gelatinization temperature were affected by changes in interior structure of starches which can occur in both amorphous and crystallize regions (Katayama et al., 2002) or by starch granule size (Chen, 2003).

The maximum viscosity of all ITARA tapioca ranged from 668.5 BU for grade III starch to 968.5 BU for grade I starch, and that of grade II starch was in the middle of that range 831.5 BU , whereas commercial brand tapioca was the highest 1356 BU. The breakdown viscosities for grade I, II, III and commercial brand were 614.5 BU, 512 BU, 327 BU, and 646 BU . While those of setback viscosities were 191 BU, 181 BU, 91 BU, and 655 BU.

Collado and Corke (1997) reported that peak viscosity have negative correlation with amylose content because the amylose restricted the starch granules swelling, resulting in low peak viscosity. This seems to be true for commercial brand tapioca but in line with the results for ITARA tapioca . The differences in peak viscosity may be due to differences in phosphorous content (Chen, 2003) , differences in size and shape of starch granules (Rahman, 2000) or difference in size and branching chain length of amylopectin (Mua and Jacson, 1997; Mua and Jacson 1998).

Starches with higher in phosphorous content exhibited a higher peak viscosity due to increasing hydration of starch by weakening the degree of bonding within the ncrystalline region(Sandhu et al., 2010). The low peak viscosity in grade III was partlt due to lower content of amylose, thus higher amylopectin content primarily very long brach amylipectin. Jane et al. (1999) reported that very long branch chains of amylopectin resembled amylose to form helical complexes with lipids and interlink with other branch chains to hold the integrity of starch granules during heating and shearing, resulting in low peak viscosity.

In term of shear and high temperature stability, the results indicated that grade III starch withstands shear and high temperature much better due to very low breakdown value, which was about 327.5 BU, compared to that other starches, ranging from 614,5 BU (grade I) to 327.5 BU (grade II). Whereas commercial brand starch was the most susceptible to shear and high temperature.

Setback viscosity can be used to predict the tendency of retrogradation. Higher setback value indicates higher rate of retrogradation. Setback values of grade I , II, and III were 191 BU, 181 BU, and 91 BU, thus the higher the amylose content , the higher retrogradation rate . However this phenomena was not observed in the commercial brand tapioca , probably the starch granules have been subjected to some modifications to alter their native properties.

Rahman (2000) and Bhattacharya et al.(1999) reported that starches with higher amylose content exhibited higher setback value, more hardness and less stickiness. Therefore, the setback was considered as another important criterion for starch selection for many food industries.

Tabel 2. Pasting properties of tapioca PD Semangat Jaya dan commercial brand

Point	Fase Pemanasan	Tapioca			
		Grade I	Grade II	Grade III	Commercial brand
A	Start of gelatinization temperature (°C)	72.9±0.14	73.4±0,28	74.9 ±0.28	67.7±1.4
B	Maximum viscosity (BU)	968.5± 0.71	831.5±6.36	668.5±43.3	1356±2.8
C	Start of holding periode at 90° , 20 min (BU)	670.5±19.1	621±7.07	632± 87.68	842±56.5
D	Start of cooling periode (BU)	353±5.66	317.5±0.71	338.5±51.62	708±14.1
E	End of cooling periode (BU)	549.5±14.85	504±9.9	435±25.46	1381±12.7
B-D	Breakdown (Paste instability) (BU)	614.5±6,36	512±7.1	327.5±94.05	646±9.89
E-D	Setback (Retrogradation) (BU)	191±8.48	181±9.9	91±26.87	655±7.07

All values are mean of three replications followed by standard deviation

Chemical contents of ITTARA tapioca analyzed were in compliance with SNI. But less white in color compared to that of commercial brand. The starch was less viscous, less stable, and tends to retrograde more as the distance of the settling areas were further . Overall, these results indicated that the starch granules in each grade has different structure , different functionality.

REFERENCES

Adams, M.R., and Nicolaides , L. 1997. Review of the sensitivity of different foodborne pathogens to fermentation. Food Control. 8:227–239

AOAC. 2005. Official Methods of Analysis Of The Association Of Analytical Chemists. 15th. Food Composition; Additives; Natural Contaminants. Vol. 2. Arlington, Virginia. Methods No. 923.03; 925.10; and 945.37.

Bhattacharya, M., Zee, S.Y., and Corke, H. 1999. Physicochemical properties related to quality of rice noodles. Cereal Chem.76: 861-867.

Chen, Z. 2003. Physicochemical properties of sweet potato starches and their application in noodle products. Ph.D dissertation No 90-5808-887-1. Wageningen University, The Netherlands

FAO (Food and Agricultural Organization of the United Nation). 2014. The statistical division. FAO. (http://faostat.fao.org/site/567) accessed 2nd June 2016.

Holzapfel , W. 2002. Appropriate starter culture technologies for small-scale fermentation in developing countries. Int J Food Microbiol. 75:197–212

Juliano, B.O. 1971. A simplified assay for milled rice amylose. Cereal Science Today 16:334-360.

Jane, J., Chen,Y.Y., Lee, L.F., McPherson, A.E., and Wong ,K.S. 1999. Effects of amylopectin branch chain length and amylose content on the gelatinization and pasting properties of starch. Cereal Chem .76: 629- 637.

Katayama, K., Komae, K., Kohyama ,K., Kato, T., Tamiya, S., and Komaki, K. 2002. New sweet potato line having low gelatinization temperature and altered starch structure. Starches/Starke 54: 51-57.

Moorthy, S.N., Blanshard, J.W.V., and Richard, J.E. 1992. Starch Properties in Relation to Cooking of Cassava. In: Proceedings of the first International Scientific Meeting of the Casava Biotechnology Network. W.M. Thro (Eds). Cartagena, Colombia, 25-28 August 1992. Working Document No 123, Centro Internationale De Agriculture Tropical (CIAT), Cali, Colombia, pp. 265-269.

Mua, J.P., and Jackson , D.S. 1997. Relationship between functional attributes and molecular structure of amylose and amylopectin fraction from corn starch. J. Agric .Food Chem.45: 3848-3854.

Mua, J.P. , and Jackson, D.S. 1998. Retrogradation and gel textural attributes of corn starch amylose and amylopectin fractions. J Cereal Sci 27: 157-166.

Rahman, S.M.M. 2000. Extraction and functional properties of different varieties of sweet potato starch. Dissertation No. BP-00-03. Asian Institute of Technology, Bangkok, Thailand

Richard, J.E., Asoaka, M., and Blanshard, J.M.V. 1991. The physico-chemical properties of cassava starch. Tropical Science, 31:189-207

Sandhu, K.S., Kaur , M. and Mukesh (2010) Studies on noodle quality of potato and rice starches and their blends in relation to their physicochemical, pasting and gel textural properties. Food Sci Technol 43: 1289-1293.

Thao, H.M, and Noomhorm, A. 2011. Physiochemical Properties of Sweet Potato and Mung Bean Starch and Their Blends for Noodle Production. J Food Process Technol 2:105. doi:10.4172/2157-7110.1000105

THE SHELF LIFE DETERMINATION OF CAPSAICIN ON RED CHILLI PASTE USING THE ARRHENIUS MODEL APPROACH

DHARIA RENATE

Faculty of Agricultural Technology, University of Jambi
Jl. Jambi – Muara Bulian Km.15 Mendalo.phone.0741-583051

email: dhariarenate@yahoo.com

ABSTRACT

Spiciness is one of the indicator quality of red chili that determined by capsaicin content which is capsaicinoid compound. During storage, the quality of red chili paste will decrease such as capsaicin degradation, loss of vitamin C, color changes. The objective of this research was to measure the rate of capsaicin degradation and to determine the shelf life using the Arrhenius model approach. Research was conducted on laboratory of Research Center For Materials Science at University of Indonesia. Raw material used was fresh red chili, the variety of Tanjung from Kerinci region, Jambi. This research was designed as a Factorial Completely Randomized Design. The treatments of red chilli paste were temperature storages (20°C, 30°C, 40°C) and storage times (0, 2, 4, 6, 8, 10 weeks). Parameter analyzed was capsaicin content (HPLC method).The data was analyzed using linier regression, curve and Arrhenius equation.The shelf life determination of capsaicin on red chili paste was predicted using kinetics model equations based on order reaction, zero and first order equation. It werezero order of $t = \frac{C - C_0}{k}$; and first order of $t = \frac{\ln Co - \ln Ct}{k}$.The results showed that red chilli paste stored during 10 weeks at 20°C caused the lowest capsaicin degradation. Degradation rate of capsaicin was first order reaction. Arrhenius equation for capsaicin was Y = -9367.3x + 28.705. Shelf life determination of capsaicin was ln k =-9367.3(1/T) + 28.705 (R^2 0.762). Kinetic reaction of first order was $t = \frac{\ln Co - \ln Ct}{k}$so that the self life of red chilli paste stored at 20°C, 30°C and 40°C were 10.21 weeks, 8.19 weeks and 8.08 weeks respectively.

Keyword: shelf life, chilli paste, capsaicin, degradation, Arrhenius model

INTRODUCTION

Peppers necessity as raw material increasing due to peppers processing industry seeks on making diversification of peppers product based on consumer consumption. Production of red peppers in Indonesia increases during last five years, it was about 7,5% a year. Production of 695,707 tons in 2008 increased to 954,310 tons in 2012 (Badan Pusat Statistik and Direktorat Jenderal Hortikultura 2013). Total need of pepper is 814.06 tons per day. It consists of 25.66 tons for household consume, 425 tons for food stall, 355 tons for red pepper paste and 8,4 tons for red pepper flour (Statistik Produksi Sayuran Indonesia, 2008). This amounts indicates correlation between the supply and demand of fresh red pepper that increasing of daily consumption person caused by increasing people and pepper consumptions.

The characteristics of peppers quality especially spiciness level needed by industries that process the raw material of peppers to be sauces. Spiciness is one of the indicator quality of peppers that determined by capsaicin content which is capsaicinoids compounds. Capsaicinoids are the compounds responsible for the pungency of pepper fruits and their products. Peppers are the fruits of plants from the genus *Capsicum*an belong to the family *Solanaceae*. There are several domesticated species of chili peppers, among them *Capsicumannuum*, C.*frutescens* and *C.chinense*, which include many common varieties. These various peppers are widely used in many parts of the world for their valued and characteristic sensory properties: color, pungency and aroma. The amount of capsaicin in a given variety can vary depending on the light intensity and temperature at which the plant is grown, the age of the fruit, and the position of the fruit on the plant.

The first test developed to measure pungency was the Scovilletest, first developed in 1912 by Wilbur Scoville (Scoville,1912). There are five levels of pungency classified using Scoville heat units (SHU): non-pungent (0–700 SHU), mildly pungent (700–3,000 SHU), moderately pungent (3,000–25,000 SHU), highlypungent(25,000–70,000 SHU) and very highly pungent (>80,000 SHU). Nowadays, however, the Scoville organoleptic test has been largely replaced by chromatographic methods which are considered to be more reliable and accurate (Weiss, 2002).

Pungency, a commercially important attribute of peppers, is due to the presence of chemicals from the characteristic capsaicinoids group. The most abundant capsaicinoids in Capsaicinoids are mainly in gested as naturally occurring pungency-producing components of *Capsicum*spices (chili, cayennepepper, red pepper). Their concentrations typically range from 0.1mg/g in chili pepper to 2.5mg/g in red pepper and 60mg/g in oleoresin red pepper (Nwokem et al., 2010).

Peppers is capsaicin (8-methyl-*N*-vanillyl-*trans*-6-nonenamide), with capsaicin accounting for~71% of the total capsaicinoids in most of the pungent varieties (Kosuge and Furuta, 1970). Capsaicin content of peppers is one of the major parameters that determine its commercial quality (Kawabata et al., 2006 and Zang et al., 2007). Pepper varieties from *Capsicumannuum*, *C. frutescens*and*C. Chinense* were found to contain 0.22–20mg total capsaicinoids/g of dry weight (Parrish, 1996). In another study, cayenne pepper samples had main capsaicin and dihydrocapsaicin contents of 1.32 and 0.83mg/g dry weight, respectively (Lopez et al., 1996). Capsaicinoid compounds consist of capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homodihydrocapsaicin, homocapsaicin, and vanillyl pelargonamide (Edmond et al., 1983; Govindarajan, 1985; Todd et al., 1997). Capsaicin is the large amoutof 69% from the total capsaicinoid compounds followed by dehydrocapsaicin of 22%. Homocapsaicin and homodihydrocapsaicin are low in the capsaicinoid compounds (Andrew, 1979; Govindarajan, 1985).

Heating process affects the color and capsaicin content (pungency level) especially if the heat temperature for processing is very high or the processing take long time (Ahmed et al., 2000). During storage, the quality of red chili pepper will decrease due to degradation of capsaicinoids compounds such as capsaicin, loss of vitamin C and color changes (Ahmed et al*.*, 2000 and Ahmed et al*.*, 2002). Nutrient loss of red chili pepper stored in room temperature and high temperatureishigher than it is at low temperature storage.

Process condition to kinetic parameter can be approached by kinetic model or mathematic model such as linear, exponential or hyperbol program. Temperature is one of factors affected food changing. It will be related with the reaction rate. The higher temperature storage of food stuff, the reaction rate of chemical compounds will be quick. It can be calculated using Arrhenius approached.

The objective of this research was to measure the rate of capsaicin degradation and to determine the shelf life using the Arrhenius model approach.

MATERIALS AND METHODS

Raw material used was fresh red chili pepper. Research consisted of two steps; the first step was to identify the effect of heating temperature and time of red chili paste to degradation of capsaicin during process; the second step was to use the result from the second step based on the treatments of the lowest capsaicin degradation.

Some steps procedure research were the first was fresh red chili peppers were sorted to get good fresh chili peppers. Then fresh chili peppers were cleaned, blanched in warm water at 80°C for 3 minutes. The second step was chili peppers were chooped and added food additive such as citric acidof 0,5%, benzoic acid of 0,1% and natrium chloride of 5%. The third step was the pasta was heated at 80°C for 25 minutes then these pasta was packed in jar bottles of 150gm for each bottle. The fourth step red chili pasta was stored for capsaicin analysis. The procedure for making red chili pasta on Fig 1.

This research was designed as a Factorial Completely Randomized Design using two factors and three replications. The treatments of the first step were the heating temperatures (70, 80 and 90 ^{0}C) and the heating times (10, 15, 20 and 25 minutes). The treatments of the second step are temperature storages (20°C, 30°C, 40°C) and storage times (0, 2, 4, 6, 8, 10 weeks). Parameter analyzed was capsaicin content (HPLC method).

The data were analyzed using analysis of variance. The significantly different treatment was further analyzed by using Duncan Multiple Range Test. The parameters include the measurement of capsaicincontent, for both fresh and chili pepper paste. The data of the third step research wasalso analyzed using linier regression, curve and Arrhenius equation (Saguy and Karel, 1980).

It was used the model based on order reaction equation $\frac{d[C]}{dt} = k[C]^n$.

Capsaicin content changed during storage processed by calculate the rate constant (k). The shelf life determination of capsaicin on red chili paste was predicted using kinetics model equations based on order reaction, zero and first order equation. These were zero order of $t = \frac{C_0 - C_t}{k}$; and first order of $t = \frac{\ln C_0 - \ln C_t}{k}$.

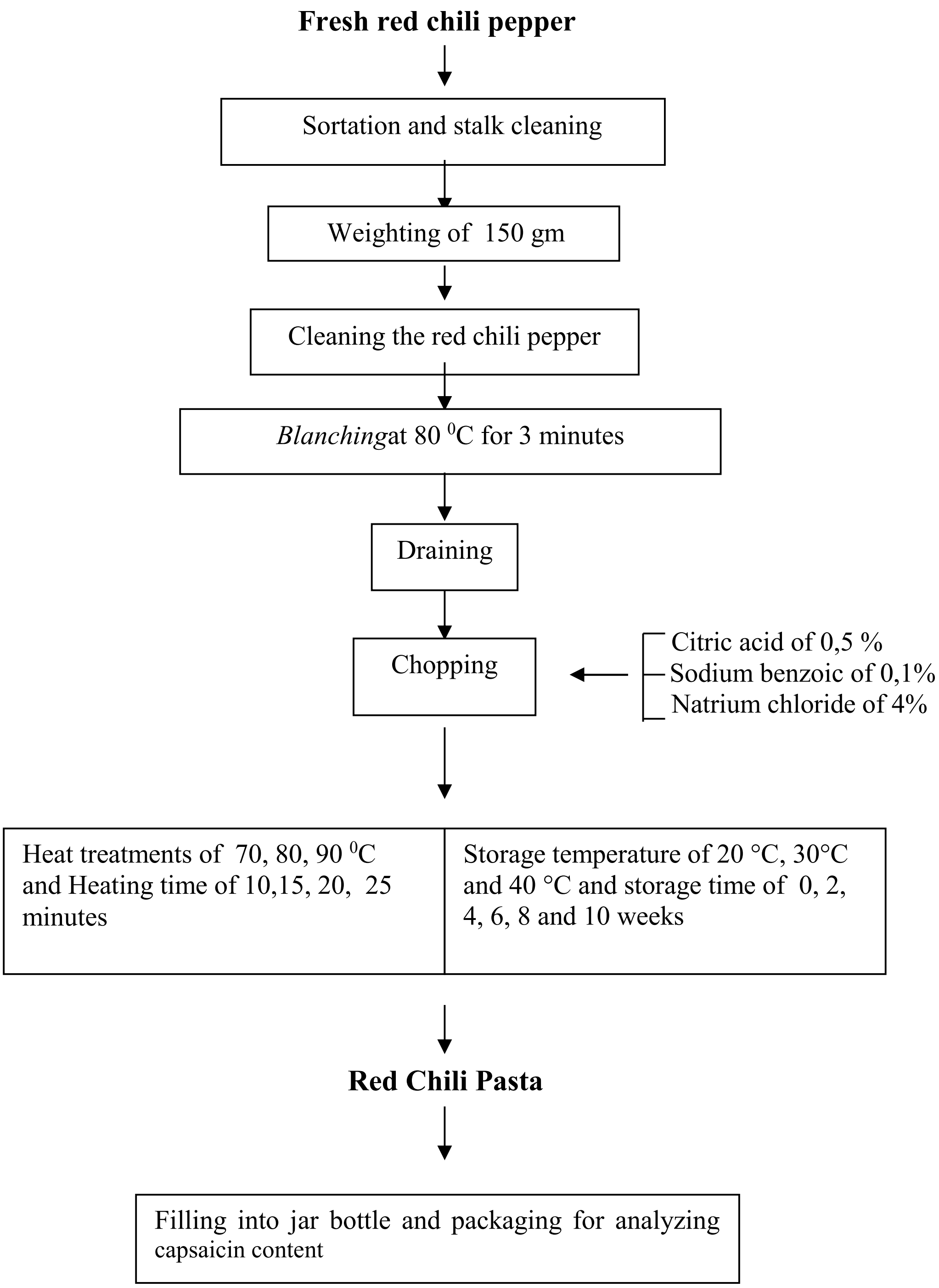


Fig 1. Procedure for making red chili pasta

RESULT AND DISCUSSION

Capsaicin Content

Capsaicin content of chili paste is 916.80 µg/g. Capsaicin content of chili paste decrease during storage. Fig. 2 shows that at the fourth week storage capsaicin content for both temperature storage of 30 and 40 ºC decrease sharply, while it is store at 20 ºC decrease slowly. These capsaicin content are 746,36 µg/g, 714,19 µg/g and 883.8097 µg/g respectively.

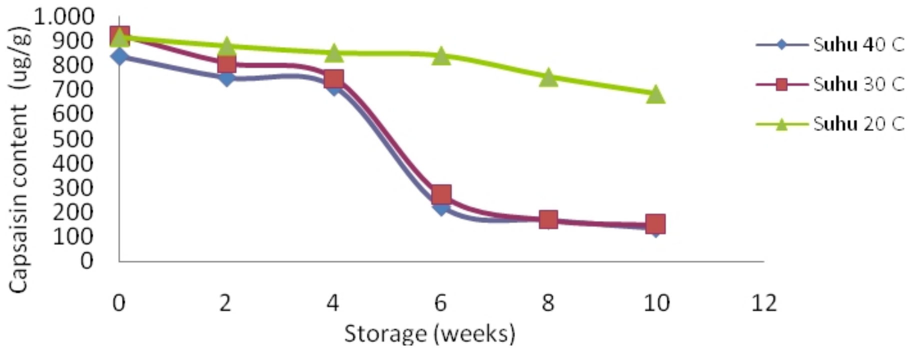


Figure 2. Storage versus capsaicin content at various temperature

When the capsaicin degradation decrease the determination of reaction order by plotting zero order data of capsaicin content versus storage time at 20 ºC. Then, it plot first order data ln capsaicin content. As a result the equation of linier are y= -22,263x + 932,89 and coefisien correlation $R^2$is 0,92 and y= -0,0121x + 2,973and coefisien correlation R^2 0,91 (Table 1).

Table 1. Linier regressionequation ofchili paste capsaicin at zero and first ordo

Temperature (^{0}K)	Equation of linier regression		R^2	
	zero order	first order	zero order	first order
293	y= -22,263x + 932,89	y=-0,0121x + 2,973	0,9243	0,9062
303	y=-89,507x + 958,6	y=-0,092x + 3,0564	0,9048	0,9095
313	y=-82,105x + 883,3	y= -0,0911x + 3,0174	0,879	0,8931

Capsaicin degradation rate is first order because it decreases regularly until the end of tenth week storage.

First order (SaguyandKarel, 1980) is

$$\frac{dA}{dt} = -k\,[A]^1$$

$$\ln A_t = \ln A_0 - kt \qquad (1)$$

Arrhenius equation:

$$k_0 = A_0 \, . \, e^{-\frac{Ea}{RT_0}}$$

$$\ln k = \ln k_0 - \frac{Ea}{R}\left[\frac{1}{T}\right]$$

where k = constanta of rate reaction

k_0= factor of reaction frequention

R = air constanta (1,987 cal / g-mole K)

E_a = activation energy, constan at certain temperature

T =temperature absolute(K)

The equation can be changed to :$\ln k = \ln k_0 - (E_a /RT)$ (2)

Table 2. Parameter of Arrhenius changing at minimum capsaicin of red chili paste

T (^{0}C)	T (^{0}K)	1/T	k	ln k
20	293	0,003413	0,012	4,414549826
30	303	0,003300	0,092	2,385966702
40	313	0,003195	0,091	2,395797475

Arrhenius equation of Fig 3is by plotting the value of ln k and 1/T at changing reaction of capsaicin.

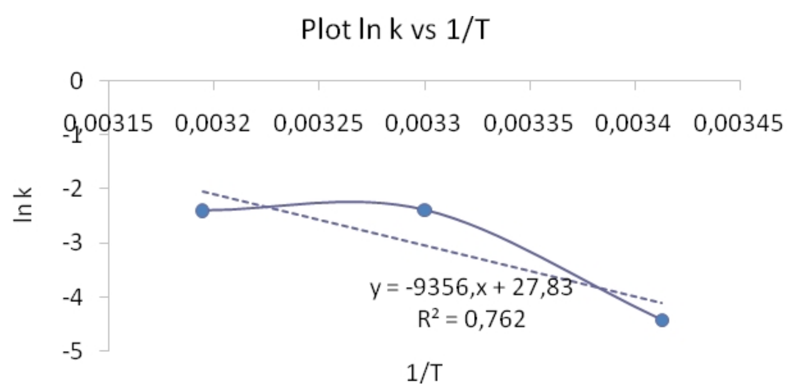


Fig. 3 Plot Arrhenius at capsaicinvalue changing of red chili paste during storage

ISBN 978-602-0860-10-7

The analysis of linear regretion1/T andln k at capsaicin degradation is Y=-9356.3x + 27.836 ;E/R = 1385,48danlnko= 27,836. The activation energy is 18581,65cal/mol, (R= air value is 1.986 cal/mol).k value is fromln k = lnko – (Ea/R)(1/T), wherelnko= intersep, Ea/R = slope. k value is used for first order of kinetic reaction equation. Shelf life determination of chili paste capsaicin is ln k = -9356.3 (1/T) + 27.836 (R^2=0.7627). Shelf life of capsaicin t = ln (Ao-At)/k, where

t = the shelf life of red chili paste (weeks)

A_o = capsaicin content of the first storage (zero week)

A_t = capsaicin content of the last storage (t weeks)

k = constanta of capsaicin degradation

Tabel 3 shows the shelf life of red chili paste at various temperature condition

Table 3. The shelf life of red chili paste at various temperature condition of capsaicin content

Temperature ^{0}C	Temperature ^{0}K	k Value	Shelf life weeks	Shelf life months
20	293	0,016625248	9,55	2,39
30	303	0,047694276	9,69	2,42
40	313	0,127914121	8,61	2,15

It is concluded that degradation rate of capsaicin is first order reaction. Arrhenius equation for capsaicin is Y = -9367.3x + 28.705. The shelf life determination of capsaicin isln k =-9367.3(1/T) + 28.705 (R^2 0.762). Kinetic reaction of first order ist = $\frac{\ln Co - \ln Ct}{k}$so that the self life of red chilli paste stored at 20°C, 30°C and 40°C are10.21 weeks, 8.19 weeks and 8.08 weeks respectively.

REFERENCES

Ahmed, J. Shivharel, U.S.and Ramaswamy, H.S. (2000). A fraction conversion kinetic model for thermal degradation of color in red chilli puree and paste. Journal of Food Science and Technology **3**(6) : 497-5003.

Ahmed, J., Shivhare1, U.S.dan S. Debnath. (2002). Colour degradation and rheology of green chillipuree during thermal processing. International Journal of Food Science and Technology **37:**57-63.

Badan Pusat Statistik dan Direktorat Jenderal Hortikultura Kementerian Pertanian RI. (2013). Produksi dan konsumsi cabai: Kebutuhan dan peluangnya. Jakarta.

Edmond, J.B., Senn, T.L., Andrew, F.S., and Halfacre, F.G. 1983. Fundamentals of Horticulture. McGraw Hill Book, Co. Inc., London.

Govindarajan, V. S. (1985). Capsicum production, technology, chemistry and quality. Chemical Rubber Press. Bocaraton-Florida.

Renate, D. 2004. The Effect of Red Chili Peppers Varitiesand Storage Time to the Quality of Red Chili Puree (Capsicum annuum L.). Research Paper of University of Jambi (not publish).

Kosuge, S.; Furuta,M. 1970. Studies on the pungent principle of Capsicum. Part XIV: Chemical constitution oft hepungent principle. Agric.Biol.Chem.(34)248-256.

Lopez-Hernandez,J.; Oruna-Concha,M.J.; Simal-Lozano,J.;Gonzales-Castro,M.J.; Vazquez-Blanco,M.E. 1996. Determination of capsaicin and dihydrocapsaicin in cayenne pepper and pardon peppers by HPLC. Dtsch. Lebensmitt.Rundsch.(92)393-395

Nwokem,C.O.;Agbaji,E.B.;Kagbu,J.A.;Ekanem,E.J. 2010. Determination of capsaicin content and pungency level of five different peppers grown in Nigeria. NY Sci.J.(3)17 21.

Statistik Produksi Sayuran di Indonesia 2003-2007. (2008). Konsumsi perkapita sayuran indonesia; Ketersediaan perkapita sayuran di Indonesia 2003-2007. Badan Pusat Statistik dan Direktorat Jenderal Hortikultura Kementerian Pertanian RI. Jakarta.

Saguy, I dan Karel, M. (1980). Modeling of quality deterioration during food processing and Storage. Journal of Food Technology 34 **:**(2)78-85.

Scoville,W.L.Noteon. Capsicum.J.Am.Pharm.Assoc.1912,1,453-454.

Tood, P.H., Bensinger, M.G. and Biftu, T. (1997). Determination of pungency due to capsicum by gas-liquid chromatography. Journal of Food Science (42):660-664.

Weiss,E.A.SpiceCrops;CABIPublishingInternational:NewYork,NY,USA,2002;p.411.

ENHANCEMENT OF THE CAMERA CAPACITY MEASURING THE CATTLE WEIGHT

H. WINOTO, H. C. PANGESTIKA, A. D. PUTRIDINANTI, A. RIYANTO, G. AL HADID AND DAUD SAMSUDEWA

Faculty of Animal Science and Agriculture, Diponegoro University, St. drh. R. Soejono Koesoemowardojo, Tembalang Semarang Postal code 50275Tel./Fax. (024) 7474750
Corresponding email: daudreproduksi@gmail.com

ABSTRACT

This aims of this study was to apply the “DAHAGA” formula obtained from previous research that has an accuracy rate of 97% into the Android OS -based smartphone application so that it becomes a practical and inexpensive tool. This application is designed to estimate the height of the object by using camera's ability, so with this feature, the application can assess the chest depth of beef.Within the Cow Breast that are found then stored in the WCB (Within the Cow Breast) variable to be calculated using the DAHAGA formula resulting in cattle weight.This application is made with the Eclipse IDE and is able to run on Android 5.0 (Lollipop). This study was conducted over five months from February to June 2016. The study was also a continuation of previous studies (PKM - P funded in 2015) which has generated a new calculation formula that is more accurate than the previous formula. This follow-up study found no difference in the formula despite the establishment of additional measurements at 50 cattle to improve accuracy but, the result does not affect the DAHAGA formula that has been found “Body Weight= ((Within the Breast x Correction factor)+22)^2/100”. The difference is found that the cattle under 1 year of age can also be used as a parameter to each Correction Factor (CF),for the nation's cattle are Limpo 2.74 and Simpo 2.92.While from previous study, the age parameters are used in only the age range of 1 - 1.5 years (CF = 2.56) and 1.5 - 3 years (CF = 3.08) for Simpo and the range of 1 - 1.5 years (CF = 2.72) and 1.5 - 4 years (CF = 2.56) for Limpo.

Keywords: DAHAGA formula and WEICOCAM body weight estimator tool

INTRODUCTION

Cattle are major meat producer commodity consumed by people. The quantity and quality of the meat produced by cattle is strongly associated with the cattle weight. Therefore, accurate cattle weight calculation is needed in every transaction of buying and selling cattle.

This problem can be overcome with conventional cattle scales. Unfortunately, this weight tool has some shortcomings, such as not easy to use, expensive and immobile. In this case, a very high price becomes an obstacle for some breeders to have this scaling tool, especially for small breeders with low fund. Therefore, a tool that is easy and inexpensive to assist small breeders in the suspect of cattle weight is needed. So that, any loss in the sale and purchase of cattle can be minimized.This study tries to prove that the smartphone's camera can be used as an aid for suspecting cattle weight. This is based on some cattle weight calculating formulas with cattle limb parameters. In previous studies, it has been proved that Within the Breast has the greatest influence in the calculation of the cattle weight and by using the principle of congruency on the camera lens, the camera android smartphone can be used to calculate Within the Breast, which is then used as the main parameters included in the formula to calculate the weight of cattle. The reason for choosing Android as the OS is because of many Android-based smartphones that is used by the community. With low price, easy to use and rapid system update, Android will continue to be used by all levels of society for several years ahead.

MATERIAL AND METHOD

This study was conducted by CV Indonesia Multi Wonderful Farm, Pati because it has more number of livestock and more accurate of the body weight. The research was conducted of the month from March to April 2016. Preparation and determination of the formula implemented in the Laboratory of Genetics Breeding and Reproduction, Faculty of Animal Science and Agriculture, Diponegoro University, Semarang.The material used in this study was 60 cattles. The tools used were the yardstick, measuring tape, stationery and a camera for documentation.

The method used in this study were divided into three stages, that are determining the appropriate formula to estimate cattle weight, making measuring instruments in accordance with the type of cattle in Indonesia, andtesting tool on 50 cattles.

Research Phase 1. Formula Determination

Formula determination is done by measuring the chest circumference, body length, height, waist circumference and scrotal circumference of 60 cattles on previous research, plus 50 cattles in this study. After all the data are collected, thenit will be calculatedby using the Schoorl formula.

Research Phase 2. Tool Making

Tool-making is done after determining the right formula. Design tools implemented by utilizing the android based smartphone camera as a sensor. The camera on the smartphone can be used to measure the physical parameters of cattle by using image reflection that occurs in the process of capturing the object by the camera.

Research Phase 3. Tool Testing

Tool testing was performed on June 17, 2016 in Indonesia CV Multi Wonderful Farm, Pati by photographing objects in the form of cattle, exactly at the time cattle was in upright position.

RESULT AND DISCUSSION

New Formula Finding

The results obtained from the Schoorlformula calculation bring body weight to raisefar adrift with the original body weight that is 59.82 ± 65.98 kg for Limpo cattle age of 1 - 1.5 years; 75.77 ± 48.64 kg for Limpo cattle aged 1.5 - 4; 23.91 ± 25.34 kg for Simpo cattle age of 1 - 1.5 years and 82.55 ± 59.67 kg for Simpo cattle aged 1.5 - 3. Akbar (2008) states that the predicted Limousin cross cattle body weight using the formula Schoorl has an average deviation of 116.21 ± 11.26 kg with a percentage deviation reaches 21.29 %.

Based on these results, it is necessary to create a new formula so a range of body weight which is close to or equal to the original body weight can be obtained. This research will create a modification of the new weight estimator formula named " DAHAGA" formula. "DAHAGA" formula is named, because "DAHAGA" means thirsty so, it is expected from this formula to provide information to breeders on a calculation method which has higher accuracy. "DAHAGA" formula can be seen as follows:

$$\text{“DAHAGA” formula} = \frac{((WCB \times CF)+22)^2}{100}$$

Annotation :

WCB : Within the Cow Breast (cm)

CF : Correction factor

ISBN 978-602-0860-10-7

The results of the Schoorl formula and "DAHAGA" formula can be seen in Table 1.

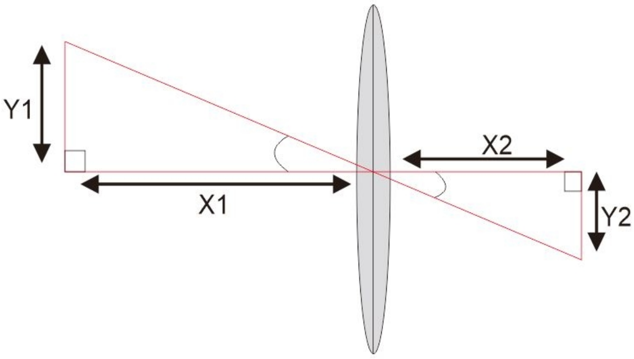
Table 1. Cattle Body Weight Calculation

Cattle	Age	Num. of livestock	Actual body weight	Schoorl body weight	ΔActual BW – Schoorl BW	"DAHAGA" body weight	Δactual BW–"DAHAGA" BW
	year	--head--	--------------------------------kg--------------------------------				
Limpo	1 – 1,5	8	352,38	331,97	59,82 ± 65,98	353,41	48,62 ± 36,08
	1,5 – 4	5	483,60	426,74	75,77 ± 48,64	467,70	70,37 ± 29,47
Simpo	1 – 1,5	4	376,50	371,13	23,91 ± 25,34	380,63	17,03 ± 18,26
	1,5 – 3	9	485,22	426,65	82,55 ± 59,67	502,15	77,28 ± 57,30

The results showed that the "DAHAGA" formula is more accurate in estimating the body weight of cattle rather than Schoorl formula. Akbar (2008) stated that the measurement of body weight on medium-sized cattle such as Indonesian cattles in general by using the Schoorl formula has a large margin that is 63.92 kg. The "DAHAGA" formula had various correction factor because the cattle body weight can be influenced by race and age of the cattle. It causes the correction factor to become important because it can improve the accuracy of the formula. The correction factor which is obtained for Limpo cattle with a lifespan of less than 1 year was 2.74. Limpo between the ages of 1 - 1.5 years was 2.72. Limpo cattle with age between 1.5 - 4 months, the obtained correction factor was 2.92. The results obtained in the calculation of the correction factor for Simpo cattle between the ages of 1 - 1.5 years was 2.56 while for Simpo cattle with less than 1 year of age was 2.58. Simpo with ages between 1.5 - 3 was 3.08. This formula will be used in the WEICO (Weight of Cow Meter) design tool.

Tool Design

Weico application design is done using the Eclipse IDE by using the camera on Android to load Within the Breast parameters. Within the Cow Breast (WCB) is a physical parameter of cattle taken from a cattle chest height. This section is located just behind the front legs of cattle. These parameters will be taken from the results of object height calculation by utilizing the camera. The working of the camera in countingthe height objects is same with the formation of shadows on the X - ray special convex lens.



Annotation;

Y1 = Actual object height

Y2 = Object height in camera (shadow)

X1 = Object length from camera

X2 = Focal length camera

Equation congruency;

$$\frac{Y1}{X1} = \frac{Y2}{X2}$$

In this case, an actual height objects (Y1) will represent the WCB variable to put in the "DAHAGA" formula. So, it can be obtaineda WCB calculation formula as follow;

Object Height Formula;

$$WCB = \frac{(Y2\,x\,X1)}{X2}$$

Y2 is an object height on the screen. In this case we will limit the measured object in the chest cattle only.The next process is comparing the existing triangle when the object in the image height (Y1) is already known in units of centimeters. X1 is the distance of the object from the camera. In this case, we made a rule that the shooting process must be donewith the distance between the cattle and camera in 1 m, so that the amount X1 is a static variable and always worth 1. X2 is a focal length camera where each phone has different specifications. Zulkhairi (2012) stated that the focal length of the camera is the distance from the optical center of the lens with focal points in the sensor or the focal length camera film can be obtained from the following code:

```
Camera.Parameters p;

p = mCamera.getParameters();
float focalLength;
focalLength=p.getFocalLength()
```

The code above will generate each focal length camera value that is used for the measurement. This value will be stored in variable X2. When the value of Y2, X1 and X2 are found, then the program will run the first formula to calculate Y1 and then stored in the WCB variable which is the height value of the actual objects. After WCB value is found, it will be sent to fill the existing WCBvariable in the formula "DAHAGA". Then the final process is to perform the calculation "DAHAGA" formula as the ultimate value. The process of making android appshave been completed using the Eclipse IDE, because it is free and does not overload the performance of the laptop. Applications which have been made have been tested to measure the height of the object with the error between 1-2 cm. So this application is already quite ready to test cattle weight measurements and lastly, all smartphones with Android OS version lollipop downward are able to run this application.

Conclusion of this research was WEICO as camera measuring the cattle weight has a high accuracy. WEICO can support the small holder farmer to reduce their budget lost in selling and purchasing cattle.

REFERENCES

Akbar, M. 2008. Pendugaan bobot badan sapi persilangan Limousin berdasarkan panjang badan dan lingkar dada. Skripsi, Fakultas Peternakan, Universitas Brawijaya, Malang.

Zulkhairi, Yohana Dewi Lulu W, Memen Akbar. 2012. Perancangan DanImplementasi Pengukuran Jarak Dan Tinggi Objek Berbasis Kamera Pada Perangkat Mobile. Program Studi Teknik Informatika Jurusan Komputer Politeknik Caltex Riau, Riau.

BODY CONDITION SCORE AND NON RETURN RATE PERCENTAGE OF COW BEEF AFTER FLUSHING IN CENTRAL JAVA

DAUD SAMSUDEWA[1], MARRY CHRISTIYANTO[1], MUKH ARIFIN[1] AND ANDRI HANINDYO[2]

[1]Department of Animal Science, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Indonesia
[2]Directorate General of Animal Production and Health, Agricultural Ministry of Indonesia

Corresponding email : daudreproduksi@gmail.com

ABSTRACT

The aim of the research was to observe the body condition score (BCS) and non return rate (NRR) percentage of cow beef after flushing in Central Java. The research was conducted in 15 farmer community of 5 regency in Central Java. Ninety cows was used in this research. BCS was measured by palpate 6 part of body. Every cow was feed 2 kg concentrate with 14% of crude protein. NRR percentage counted by number of the cows that non repeat breeding divided by number of the cows was inseminated times by 100%. Data was analized used descriptive analysis. The results showed that increasing of BCS in range 0.3 to 2.0. Increasing BCS was different in every reproductive physiology. NRR-21 days before and after flushing was 72,40% and 76,15%, repectively. NRR-42 days before and after flushing was 66,07% and 72,32%, respectively. Conclusion of this research was flushing increased BCS and NRR.

Keywords: BCS, NRR, Flushing, Cows

BACKGROUND OF STUDY

Increasing beef production was the key success for protein sufficiency of Indonesian. Beef cattle was the main source of animal protein. But, beef meat only shared 23% from all of meat consumption in Indonesia. Other source was covered by broiler.

Population of beef cattle in Indonesia was not significantly increased. Publish data by Statistic Centre Bearue showed that in fifteen years has fluctuative dynamics, eventhough increasing in cattle population showed from 11.008.000 head in year 2000 become 14.703.000 head in year 2014. The number showed that previous target of 5% increase in cattle population was not reached.

One of the key for increasing population of beef was in cow productivity. On other hand, breeding farmer in Indonesia 98% was small holder farmer with 1 to 2 head each. The biggest problem for cow breeding in small holder was malnutrition (Susilawati, 2011).

Basic needs for cow was crude protein (CP) and total digestible nutrient (TDN) 14% and 68%, respectively (Umiyasih dan Anggraeny, 2007). The basic needs was difficult to reach because of finance restriction. Farmer was feel enough with forage to cover the basic need. This condition must be supported by goivernment to increased the cow productivity. In 2015, Directorate General of Animal Production and Health, Agricultural Ministry of Indonesia supported for increasing production of cow through Strengthening of Cows feed 2015. Some parameter was used in this program including body condition score and reproduction performance.

The aim of this research was to observe body condition score and non return rate of cow that was joined with Strengthening of Cows feed 2015. This researh will inform to the farmers what is the effect of Strengthening of Cows feed to the productivity oif cows.

MATERIAL AND METHODS

This research was done in 8 Province (West Sumatra, Lampung, Banten, West Java, DIY, Central Java, East Java and West Lesser Sunda). Research was started rom May to November 2015.

One thousand Two Hundred and Eighty cows was used for body condition score measurement and reproduction performance were used in reproductive performance. Feed consentrate with CP 14% and TDN 68% was given 2 kg each for 180 days. Body condition score measurement was observe on 6 parts of body it was tail head, pin bone, rump, hip bone, backbone and ribs (Figure 1). Score of BCS was ranged from 1 to 9. Observation of BCS was Saw, Touched, Pressed and Evaluated to the 6 parts of cows body. The ideal BCS of cows was ranged 4 to 7. Recording was used in this research for information of cows reproductive performance.

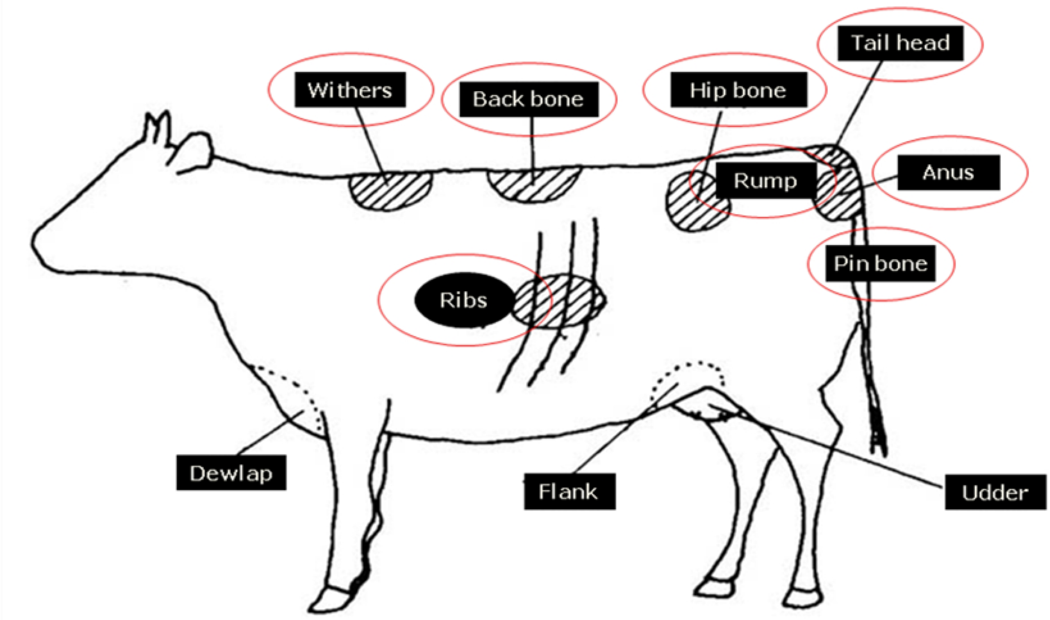


Figure 1. Body Parts for BCS Measurement

Data BCS and reproductive performance was was analized used descriptive statistics. Mean of increasing BCS and non return rate was the main data for discussion.

RESULTS AND DISCUSSIONS

Results of the research showed that increased of BCS was ranged 0,3 to 2,0. The highest incresing BCS showed by the cows with BCS 2 (1,0 to 2,0) and the lowest was cows with BCS 8 (0,3). Commonly, highest increasing BCS showed by thin cows. This result was supporting the thin cows to be ideal cows (BCS 4-7). Results of this research was showed that in different physiologic condition has a different respons of BCS. Average increasing BCS of cows in different physiologic condition showed on Table 1.

Table 1. Average Increasing BCS of Cows in Different Physiologic Status

	PHYSIOLOGIC START-FINAL	STARTING BCS						
		2	3	4	5	6	7	8
AVERAGE INCREASING BCS	Non Pregnant- Non Pregnant	1,4	1,2	0,7	0,4	0,7	-	-
	Non Pregnant-Pregnant	1,0	1,3	0,7	0,5	0,5	-	-
	Pregnant-Pregnant	-	1,4	0,9	0,9	0,5	1,0	0,3
	Pregnant-Milking	2,0	1,0	0,4	0,4	-	-	-
	Milking-Milking	1,0	0,8	0,3	0,5	-	-	-

Table 1. showed that cows with status physiologic non pregnant has the highest increasing BCS (0,4 to 1,4) after fed with 2 kg consentrate (CP 14% and TDN 68%). In this research, additional fed concentrate 2 kg (CP 14% and TDN 68%) will keep the BCS of cows esspecially for the milking cows. Commonly milking cows will decrease BCS because of mal nutrition. Unfortunately, additional 2 kg of concentrate (CP 14% and TDN 68%) can keep the stable BCS.

BCS was connected with reproductive performance. Ideal BCS was shown the good fat deposition and connected with stabilitation of reproductive hormone. Increasing BCS was followed with increasing non return rate (NRR) of cows. NRR 21 days (NRR-21) and NRR 42 days (NRR-42) of cows before and after showed on Table 2.

Tabel 2. NRR-21 and NRR-42 Before and After Flushing (Study Case in Central Java; Sample 90 head)

BEFORE FLUSHING		AFTER FLUSHING	
NRR-21, %	72,40	NRR-21, %	76,15
NRR-42, %	66,07	NRR-42, %	72,32

The result showed that flushing was increased NRR of cows. Increasing of NRR was 3,75% for NRR-21 and 6,25% for NRR-42. BCS is closed related to status of the energy body reserves that are affected by feeds consumed prior to eficiency reproduction, pregnancy period and parturition (Winugroho, 2002). NRR as a parameters of eficiency reproduction in this research shown increasing after flushing. It was connected with stabilization of hormone, esspecially estrogen. Estrogen will stabil when the source of fat is enough.

The results concluded that flushing fed with concentrate 2 kg/head (CP 14% and TDN 68%) can support the stabilization of BCS. Flushing was supported reproductive perfoirmance esspecially NRR-21 days and NRR-42 days.

ACKNOWLEDGEMENT

Deepest thanks was delivered to the Directorate General of Animal Production and Health, Agricultural Ministry of Indonesia for supporting this research. Thanks also to Dean of Faculty Animal and Agricultural Sciences, Diponegoro University, Indonesia for permit to do this research.

REFERENCES

BPS. 2014. Indonesia in Statistics. Badan Pusat Statistik, Jakarta.

Susilawati, T. 2011. Succesfully of Artificial Insemination with different semen quality and deposition on Ongole grade cows. Jurnal Ternak Tropika. 12 (2) : 15-24.

Umiyasih, U. And Y.N. Anggraeny. 2007. Guidelines of Balance Ransom, Feed Strategy in Beef Cattle. Center of Research and Development of Animal Production. Grati, Pasuruan, Indonesia.

Winugroho, M. 2002. Feeding strategy to improve reproductive efficiency in cows. Jurnal Litbang Pertanian 21 (1): 19-23.

BODY MEASUREMENT OF TIMOR DEER (*Rusa timorensis*) IN CAPTIVITY OF CENTRAL JAVA

DAUD SAMSUDEWA[1)], ALFINA HANDAYANI[2)] AND BAROTO AGUS ARYADI [3)]

[1)]Faculty of Animal and Agricultural Sciences, Diponegoro University
[2)]Research and Development Agency of Central Java
[3)] Forest Park of Mangkunagoro I, Office of Forestry of Central Java

Corresponding email : daudreproduksi@gmail.com

ABSTRACT

The aim of this research was to collect the data base of body measurment of Timor deer. Five stag and 6 doe in age 3 to 4 years was used in this research. The research was done in Karanganyar and Kudus regency of Central Java. Body weight, body circumferences (neck and chest), body height (waist and shoulder), body length, testical (length, wide, circumferences and volume) for stag and vulva (length and wide) for doe was measured. Descriptive and regression analysis was used. The results showed that body weight; neck circumferences; chest circumferences, shoulder height; waist height; body length; length of testical; wide of testical; testical circumferences and testical volume of stag was 56.80 kg; 53.10 cm; 87.98 cm; 80.04 cm; 84.64 cm; 70.08 cm; 6.43 cm; 3.51 cm; 18.10 cm and 126.80 ml, respectively. Body weight; neck circumferences; chest circumferences, shoulder height; waist height; body length; length of vulva and wide of vulva of doe was 37.67 kg; 35.83 cm; 76.12 cm; 72.02 cm; 77.95 cm; 60.50 cm; 2.66 cm and 1.19 cm, respectively. Increasing of neck circumferences was related with measurement of reproductive organs in stag.

Keywords: body measurement, Timor deer and captivity

INTRODUCTION

Timor Deer (*Rusa timorensis*) is one of the wildlife that conserve by Indonesian government through Government rule Number 7 Year 1999 about Conservation of Plant and Animal. The utilization of Timor deer have been set on Act number 5 year 1990 about Utilization of Timor Deer in Filial 2 (F2). Timor deer captivity was developed in some country including Australia, New Zealand, Cina and some others country (Semiadi, 2006). Today, development of Timor deer vcaptivity in Indonesia have been low in increasing population. One Timor deer captivity on Kudus regency was noted the increasing population 0,5 head/year. This condition affected by missmanagement of feed, cage and mating.

Timor deer is a potential animal for meat production. Timor deer is the second biggest deer in Indonesia after Sambar deer (*Rusa unicolor*). Unfortunately, number of Timor deer in captivity was limited. This condition affected to the inbreeding. One of the parameter of inbreeding was decreasing body measurement. Data about Body measurement of Timor deer in captivity still limited.

The aim of this research is to collect data base about body measurement of Timor deer. This information will support the following research about effect of inbreeding to the body measurement of Timor deer.

MATERIALS AND METHODS

This research was conducted in H. Yusf Wartono Timor deer captive breeding, Margorejo village, Dawe District, Kudus regency and Forest Park of Mangkunagoro I, Office of Forestry of Central Java. Five months research start on June until November 2014 was done.

Five stag and 6 doe in age 3 to 4 years was used in this research. Measurement tape, measurement glass, measurement stick and milimeter ruler were used as measurement tools. Body weight, body circumferences (neck and chest), body height (waist and shoulder), body length, testical (length, wide, circumferences and volume) for stag and vulva (length and wide) for doe was measured. Method to measured volume and circumferences of testis showed in figure 1.

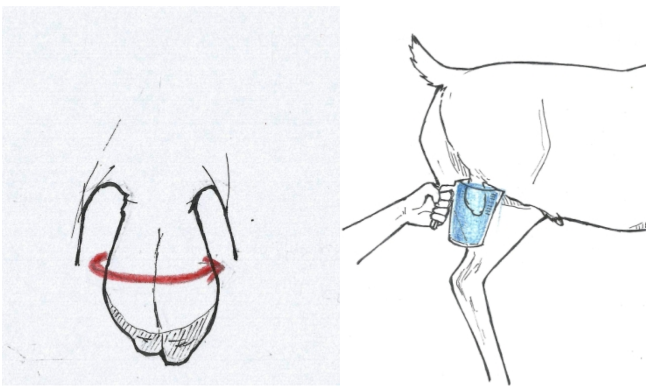


Figure 1. Testis Circumferences (Left), Testis Volume (Right)

ISBN 978-602-0860-10-7

Descriptive statistic analysis was used in this research. Mean and standar deviation were analized.

RESULTS AND DISCUSSION

Body and reproductive organ measurement of male Timor deer on captivity in Central Java Province showed in Table 1.

Table 1. Body Measurement of Male Timor Deer

PARAMETER	AVERAGE	STANDAR DEVIATION
Body Weight, kg	56,80	11,63
Neck circumferences, cm	53,10	12,51
Chest circumferences, cm	87,98	7,12
Waist beight, cm	84,64	4,81
Shoulder height, cm	80,04	5,93
Body length, cm	70,08	5,03
Testical:		
- Length, cm	6,43	1,38
- Wide, cm	3,51	0,86
- Circumferences, cm	18,10	3,74
- Volume, ml	126,80	66,77

Table 1. showed that body weight of male Timor deer (56,80 ± 11,63 kg) was in normal range. Handarini and Nalley (2008) stated that body weight of male Timor deer was around 48 to 86,9 kg. Semiadi and Nugraha (2004) stated that Timor deer in Indonesia has normal range of body weight 50 to 80 kg. Regression statistic between testis measurement (colume and circumferences) and neck circumferences showed coefficient regression 0,62 and 0,53. In this case, testis measurement connected to the testosterone level that affects to the neck circumference because testosterone causes muscle dilation. Rudiono (2007) reported that administration of testosterone at various levels in Kacang Ewe causes dilation of fibril muscle longissimus dorsi and rectus femoris. He further stated that dilation of fibril muscle can be explained by two different reasons. First, androgen receptor in muscle binds to testosterone hormone, causing the nucleus in muscle to produce protein. Second, high testosterone levels stimulate the release of other hormones such as growth hormone from the hypothalamus. Dilation of fibril muscle also need to be exercised to maintain muscle strength. Monfort *et al*., (1993) reported that in Eld's deer stags, aggressive behavior increased rapidly along with increasing testosterone level. One of the manifested aggressive

behaviors was rubbing antler. Beside for scent marking, rubbing antler was also used for training the neck and shoulder muscle (Savanth et al., 2011).

Body and reproductive organ measurement of female Timor deer on captivity in central java province showed in Table 2.

Table 2. Body Measurement of Female Timor Deer

PARAMETER	AVERAGE	STANDAR DEVIATION
Body Weight, kg	37,67	6,88
Neck circumferences, cm	35,83	5,06
Chest circumferences, cm	76,12	4,84
Waist beight, cm	77,95	3,05
Shoulder height, cm	72,02	2,96
Body length, cm	60,50	6,91
Vulva:		
- Length, cm	2,66	0,43
- Wide, cm	1,19	0,22

Table 2. showed that body weight of female Timor deer (37,67 ± 6,88 kg) was in lower than normal range if compare with results of measurement Semiadi and Nugraha that body weight of female Timor deer was 40 to 60 kg. But, Garsetiasih *et al*., (2003) stated that female Timor deer was 22,5-34,5 kg.

The conclusion of this research is body measurement of male Timor deer in normal range. But, for the female Timor deer was not in normal range. The following research need to conduct for observation the body measurement of Timor deer.

ACKNOWLEDGEMENT

Deepest thanks was delivered to the Research and Development Bearau of Central Java Indionesia for financial supporting. Thanks also to Dean of Faculty Animal and Agricultural Sciences, Diponegoro University, Indonesia for permit to do thid research.

REFERENCES

Garsetiasih, R., N. M. Heriyanto and J. Atmaja. 2003. Effect of Rice Mill By Product for Flushing of Timor Deer. Buletin Plasma Nutfah Vol.9 (2): 23-27.

Handarini, R., W. M. Nalley. 2008. Testosterone Hormone Profile in One Antler Cycle of Timor Deer(Cervus timorensis) stag. Media Konservasi Vol. 13, No. 3 Desember 2008 : 1–7.

Monfort, S. L., J. E. Brown, M. Bush, T. C.Wood, C. Wemmer, A. Vargas, L. R. Williamson, R. J. Montali, D. E. Wildt. 1993. Circannual inter-relationships among reproductive hormones, gross morphometry, behaviour, ejaculate characteristics and testicular histology in Eld's deer stags (*Cervus eldi thamin*). Journal of Reproduction and Fertility. 98 : 471-480.

Rudiono, D. 2007. The effect of testosterone hormone and age on muscle development of Kacang doe. Animal Production 9 (2): 59-66.

Savanth, V. V., P. C. Sassendran, K. S. Anil, V. Ramnath, J. Davis, A. Prasad, 2011. Observations on Sambar *Rusa Unicolor* (Cetartiodactyla: Cervidae) stags during hard and velvet stages of antler cycle in captivity. Journal of Threatened Taxa 3 (10): 2128-2135.

Semiadi, G. dan Nugraha, R.T.P. 2004. Panduan Pemeliharaan Rusa Tropis. Edisi Pertama. Pusat Penelitian Biologi, LIPI. Bogor.

Semiadi, G. 2006. Biologi Rusa Tropis. Pusat Penelitian LIPI, Cibinong.

THE ACCURACY LEVEL OF GOLD RING FOR SEX DETERMINING USING THE THEORY OF INTENSITY ELECTROMAGNETIC WAVES AGAINTS ULTRASONOGRAPHY (USG)

M. ANWAR, A. ZABIQ, M. SHOBIRIN, Y. FATIKHATURROHMAH, M. F. RIDHO AND DAUD SAMSUDEWA

Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang
e-mail: daudreproduksi@gmail.com

ABSTRACT

Currently, sex determining in cattle only able to use ultrasonography (USG). But, this method was high cost and need expertise. In other hand, the beliefs and customs of ranchers in Madura are using a pendulum of gold ring to determine sex of foetus applied the theory of Maxwell in the reaction back and forth on the pendulum called electromagnetic waves. The aim of this research was observed the intensity of electromagneticc of male and female foetus and tested the accuracy of pendulum for sex determination compared with USG. The method of this research was observation of electromagnetic intensity. Beside that sex determination of foetus was done used USG and gold ring as pendulum.Data obtained were analyzed using descriptive statistic. The results of this research showed that the intensity of electromagnetic waves in different part of body was different.The electromagnetic waves in fetal males higher (0,03 – 0,06 Tesla) than female fetuses (0,02-0,05 Tesla) and the accuracy of the gold ring pendulum method was 88,64% compared with USG.

Keyword : Gold rings pendulum, sex determination, electromagnetic waves

BACKGROUND OF STUDY

Cows are ruminants of which has long pregnancy periods. Pregnancy period was different between breeds, while the average cows pregnancy periods ranges from 280-290 days (Prasojo *et al*., 2010). Beef cattle breeders mainly need produce a calf because its higher price. On other hand, dairy farmers want cows to increase milk production per day. Long pregnancy periods makes farmers want to know the sex of foetus as soon as possible..

One of the efforts to find out the sex of the fetus by using ultrasonography. Madura community has a belief that in order to find out the sex of the fetus can be used a gold ring and put in the abdominal part of the cows and the decisive indicator is if the move in line then the sex of the fetus is male and on the other hand, if the ring moves rotate the sex of the fetus is female. The male is known have the power electromagnetic higher than females. Electricity law and magnet Maxwell explained that the back and forth movement/direction of the pendulum is called electromagnetic wave in which the wave speed electromagnetic with its approximately 300,000 km (186,000 miles) per second (Niven, 2003). Based on this belief of that society, then some research is needed to elucidate this belief.

MATERIALS AND METHODS

The research conducted in area center breeding of Madura cattle at Pamekasan regency East Java Province. Three months research was done starting from March to May 2016.

Twenty six pregnant cows age 4 month up to 9 month was used in this research. The equipment of USG, gold ring as a tool of pregnant detector, ropes for gold ring as a pendulum and EM-827 to count the wave electromagnetic used in this research.

Crosschecking the suitability of the pendulum theory with ultrasonography for sex determining was the first step of this research. Second step was count the number of electromagnetic wave. Second step was conducted on four part of the body, it was head, backbone, abdominal and tail. Measurement of the electromagnetic wave used EM-827. Data obtained were analyzed using descriptive statistic.

RESULTS AND DISCUSSION

Results of this research showed that different part of the body of fetus will shown different number of electromagnetic wave. Different months of pregnancy also showed different number of electromagnetic wave but they made non linier or fluctuative (Figure 1).

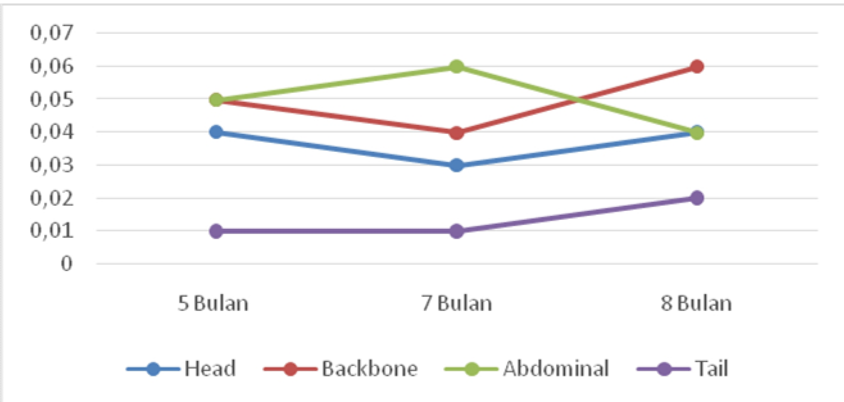


Figure 1. Number of Electromagnetic Wave in Diferrent Part of Body and Months of Pregnancy

Figure 1. indicates that a large number electromagnetic wave was found in abdominal parts. Abdominal as large areas of the body has the highest number of electromagnetic wave. Hartina *et al*., (2001) stated that number of radiation and large surface area are connected. The lowest wave electromagnetic was found in tail. But, in 8 months increasing number of wave electromagnet was shown along with growth of tail. This condition was along with statement by Rodning *et al*., (2012), that last two thirds of early pregnancy, fetuses develop slowly and only in the last third of pregnancy fetuses develop very quickly.

Male and female fetus has different number of electromagnet wave. Male fetus shown highest electromagnet wave except in backbone and tail (Figure 2).

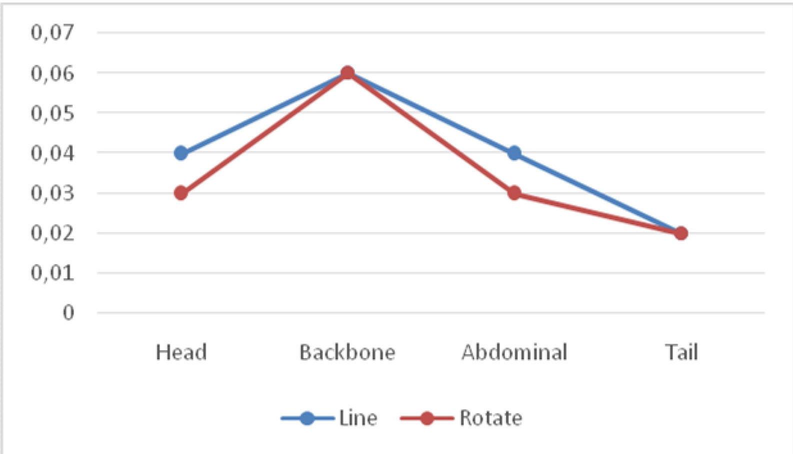


Figure 2. Number of Electomagnet Wave Between Male and Female Fetus

Figure 2. showed that in the parts of head and abdominal showed male fetus has higher number of electromagnetic wave. But, in parts of backbone and tail was not different. Backbone and tail is not the large parts of the body. So, they give not different number of electromagnetic wave.

Different direction of gold ring was influenced by the density of the ions in the body that cause the direction of the different radiation beam. The number of ions in the body affects to the differentiation of density so that waves of different frequency will appear, this is called biopotensial. The existence of different biopotensial in body organism causing different direction of gold ring.

The results of crosschecking between pendulum ring and USG showed 88.46%. This indicated that the pendulum ring has high accuracy and effective to be applied in detecting sex of the cow fetus.

The intensity of the electromagnetic waves in fetal males than females with the same quantities in males of 0.03 – 0.06 Tesla and in females of 0.02 – 0.05 Tesla. The level of accuracy of the pendulum method using gold ring reached 88.64%.

REFERENCES

Hartina, Iswadi, dan Muh. Said L., 2014. Pengukuran Intensitas Radiasi Yang Dipancarkan Oleh Handphone dan Pengaruhnya Terhadap Kesehatan. Jurnal Teknisains. 8 (1) :109-120

Niven, W. D., M.A. dan F.R.S. 2003. The Scientific Papers of James Clerk Maxwell Volume II. Dover Publications, INC. Mineola, New York

Prasojo, G., Iis Arfiantini dan Kusdiantoro Mohammad. 2010. Korelasi antara lama kebuntingan, bobot lahir dan jenis kelamin pedet hasil inseminasi buatan pada Sapi Bali. Jurnal Veteriner. 11 (1) : 41-45.

Rodning, S, W. Prevatt, R. Carson, J. Elmore, and M. Elmore. 2012. Annual Beef Cow Pregnancy Examination. Animal Sciences Series Timely Information: Agriculture & Natural Resources. Alabama Cooperative Extension System and Auburn University.

EFFECTIVENESS OF POLISULFON MEMBRANE WITH NANOSILICA ADDITION OF BOILER ASH OF SUGAR INDUSTRY

ELSA WINDIASTUTI[a], SUPRIHATIN[b], NASTITI SISWI INDRASTI[b], AND UDIN HASANUDIN[c]

[a]Student Departement of Agroindustrial Technology, Bogor Agriculture University
[b]Teacher Departement of Agroindustrial Technology, Bogor Agriculture University
[c]Teacher Departement of Agricultural Technology, University of Lampung

email: elsa.windiastuti91@gmail.com
*coresponding author: Nastiti Siswi Indrasti (nastiti.indrasti@gmail.com)

ABSTRACT

Silica (SiO_2) is the most dominant inorganic mineral elements in the boiler ash with maximum concentration up to 70.97%. Silica in nano size can be used as an additional ingredient in the making of a polysulfone membrane. Polysulfone membrane is generally used as a water processing media and wastewater treatment. The purpose of this research is to analyze about the effect of adding nanosilika on polysulfone membrane on the quality of poluted river. In this research, the manufacturing process of nanosilica membranes of boiler ash is done by performing nanosilica mass variations of 0%, 1%, 3%, and 5%. Chemical Oxygen Demand (COD) measurement showed nanosilika membrane with the addition of 3% could reduce levels of COD in the sample up to 8 mg / l. Measurements of microbial content of the test parameters of e-coli and total coliform indicates samples that have passed through the membrane does not contain microbes. Heavy metals was analyzed using an atomic absorption spectroscopy with test parameters such as Mn, Fe and Zn. showed polysulfone membrane with nanosilika addition of 3% and 5% have the best results.

Keywords—Nanosilica, Polysulfone Membrane, Nanosilica Membrane, Nanosilica Boiler Ash

I. INTRODUCTION

The most dominant Inorganic mineral elements in the boiler ash is silica (SiO_2) with maximum concentration of up to 70.97% (Hernawati and Indarto 2010). The same particle size and homogeneous in the nanoscale is essential, both in science and in industrial applications, such as catalysts, pigments, pharmaceuticals, (Zawrah et al, 2009), pharmaceuticals, cosmetics, and food (Nabeshi et al 2011). One material that become deep concern to the researchers are nanoparticles of silica (SiO2). This is because the silica nanoparticles have good stability, chemically inert, biocompatible character who is able to work in harmony with the body's systems work, and form a single spherical (Yuan et al 2010).

Moreover, the issue of environmental pollution become a great concern especially water problems. The main sources of water pollution are generally derived from the domestic form of the residue of household and industrial waste, and other pollution sources. Population growth and industrial expansion makes the environmental pollution is a serious concern, especially in developing countries like Indonesia. Along with the development of technology, water separation by membrane filtration developed rapidly in various industries due to their low energy consumption and environmental factors. Membrane technology can replace chemical wastewater treatment in reducing the cost and use of chemicals, and to produce cleaner effluent for disposal or for recycling.

Membranes are commonly applied in water treatment and waste water is a polysulfone membrane (Psf). Polysulfone membrane was chosen because it has the mechanical stability, thermal, and chemical good.Psf hydrophobic characteristics causing particles or hydrophobic molecules can teradsorb on the membrane surface. In this research will be the utilization nanosilika boiler ash as an additive membrane filtration. Membrane filtration nanosilika generated will be used as a water filter. The purpose of this research is to study the effect of adding nanosilika on polysulfone membrane on the quality of river water is polluted, with test parameters such as decreased levels of COD, total microbes and reduction in heavy metals (Mn, Zn, Fe).

II. MATERIALS AND METHODS

Materials

The materials applied for this research are polysulfone (Psf) with a molecular weight of 35 kDa from Sigma-Aldrich was used as themembrane base polymer. Dimethylformamide (DMF) from Merck, Germany used as a solvent in printing solution (dope). Distilled water, boiler ash nanosilika of the sugar industry, river water, and other analytical materials.

Methods

This research was conducted in three stages, There were the creation phase polysulfone membrane with additional additives nanosilika, characterization phase and the membrane performance. The Membrane performance is measured by the application of impairment COD, the total microorganisms and decrease in heavy metal polluted river water. The River water that used for this research was Cihideung river water.

The Polysulfone membrane made by phase inversion. Polysulfone dissolved in dimethylformamide (DMF) in the closed erlenmeyer and left for ± 16 hours until the crystals dissolve polysulfone perfect. In assessing the effect of the additive, then nanosilika added to DMF solution of 85% to maintain the concentration of solvent and additives remain as shown in Table 1. Further, the solution stirred with a magnetic stirrer until it became homogeneous and transparent for 3 hours at room temperature. And then, The Nanosilika was inserted into the solution and stirred until it was homogeneous magnetic by magnetic stirrer for 30 minutes.

Left the solution for 2 hours at ambient conditions prior to printing membrane (casting) to remove air bubbles. Poured The solution into a glass plate and then leveled with a rod stirrer with a thickness of ± 200-300 lm. The solvent was allowed to evaporate for 30 seconds in a chamber with controlled humidity. Furthermore, the membrane is immersed in a coagulation bath containing a non-solvent is water at room temperature (demixing process).After a few minutes, the membrane will be separated from the glass plate and sheet forming the membrane. Membranes that have been printed, washed with running water and dried. Then cut a circle with a diameter of 5 cm and a thickness measured.

Tabel 1. Dope Composition

Membrane code	Dope Composition(% w/w)		
	Polisulfon	DMF	Nanosilica
Psf-N1	15	84	0
Psf-N2	14	83	1
Psf-N3	12	82	3
Psf-N4	10	81	5

Membranes that will be used for testing were placed inside the reactor cross flow. Next polluted river water flowed into the reactor. A total of 10 L polluted river water was pumped into the membrane, and then the pressure was added by closing the valve. The pressure before the membrane is greater than the pressure after the membrane, so that the waste water would flow down to penetrate the membrane and the other flow across the membrane so that the unfiltered pollutants flowing into concentrate and go back to the beginning tub container. The testing of the membrane in the reactor had been done for 30 minutes for each variety and the permeate collected in container vessel. Permeate obtained and then tested COD reduction, the total microbial and heavy metals in the form of a decrease in Mn, Zn and Fe. Testing of heavy metals using Atomic Absorption Spectrophotometry (AAS).

III. RESULT

The Decrease COD Polluted River Water

Chemical Oxygen Demand (COD) is the amount of oxygen (mg O_2) which required to oxidize organic substances in one liter of water samples (mg / l). The Oxidizer used was $K_2Cr_2O_7$. The Figures of COD is a measurement of water pollution by organic substances that naturally can be oxidized through a microbiological process and causing decreased oxygen dissolved in the water. Most of the organic matter through this COD test was oxidized by $K_2Cr_2O_7$ in an optimum boiling acid.

The process of reduction in COD levels in this research had been done by flowing water polluted rivers on the membrane with the flow of cross flow. Filtration process used membrane to filter or block the organic compound in water polluted rivers that have molecular sizes larger than the size of the membrane pores.The following table analyzes the results of the measurement of polluted river water COD levels are presented in Table 2.

Tabel 2 Results of Measurement COD

Membrane code	COD	% COD reduction
Without filtration	36	-
Psf-N1	24	33,33
Psf-N2	12	66,67
Psf-N3	8	77,78
Psf-N4	12	66,67

Tabel 3 Class river water quality standards (maximum limits in mg / l)

Class I	10
Class II	25
Class III	50
ClassIV	100

Source: PP No 82, 2001

Decreased levels of polluted river water COD in Table 4, declines in proportion to the increase in mass of nanosilika used as additives polysulfone membrane. The addition of silica mass as much as 3% have the best results with a reduction in COD value of 77.78%. While the addition of as much as 5% decrease nanosiika again increased, this is diseababkan because the membrane pores are formed on the addition of 5% larger nanosilika be compared to the addition of 3%. COD destruction associated with reduced organic compounds are retained by the membrane when the filtration process. Reduced organic compounds will be related to the amount of oxygen required to oxidize compounds contained in the sample. Membranes without additives nanosilika can only reduce COD is 33.33%. Based on Government Regulation No 82 (2001), the river water into the beginning of class III, after transactions are carried out using membrane filtration Psf-N3, the river water is in a class I for the parameters COD.

Microbiology (Total Coliform AndE.Coli Total)

Water quality is determined by the presence of microbes, because the presence of microbes in the water can affect turbidity, color and pH of the water. Polysulfone membrane can be used as water disinfection. River water that has been filtered using polysulfone membrane with the additive nanosilica (Table 4) can not be found either coliform or E. coli microbes on the permeate produced. This is because the large pores contained in the polysulfone membrane is very small. While microbial molecules either coliform or E.coli expected greater than polysulfone membrane pore.

Table4. Microbiological Test Results

Membrane code	***E.coli***	***coliform***
Without Filtration	15	25
Psf-N1	Negative	Negative
Psf-N2	Negative	Negative
Psf-N3	Negative	Negative
Psf-N4	Negative	Negative

Based on the above microbiological testing can be seen that the polysulfone membrane has effectiveness as river water disinfection. Thus, polysulfone membrane with nanosilica additives can act as a substitute for chlorine which serves as a disinfectant (sterilitator). The use of a membrane as sterilitator have advantages over the use of chlorine, because the use of chlorine as a desinfectant should be the correct dosage.

Heavy Metal

The content of heavy metals (Fe and Mn) in the water causes the water color changes to yellow-brown after a while contact with air, but it can be detrimental to health and cause odor (Erlani, 2011). Cihideung river water that has been contaminated contain heavy metals such as zinc (Zn), manganese (Mn) and iron (Fe). Pollution in river water mingles with the smell of heavy metals in the water. Communities around the river Cihideung regular use river water as a source of water everyday. If allowed to continue, there will be health problems in people who consume the water.

After the transactions are carried out using membrane filtration nanosilikapolysulfone obtained in decreased concentrations of heavy metals in river water permeate Cihideung (Table 5). From these data it can be seen that the polysulfone membrane with nanosilika addition of 3% and 5% had good results. On the decreased levels of iron (Fe), polysulfone membrane with the addition of 5% nanosilika can reduce up to 82.69% iron. Nanosilikapolysulfone membrane with the addition of 3% and 5% have the same ability to reduce the content of Mn and Zn. Mn content of the river water was not identified after using membrane filtration and Psf Psf-N3-N4.

Tabel 5 Results of Heavy Metals Decline

Membrane code	The content of heavy metals(mg/L)		
	Fe	Mn	Zn
Without filtration	1.199	0.209	0.7095
Psf-N1	0.843	0.04	0.252
Psf-N2	0.6825	0.0045	0.21
Psf-N3	0.676	Not identified	0.091
Psf-N4	0.2075	Not identified	0.091

Tabel 6 River water quality standard grade heavy metals (maximum limit in mg / l)

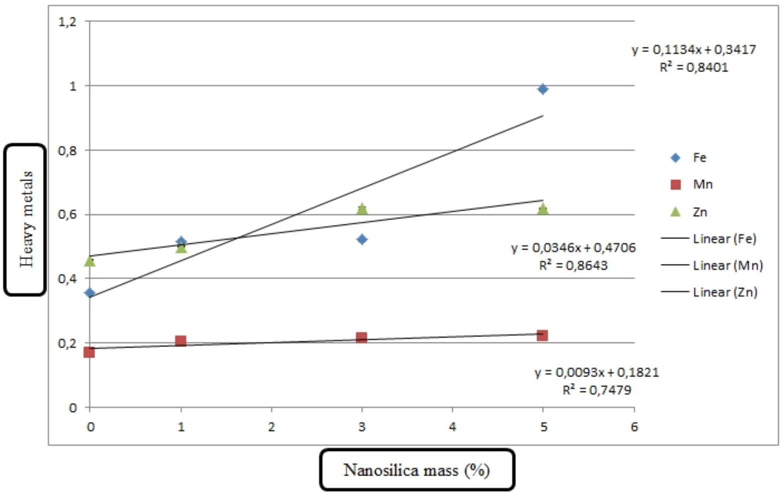
	Fe	Mn	Zn
Class I	0.3	0.1	0.5
Class II	5	(-)	0.5
Class III	5	(-)	0.5
Class IV	5	(-)	2

Source: PP No 82, 2001

The decline of the two membranes Zn amounted to 87.17%. The decline of heavy metal content in the sample due to the difference in charge between the ions of heavy metals with nanosilika used as an additive. Silica has a negatively charged ion free while Fe, Mn and Zn have free positively charged ions. The ionic charge difference causes the heavy metals contained in the sample binds to the membrane nanosilica.

Based on Government Regulation No 82 (2001), the content of Fe and Mnsebelum filtration beada class II, after the filtration process Fe meet the standards of class I. While in Zn prior to the filtration process is a fourth grade, after filtration into class I. In addition, under the rules of the minister health (2010) drinking water quality requirements, standards for Fe, Mn, Zn respectively 0.3mg / l, 0.4mg / l and 3 mg / l. In the table decline of heavy metals can be seen that the Fe content after filtration using a membrane Psf-N4 is 0.2075mg / l. The content of Mn prior to filtration has met the standard that is equal to 0.209mg / l. After filtration using a membrane Psf-N3 and N4 Psf-Mn content in the permeate was not identified. Drinking water standards for Zn is equal to 3 mg / l. The river water after filtration using a membrane Psf-N3 and N4 Psf-containing Mn at 0.091mg / l. The test results of heavy metals in the river water is filtered using a membrane shows have met the drinking water quality standard in accordance with the regulations of health minister in 2010.

Figure 1. Regression Heavy Metal



Based on the picture above, can be seen that the membrane filters used in normal conditions have a good performance to degrade contaminants Zn, it can be seen from the curve intercept Zn most distinguished among the others. Extra nanosilica into the matrix of filter membranes proved to improve membrane performance to decrease contamination of Fe and Zn, but does not occured in Mn contamination. The effect of adding to the improved performance decline nanosilica metal contamination in the river water is greater in Fe contamination, it can be seen from the slope changes in the amount of contamination that is filtered by the number nanosilica added. The greater the slope, the more effective nanosilika in improving the performance of the membrane.

ACKNOWLEDGEMENTS

This research was supported by LPPM-IPB and KEMENRISTEKDIKTI through Competitive Grant scheme.

REFERENCES

Azkiyah, INF dan Joko S. 2014. Penurunan Kadar Besi (Fe) Dan Mangan (Mn) Pada Air Sumur Gali Dengan Menggunakan Metode Aerasi Dan Filtrasi Di Sukodono Sidoarjo. Jurnal Teknik WAKTU Volume 12 Nomor 02 – Juli 2014 . Indonesia :28-33

Erlani , 2011. Variasi Luas Wilayah Cascade Terhadap Penurunan Kadar Besi. Makassar (ID): Poltekes Makassar.

Febrina L dan Astrid A. 2014. Studi Penurunan Kadar Besi (Fe) Dan Mangan (Mn) Dalam Air Tanah Menggunakan Saringan Keramik. Jurnal teknologi universitas muhammadiyah jakarta Volume 7 No.1 Januari 2015. Indonesia:35-44

Hernawati and Indarto. 2010. Budi Daya Jagung Hibrida. P. Indonesia: 9-11

Menteri Kesehatan. 2010. Peraturan Menteri Kesehatan Republik Indonesia Nomor 492 tentang Persyaratan Kualitas Air Minum.Jakarta (ID).

Nabeshi H, Yoshikawa T, Arimori A, Yoshida T, Tochigi S, Hirai T, Akase T, Nagano K, Abe Y, Kamada H, Tsunoda, Shin-Ichi, Itoh N, Yoshioka Y, Tsutsumi Y. 2011. Effect Of Surface Properties Of Silica Nanoparticles On Their Cytotoxicity And Cellular Distribution In Murine Macrophages. Nanoscale Research Letters. Vol.6, No. 23.

Pemerintah Republik Indonesia. 2001. Peraturan Pemerintah Nomor 82 Tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air. Jakarta (ID) : Presiden Republik Indonesia.

Said, NI. 2003. Metoda Praktis Penghilangan Zat Besi dan Mangan di Dalam Air Minum. Jakarta. Indonesia.

Siburian MP. 2006. Kajian Efektifitas Membran Polisulfon untuk Desinfeksi Air. Bogor. Indonesia.

Standar Nasional Indonesia (SNI) 06-6989.15-2004, Air dan Air Limbah-Bagian 15: Cara Uji Kebutuhan Oksigen Kimiawi (KOK) Refluks Terbuka dengan Refluks Terbuka Secara Titrimetri, Jakarta. Indonesia.

Suprihatin E, Anita TZ, Wahyuni N. 2015. Pembuatan Membran Silika dari *Fly Ash* dan Aplikasinya untuk Menurunkan Kadar Cod dan Bod Limbah Cair Kelapa Sawit. Pontianak (ID): JKK, Tahun 2015, Volume 4(3):48-53.

Rosnelly CM. 2010. Perancangan proses pembuatan membran ultrafiltrasi selulosa asetat secara inversi fasa dari selulosa pulp kayu sengon (*Paraserianthes falcataria*) [disertasi]. Bogor (ID): Institut Pertanian Bogor.

Yuan H, Gao F, Zhang Z, Miao L, Yu R, Zhao H, Lan M.2010. Study Of Controllable Preparation Of Silica Nanoparticles With Multi-Sized Anf Their Size-Dependent Cytotoxicity In Pheochromocytoma Cells And Human Embryonic Kidney Cells. Journal Of Health Science. Vol. 56, No. 6, 2010,Pp:632-640. China.

Zawrah MF, El-Kheshen AA, Abd-El-All H.2009. Facile And Economic Synthesis Of Silica Nanoparticles. Journal Of Ovonic Reasearch. Vol.5,No.5, 2009, Pp:129-133. Egypt.

INFESTATION OF MAJOR PESTS AND DISEASES ON VARIOUS CASSAVA CLONES IN LAMPUNG

I G. SWIBAWA, F.X. SUSILO, PURNOMO, T.N. AENY, S.D. UTOMO AND E. YULIADI

Faculty of Agriculture, University of Lampung- Indonesia

ABSTRACT

Lampung Province is one of cassava producers in Indonesia. Many cassava clones are cultivated in this area, contributing to more than thirty percent of total national cassava production. Cassava is also an important cash crop in Lampung. However, the infestation of pests and diseases can limit cassava production in the field. These infestations may vary from clone to clone. The objective of this research was to document the infestation level of major plant pests including mealy bugs, red mite, and leaf spot disease on various clones from some locations of cassava fields in Lampung. A survey was conducted on August 2016 in cassava fields belong to farmers in several locations in East Lampung (NTF, Margatiga), Bandar Lampung (Sukarame), and South Lampung (ITERA) as well as field experimental plots belong to Faculty of Agriculture, University of Lampung at Natar. The results showed that cassava mealybug (*Phenacoccus manihoti*), papaya mealy bugs (*Paracoccus marginatusi*) and red mite (*Tetranychus urticae*) have infested almost all cassava clones in surveyed locations. The prevalence of red mite infestation tended to be higher than that of mealy bugs. Cassava diseases found were brown leaf spot and virus mosaic. Brown leaf spot infested cassava clones in mild to moderate severity found on all cassava clones and locations, while viral disease with prevalence of 78% was only found on Duwet 1 clone in field experimental plot.

Keywords: mealybugs, red mite, brwon leaf spot, cassava clones

INTRODUCTION

Cassava (*Manihot esculenta* Cranz.) is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world, including Indonesia. In Indonesia, cassava is not only used as food materials but also as feedstuffs and used as raw materials on various industry. Cassava is rich in carbohydrates, calcium, vitamins B and C, and essential minerals. However, nutrient composition differs according to variety and age of the harvested crop, and soil conditions, climate, and other environmental factors during cultivation. Cassava has also been developed as the source of alternative energy to substitute fossil oil. Therefore, the demand of cassava tends to increase every year. Departemen Pertanian (2015) reported that cassava was exported to many other countries such as Taiwan, UK, Australia, and Philippines as fresh products as well as processed products.

Lampung province is one of cassava producer in Indonesia. This province, contribute more than 30.11% to national production. The total Indonesian cassava production in 2013 was 23,824,008 ton and the planting area was 1,061,254 ha. The total production and planting area of cassava in Lampung were 8,237,627 ton and 314,607 ha respectively (BPS, 2014). Cassava planting area growth in Indonesia tends to decline, but their productivity increase. Indonesian government encouraged increasing of national cassava production by expansion of planting area (Departmen Pertanian, 2015).

Commonly, the expansion of cassava planting area can raise pest and diseases risk. According to Bellotti (2002), around 9 pest species infested cassava in Asia, including mite, mealy bugs, white fly, scale fruit fly, grubs, and termite and stem borer. Abaca *et al.* (2014) list pests and diseases on cassava in Africa including *cassava mosaic disease* (CMD) that was transmitted by white fly (*Bemisia tabaci*), *cassava brown streak virus diseases* (CBSD), cassava bacterial blight (CBB: *Xanthomonas axonopodis pv manihotis*), cassava anthractnose (CA: *Colletotrichum gloeosporoides*), Cassava mealybug (CM: *Phenacoccus manihoti*), African root scale insect (*Stictococcus vayssierei*), green mite (CGM: *Mononychelus tanajoa*) and nematodes mainly root knot nematodes (*Meloidogyne* spp.)

Many pest and diseases was raise to serious problem in many country of cassava producer. Abaca *et al.* (2014) reported that green mite; mosaic wilt and cassava wilt bacteria were the main pest and diseases in Northwest of Uganda. Infestation of green mite in this region reached 37 – 100 percent. Other important pest in this regions was white fly (*Bemisia tabaci*), it was a vector of mosaic Gemini virus disease on cassava, that was reported result crop lost more than 1.5 million USD in Africa (Ewusie *et al*., 2010). The green mite was capable to spread in very wide area every year in Ivory Coast (Yaninec *et al*., 1989).

The major pest of cassava in Indonesia consisted of mite, mealy bugs, and grubs. Red mite (*Tetranycus bimaculatus*) synonym *T. urticae* have been reported attacking cassava for several years ago in Indonesia (Kalshoven, 1981), but Astuti (2014) found *T. kanzawai* attacked cassava in West Java caused of 95% production lost. According to Muniapan *et al*., (2009) cassava mealybug (*Phenacoccus manihoti*) was also others important and very destructive pest.

Mealy bugs were the main pest of cassava in West Java. Wardani (2015) reported that cassava mealy bug was exotic pests and as a main pest of cassava since 2007 in West Java. Other species attacked cassava was papaya mealy bug (*Paracoccus marginatus*). Mealy bugs infestation on young crops caused the *bunchy top* symptoms, stunting followed by dropping leaves and reduced a production around 40-50%.

Plant breeding was conducted to improve quality and yield of cassava production. The effort was done to find out an ideal cassava clones. Widodo and Puspodarsono (1990) described that prime cassava clones are characterized by: capable to produce more than 35 ton/ha of tuber with cyanide content less than 25%, response to fertilizer external inputs, resistant to plant pests and diseases and with no branching plants. Although, there are many cassava clones cultivated by farmer in Lampung Province, the popular clones are UJ-3 and UJ-5. These clones produced tubers that contain highstarch (Sholihin, 2013). More than thousand clones were planted for selection study in Experiment Plot of Faulty of Agriculture, Lampung University. The crops may infested by vary pest and disease severity.

The resistance to plant pests and diseases was important aspect of cassava breeding, in addition to high quantity and quality of production. It is still limited information of pest and disease infestation on various cassava clones in Lampung. Severity level of pests and diseases infestation can express of crops resistance. Lower severity indicates higher resistance to pest and disease, vice-verse. The objectives of this study were to observe the infestation level of major pests including mealy bugs and red mite and leaf spot disease on various clones from several locations of cassava fields in Lampung.

MATERIALS AND METHODS

Sampling of pest and diseases were conducted on two type of cassava field, first was cassava field belong to farmer and the second was cassava plot in Experimental Station of Faculty of Agriculture University of Lampung, in Natar. The cassava field belong to farmer distribute to several location, in Bandar Lampung and East Lampung District. Two major cassava clone i.e. UJ5 and UJ3 were dominated the cassava belong to farmer. Many clones were grow in experimental plots. Description of sampling site and cassava clones was described in Table 1. Laboratory processes was done in Plant Pest and Diseases Laboratory of Lampung University, Indonesia. Sampling of cassava pest and diseases was done on May to August 2016.

Sampling of pests and diseases were done in every clones of cassava. Around 2 ha of cassava field was assigned as sampling site. Within sampling site, 10 rows subsamples each contain 10 plant were taken in interval 3 rows systematically across diagonal of field. Pest and disease prevalence was counted in each subsample and the disease severity was grouped into healthy leaf, mild disease, moderate disease and severe disease respectively. The prevalence of pest or disease were count for present or absent of mealy bug and mite infestation or brown leaf spot caused by fungi.

Table 1. Locations, clones and age of cassava object of sampling of pest and disease

No.	Locations	Number of Clones	Crops Age (MAP)
1	Sukarame, Bandar Lampung	1 (Adira-1)	8
2	ITERA, South Lampung	1 (UJ5)	7
3	NTF-1, East Lampung	1 (UJ5)	7
4	NTF-2, East Lampung	1 (UJ5)	1
5	NTF-3, East Lampung	1 (UJ5)	8
6	NTF-4 East Lampung	1 (UJ3)	1.5
7	Plot H Expt, Natar, South Lampung	21clones	1.5

Five infested plant by mealy bug and mite were taken randomly as sub-subsample, to count pest population. From sub-subsamples infested plant, three lower and three middle cassava leaves were taken randomly as leaf sample and then bring to laboratory for pest population counting.

There were many plots of cassava crops with various ages in Experimental Plot Field of Agriculture Faculty. Each plot contained 21 rows; one row contained 10 individual plants of one clone. Observation of pest and disease infestation was conducted on this experimental plot field. Prevalence of mealy bugs and mite infestation and brown leaf spot disease were measure for all plant in every row. Three pest infested of plant were taken randomly as sub-samples, and then from every sub-samples of plant, 3 lower leaves and 3 middle leaves respectively were taken from sub-sample for mealy bugs and mite population counting. In laboratory, mealy bugs and mite were count under stereo microscope with 40 times magnification from lower leaves surface in a round of base stake part of cassava leaf sheet.

The variable observed in this research was absolute infestation of mealy bugs and mite and brown leaf spot disease incidence. The absolute pest infestation was measured by formulae as below:

$$Absolute\ pest\ infestation\ or\ disease\ incident\ \frac{number\ of\ infested\ plant}{total\ number\ of\ plant\ observed}\ x\ 100\%$$

RESULTS AND DISCUSIONS

Results

The major pesta that infested cassava crops in Lampung were red spider mite (*Tetranychus* spp., Acarina: Tetranychidae), mealybugs including cassava mealybugs (*Phenacoccus manihoti* Matile-Ferrero., Hemiptera: Pseudococcidae) and papaya mealybug (*Paracoccus marginatus* Williams and Granada de Willink., Hemiptera: Pseudococcidae). While the major disease that infested cassava in Lampung was brown cassava leaf spot disease caused of fungi *Cercospora henningsii*. Figure 1 indicated that the pests were found in almost all of locations surveyed, and infestation was low in ITERA. Except of cassava in Sukarame, the prevalence of infestation of red mite tended to be higher than that of mealy bugs in all locations. In NTF-1 and NTF-2, the infestation of mealy bugs was low.

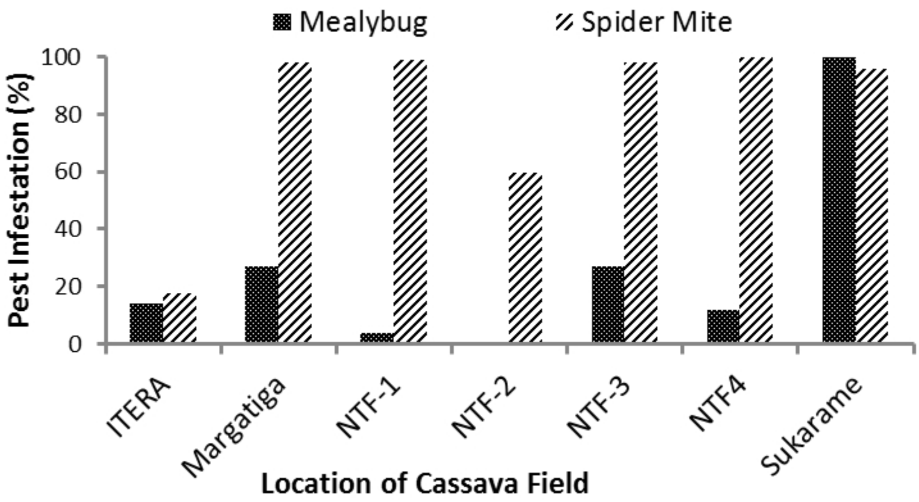


Figure 1. Pest infestation on several location of farmer cassava field in Lampung

Disease infestation was found in all location, almost all crops were infested with the severity a range from severe to mild. The moderate to severe infestation of disease occurred on cassava located in NTF-1 and NTF-3, the most of mild infestation category occurred in others location (Figure 2). on locations other than NTF-1 and NTF-3, the infestation of disease was mild?

The pest including red mite and mealy bugs infested all cassava clones observed in Lampung. Prevalence of red mites tended to higher than mealy bugs in all clones except of Adira-1 clone. Compared to other clones, prevalence of red mites infestation on UJ5, around 70%, tends to lower than the prevalence on three others clones, Adira-1, UJ3, and Medan (100%). The prevalence of red mite infestation tend to higher than prevalence of mealybugs infestation on all cassava clones, except on Adira-1 (Figure 3).

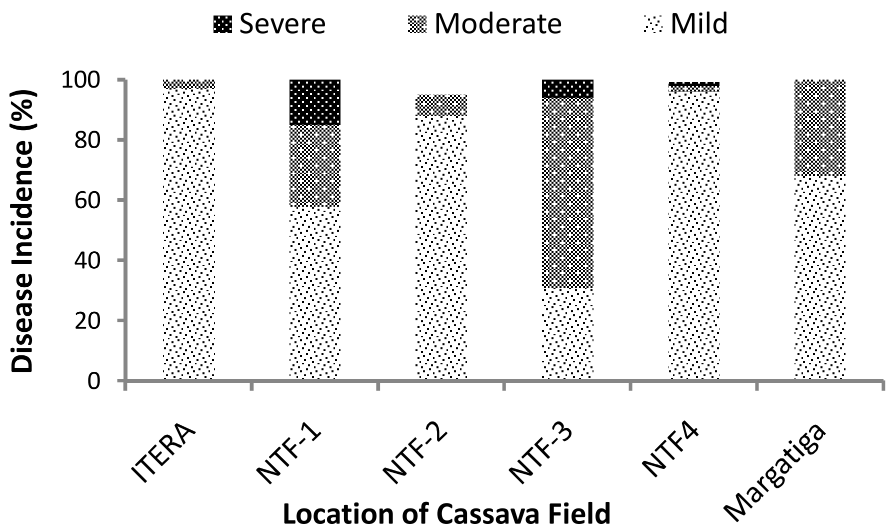


Figure 2. Disease infestation on several location of cassava farmer field in Lampung

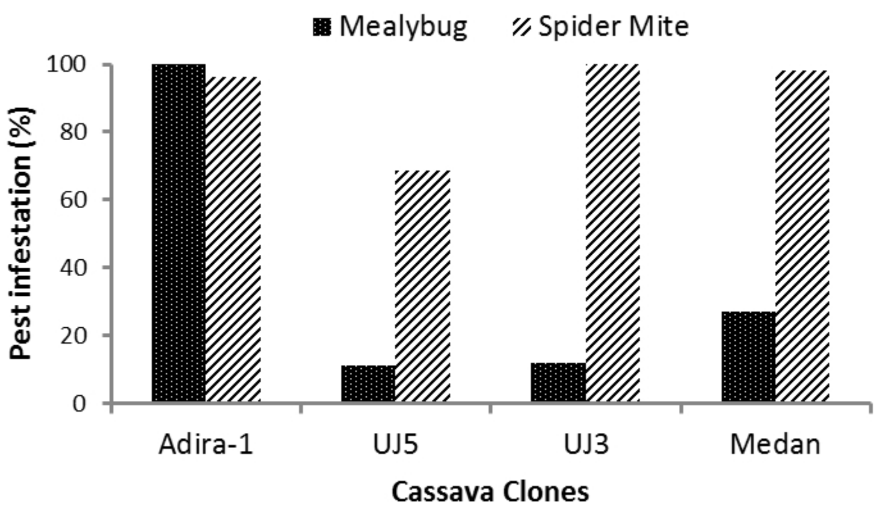


Figure 3. Pest infestation on several clones of cassava belongs to farmer in Lampung

The population of red mite and mealy bugs on lower and middle cassava leaves of several cassava clones was described on Table 2. Generally, population of mealy bugs was low on all cassava clones except of Adira-1. The population of mealy bugs on Adira-1 in Sukarame were range of 23.7 - 55.5 individual per part of leaves and tend to be higher than thepopulation on other clones that were range of 0.0 – 1.5 individual per part of leaves. The population of red mite pest on UJ5 in NTF-2 were range from 4.2 – 14.5 individual per leaf parts tend to be higher than that pest population on others clones.

Table 2. Mean and standard deviation of population of mealy bug and mite on several location of cassava field in Lampung

Location (Clone)	Mealybug				Mite			
	LL		ML		LL		ML	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Sukarame (Adira-1)	55.3	26.7	23.7	14.5	2.8	5.0	3.9	4.9
ITERA (UJ5)	1.5	1.45	0.7	0.7	2.6	2.9	4.5	3.5
Margatiga (Medan)	0.5	1.19	0.0	0.0	0.9	1.3	6.6	8.7
NTF-1 (UJ5)	0.2	0.45	0.3	0.6	2.5	1.6	4.9	4.9
NTF-2 (UJ5)	0.3	0.43	0.1	0.3	4.2	3.1	14.5	13.3
NTF-3 (UJ5)	1.0	0.67	1.1	1.5	2.3	1.5	3.4	1.7
NTF-4 (UJ3)	0.7	1.15	11.1	12.4	2.5	1.7	8.3	15.7

Based on the population of pest on different leaves position, mode of mealy bugs infestation were different from red mite, the mealy bugs were prefer to attack lower leaves while red mite was prefer on middle leaves. The population of mealy bugs on lower of leaves was higher than on middle one. In contrast, the population of red mite was higher on middle than lower of leaves (Figure 4).

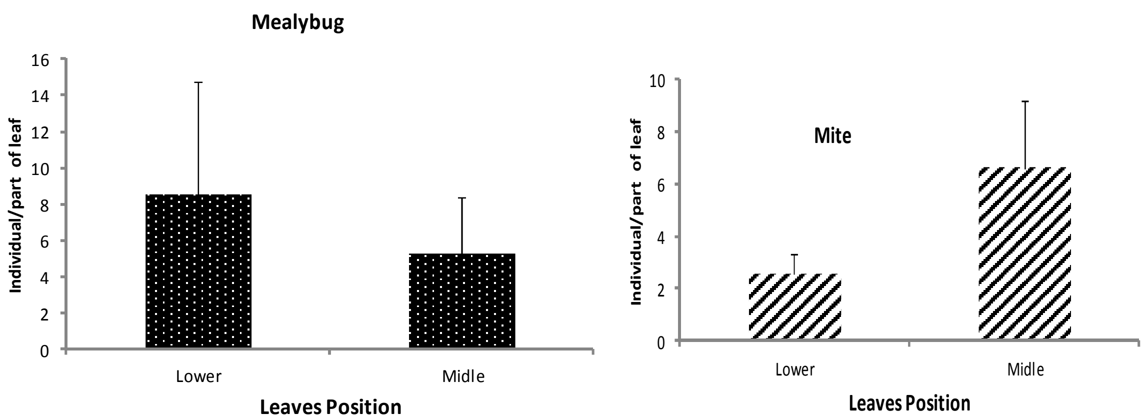


Figure 4. Population of mealy bug and mite on lower and middle cassava leaves

The population of mealy bug on several cassava clones of field Experimental Plot of Faculty of Agriculture, University of Lampung in Natar was low. The higher population of this pest was found on UJ3 (1) clones reached 9 individual per a part of leaves, while that population on 19 others clones were less than 2 individual per a part of leaves (Figure 5).

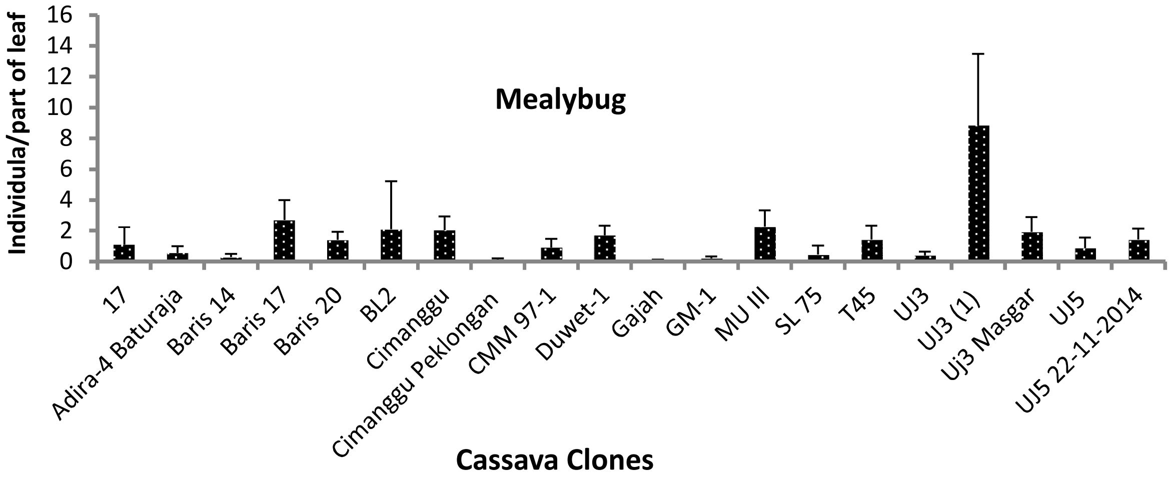


Figure 5. Population of melaybug on several clones of cassava in experimental plots in Natar

The red mite population on several clones in Experimental Plot of Agriculture Faculty, Lampung University, Natar also low. The mean of red mite population on four cassava clones namely Baris 14, Baris 17, Gajah and SL 75 were 2 individual per a part of leaves and tend to higher than that population on 16 others clones (Figure 6).

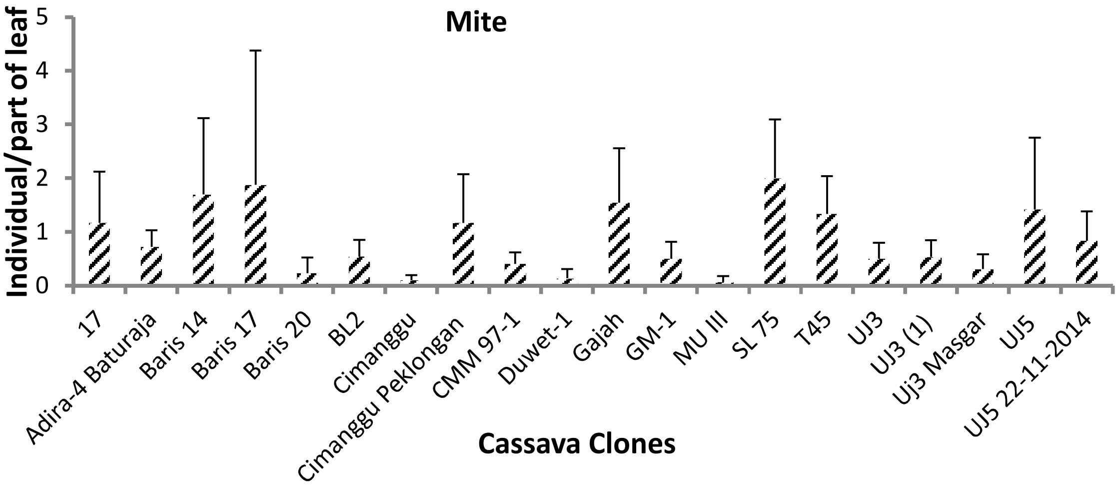


Figure 6. Population of mite on several cassava clones in experimental plots in Natar

The brown leaf spot disease infested all cassava clones in Field Experimantal Plot of Faculty of Agriculture, University of Lampung in Natar. Disease severity was mild up to moderate categories. Many clones have 100% of disease prevalence and others clones were range of 40-80%. Two clones namely SL75 and T45 have 100% and 60% disease severity moderate respectively, while Pekalongan, 4 Baturaja, MG 97 (17), UJ5 22-11-2014, 17, UJ3(1), Baris 14, Gajah, and Baris 17 have 100% disease severity in mild category. Others clones have disease severity in mild and moderate categories. No severe disease category was found in this experimental plot (Figure 7).

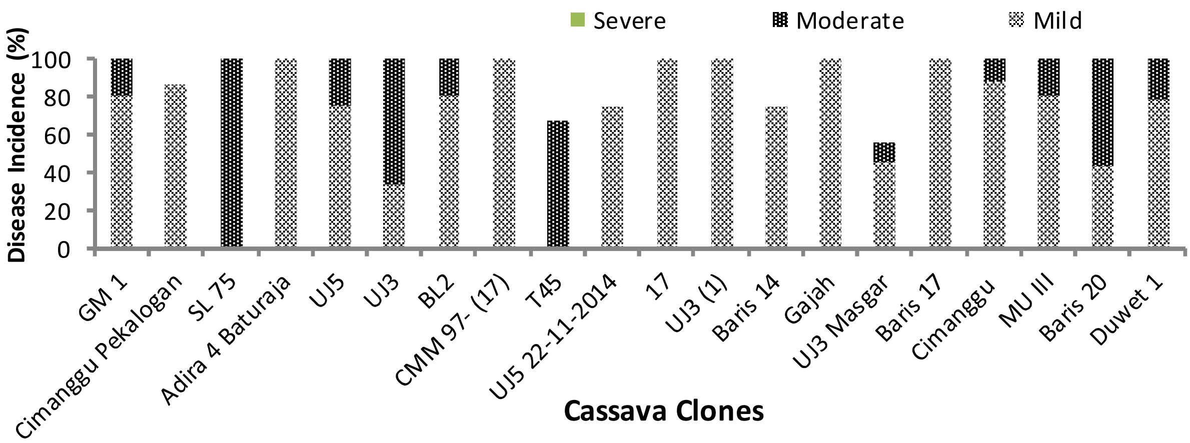


Figure 7. Disease incidence on several clones of cassava in experimental plots in Natar

In addition to fungal diseases, the cassava in Experimental Plot of Faculty of Agriculture, University of Lampung in Natar was also infested by viral disease. Viral disease on cassava showed dwarf, small leaves and curly symptoms. Many clones of cassava namely T45, UJ5 22-11-2014, UJ3(1), Baris 14, UJ4 Masgar, MU III, Baris 20, and Duwet 1 were also showed the symptoms of viral disease. The clones Baris 20 and Duwet 1 have more than 70% prevalence of that viral disease (Table 3).

Table 3. Viral disease incidence on several clones of cassava in Natar experimental plots

Clones	Viral disease incidence (%)
T45	33
UJ5 22-11-2014	25
UJ3 (1)	50
Baris 14	25
UJ3 Masgar	44
MU III	60
Baris 20	71
Duwet 1	78

Discusions

Most of cassava farmers in Lampung cultivated their field with cassava UJ5 and UJ3 clones, and few of them planted cassava Adira-1 and Medan clones. Although local government has released at least nine (9) clones of cassava clones (Suhartina, 2005), most of the cassava farmers in Lampung preferred in cultivating UJ5 and UJ3 cassava clones. Those two clones of cassava can be observed on many locations in East Lampung, i.e. NTF area. The UJ5 and UJ3 cassava clones become favourite may because those clones have a high yield.For example, UJ5 produce 25-28 ton/ha, and UJ3 produce 23 – 35 ton/ha tuber (Suhartini, 2005). According to Sholihin (2013), cassava farmers cultivated clones of UJ5 and UJ5 because of their high content of starch.

Pests mainly mealy bugs and red mite and disease especially brown leaf spot infested all of cassava crops observed in Lampung. The major pests of cassava in Lampung were cassava mealybugs (*Phenacoccus manihoti*) and papaya mealybug (*Paracoccus marginatus*) and red mite (*Tetranychus urticae*). Wardani (2015) described that the cassava melaybugs infested cassava in West Java, and farmer notes that the pest have been attacked cassava since year of 2007 ago. According to Muniapan *et al.* (2009), *P. manihoti* was new invasive species attacked cassava in Indonesia. Meanwhile, the polyphagia papaya mealybug was reported to attack around 31 genera of plant out of papaya, including cassava wich is in severe category (Susilo *at al*., 2010). The attack along *P. menihoti* to *P. marginatus* in cassava crops in the field unrecognized, so farmers generally assume that they were the same pest. The major pest of cassava in Lampung was different with cassava pest in Africa. According to Abaca *et al.* (2014) the main pest of cassava in Africa were cassava mealybug (*P. manihoti*), African root scale insect (*Stictococcus vayssierei*) and cassava green mite (*Mononychelus tanajoa*). Bolleti (2002) described that 9 species of pest attacked cassava in Asia, including mite, melaybugs, whitefly, scale fruit fly, grubs, termite, and stem borer. The others pest as mention of Bolleti (2002), may a minor pest of cassava in Lampung, so they were not recorded in this study.

Brown leaf spot (*Cercospora henningsii*) disease was found infested cassava, almost all cassava crops belong to farmer were infested by that fungal disease in Lampung. Mosaic virus disease also found in small plot of Experimental Plot of Faculty of Agriculture, University of Lampung in Natar. The result of this study not consistent with Sundari (2010), that report cassava diseases in Indonesia were cause of bacteria and fungi. The number cassava diseases species that were recorded in this study was lower than the number of cassava diseases species in Africa. Abaca *et al*. (2014) reported that cassava in Africa was infested by five species, namely, cassava mosaic diseases (CMD) brown streak virus disease (CBSD), cassava bacterial blight (CBB) cause of *Xanthomonas axonophodis* pv *manihotis* and cassava anthracnose cause of *Colletotrichum gleosporoides* (CA). The mosaic virus recorded in this survey is sill need to advance study to identify the vector transmits the virus.

Mealy bugs and red mite were found in all observed of cassava location in Lampung, including of field experimental plot of Faculty of Agriculture, University of Lampung in Natar (Figure 1, 5, and 6). The data indicated that mealy bugs and red mite spreading in almost all location in Lampung. Even though mealy bugs and mite unable to move to long distance alone, the pest able to move for long distance by win and plant material transportation. Yaninec *et al.* (1986) reported that green mite able to spread 600 km per year in Code Ivory. Papaya mealy bug (*P. marginatus*) was first reported in Bogor East Java in 2008, the mealy bug has been found in Lampung in 2009, infested many plants species (Susilo *et al*., 2010).

Prevalence of mealy bug and mite infestation were high in all location and clones (Figure 1), but their population were low (Table 2). The high prevalence of the pest infestation on various cassava clones and crop location may because of more of plants observed were old (Table 1). This result was consistent with Indiati (2012) reports, that all of early maturing cassava clones attacked by red mite. The high prevalence of the pest infestation may not impact of cassava production seriously, because their populations were low. In additions, mealybug also more common on lower old leaves and mite at middle old leaves. The stunting or bunchy top symptom and leaf fall of cassava occurred and followed by reducing 40-50% of production, when cassava mealy bugs attacked young cassava (Wardani, 2005).

Brown leaf spot and mosaic virus diseases were found in this observation .The brown leaf spot disease was dominant in both of cassava belong to farmer and cassava in experimental plots (Figure 2 and 7). The high prevalence of this disease may because most of crops observed ages was 7-8 month after planting, more infestation occurred on older crops. This data not consistent with Batino *et al.* (2007) which were reported that brown leaf spot incident not related with crop age. The disease have negative correlated to crop system and vegetation type. Mosaic virus disease only found in small of Experimental Plot in Natar, indicated that this disease not spreading yet in Lampung. It is still not clear, the vector transmitted the disease. Acording to Ewusie *et al*., (2010), Gemini mosaic virus disease of cassava was transmitted by white fly (*Bemisia tabaci*) in Africa. In this study, the virus disease may carried with stem of planted material, because there was no white fly observed.

The pest of cassava crops in Lampung were dominated by cassava mealybug (*Phenacoccus manihoti*), papaya mealybug (*Paracoccus marginatusi*) and red mite (*Tetranychus urticae*). Those pest infested on almost all cassava clones in surveyed locations. The prevalence of red mite infestation tends to higher than mealybugs. The cassava diseases found were brown leaf spot and mosaic virus disease. Brown leaf spot infested in mild and moderate severity found on all cassava clones and locations, while virus disease with prevalence 78% only found on clone of Duwet 1 in field experimental plot. It is still need to advanced study to find out whatever of environmental factors and agronomic practiced influence the cassava pests and diseases infestation in Lampung.

ACKNOWLEDGMENT

This research was partially supported by National Strategic Research Grant (*Hibah Strategis Nasional*) The Ministry of Research, Technology, and Higher Education (*Kemenristekdikti)* Year 2016, based on the Letter of Appointment from the Head of LPPM Unila # 419/UN26/8/LPPM/2016. The authors appreciate and thank to the financial support.

REFERENCES

Abaca, A., M. Kiryowa, E. Awori, A. Andema, F. Dradiku, A.S. Moja and J. Mukalazi. 2014. Cassava pest and diseases, prevalence and performance as revealed by adaptive trial sites in North Western Agro-Ecological Zone of Uganda. Journal of Agricultural Science 6 (1): 116-122.

Astuti, W. 2014. Ketahanan empat kultivar ubikayu terhadap *Tetranychus kanzawai* Kishida (Acari : Tetranichidae). Skripsi, Institut Pertanian Bogor

Batino, A., V. Verdier, K.E.Kpemoua and K. Wydra. 2007. Assessment of major diseases in Togo relation to agronomic and environmental characteristic in a system approach. African Journal of Agricultural Research 2 (9) : 418-428.

Bellotti, A.C. 2002. Artropods Pest. In Cassva: Biology, Production and Utilization, (R.J. Hillock, J.M. Thresh, and A.C. Bellotti, eds). CAB International.

BPS. 2014. Produksi Ubikayau Nasioanl. https://www.bps.go.id/index.php/publikasi/1103

Department Pertanian. 2015. Out Look Komoditas Pertanian Subsektor Tanaman Pangan: Ubi kayu. Kementerian Perranian-Jakarta

Ewusie, E.A., M.N. Parajulee, A. Aba Adambie-Gomez, and D. Wester. 2010. Strp Cropping: a potential IPM Tool for reducing whitefly, *Bemisia tabaci* Gennadius (Homoptera: Aleurodidae) infestation in cassava. West African Journal of Applied Ecology 17: 100-119.

Indiati, S.W. 2012. Ketahanan varietas/klon ubikayu genjah terhadap tungau merah. Penelitian Pertanian Tanaman Pangan 31 (1) : 52-59.

Kalshoven, L.G.E. 1981. The Pest of Crop in Indonesia (*revised by* Van der Laan). PT Ichtiar Baru - Van-Hoeve, Jakarta.

Muniapan, R., B.M. Shepard, G.W. Watson, G.R. Carner, A. Rauf, D. Sartiami, P. Hidayat, J.V.K. Avun, G. Georgen, and A.K.M. Ziaur Rahman. 2009. New record of invasive insect (Hemiptera: Sternorrhyncha) in South East Asia and West Africa. J. Agric. Urban Entomol. 26 (4) : 167-174.

Sholihin. 2013. Prospek klon-klon harapan dan varieatas ubikayu di Kalimantan Timur. Seminar Nasional: Menggagas Kebangkitan Komoditas Unggulan Lokal Pertanian dan Kelautan Fakultas Pertanian, Universitas Trunojoyo, Madura

Suhartina. 2005. Deskripsi varietas unggul kacang-kacangan dan umbi-umbian. Balai penelitian kacang-kacangan dan umbi-umbian. Malang.

Sundari, T. 2010. Pengenalan varietas unggul dan teknik budidaya ubikayu, Materi Pelatihan Agribisnis bagi KMPH. Nov. 2010, Malang.

Susilo, F.X. Purnomo, and IG. Swibawa. 2009. Infestation of the papaya mealybug in home yard plants in Bandar Lampung, Indonesia. in Proceeding of the 3rd International Meeting for the Development of IPM in Asia and Africa, Bandar Lampung, Indonesia, December 7-9, 2009. J. Lumbanraja, F.X. Susilo, Purnomo, R. Hasibuan, A. Niswati, S. Yusnaini, H. Hori., and K. Okazaki, Eds. University of Lampung Press, Bandar Lampung. Pp. 81-92.

Wardani, N. 2015. Kutu putih ubikayu, *Phenacoccus manihoti* Matile-Ferrero (Hemitera: Pseudococcidae), hama invasive baru di Indonesia. Disertasi, Institut Pertanian Bogor.

Widodo, Y. dan S. Poespodarsono. 1990. Recent progress in cassava varietal improvement in Indonesia. in Cassava Breeding, Agronomy and Utilization Research in Asia, R.H. Howeler (Tech. Eds.). Proceeding of The Third Regional Workshop held in Malang, Indonesia Oct 22-27, 1990. pp 4-27

Yaninec, J.S., G.J. de Moraes and R.H. Markham. 1989. Hand book on the cassava green mite *Mononychellus tanajoa* in Afrika. International Institute of Tropical Agriculture. Ibadan Nigeria.

INTEGRATION OF OIL PALM PLANT AND ANIMAL IN LAMPUNG PROVINCE

MUHTARUDIN*, KUSUMA ADHIANTO*, LIMAN*, YUSUF WIDODO* AND APRIANSYAH MARGA*

*Department Animal Science, Agricultural Faculty Lampung University,
e-mail: muhtarudin.1961@fp.unila.ac.id

ABSTRACT

The aims of the research were to evaluate carrying capacity of palm oil by product including of forage among palm oil plant. The data were collected consisted of secondary and primary data. Secondary data was collected from agriculture department. Primary data was collected by dry weight range method. The samplings were collected from forage among palm oil plant. Primary data and secondary data were combined to evaluate the carrying capacity of forage.The research showed that there were two methods of farmer to integrate of oil palm and animals. The first the animal cattle was housed and secondary the animal was grazed among oil palm plant. Each farmer had 4—5 cattle in housed anime method. The cattle tend to fattening. In grazing method, the farmer had 5—20 cattle. This method was efficient for breeding system of cattle. The totally potency of forage from palm oil in Lampung Province was 670.852, 23 ton/years. The carrying capacity of the forage was 204.208,59 animals unit. If the assumption of dry matter requirement of cattle was 9 kg/day, therefore, 1 ha of palm oil plant had 3 animals unit for its carrying capacity. On the other hand, if the resource of forage was only from among palm oil plant then the carrying capacity was 2.2 animals unit. From field observation on forage in palm oil plant that non productive site (such as in young plant palm) we found 20 species of plants, and 15 species of plant found in plant oil palm productive site.

Keywords: carrying capacity, integration of oil palm and animal

INTRODUCTION

Beef importing in Indonesia was increasing, to decreasing beef importing livestock population must be increased. On the other head productivity of livestock must be improved. To improve productivity of livestock, feed management must be combined by feed technology, including feed processing and feed supplement utilization.

A viability of forage was a problem to developed ruminant productivity. Integration program between livestock and crop plant could increase viability of forage in palm oil plant. Forage among palm oil plant had high potential to serve forage for livestock, especially cattle. Carrying capacity and botanical composition of forage was important to observe.

METHODS

The date was collected consisted secondary and primary data. Secondary data was collected from agriculture department. Primary date was collected by dry weight range method. The samplings were collected from forage among palm oil plant. Primary date and secondary date were combined to evaluate the carrying capacity of forage. To collect carrying capacity date, was used assumption that dry matter consumption was 3% from weight of animal (Parakkasi, 1999). One animal unit (AU) equal with one cattle that weight 455 kg (Santoso, 1995).

RESULTS AND DISCUSSION

Based on field observation, there were two methods/ways of farmer make integration between oil palm plant and animal, first livestock was housed, and second livestock was grazed.

A. Housed way/system

In housed system farmer used cut and carry to serve forage. Farmer was not fully used forage from palm oil plant. The farmer also used other forage.

In housed system, the livestock feces was collected and used for fertilizer. In this system, dietary feed concentrate was used to improve of growth of the livestock. This housed system attempted to fattening livestock, especially cattle. Otherwise, most of farmer had breeding system. In housed system was suggested to fattening of cattle.

B. Grazing System

Based on field observation, grazing system was used in the palm oil plant at PTPN VII Lampung, in where Rejosari and Bekri plantation area cattle were let grazing among the crops. At this condition, the system had high efficient for the farm, it could be grazed by 5—20 of cattle. Further information in regard the plantation, the palm oil plants were in five years old.

Carrying Capacity

Based on sampling unit the forage among the plant of palm oil could produce 7237.42 kg/ha/years and produce of palm leaf blante was 264785 kg/ha/years. If the asumption one animal unit (1 AU) needs 9 kg of dry matter per day so, one ha of palm oil plantation could have carrying capacity of 3 animals unit.

The potential carrying capacity of palm oil plant to serve forage could be seen in Table 1. From this Table 1, Mesuji district had high potential to serve forage from palm oil plant (53669.75 AU) and followed by Way Kanan district (35903.25 AU) Lampung Tengah district (28279.75 AU), and Tulang Bawang district (24185.39 AU). Total ability of Lampung Province to be potential to serve forage from oil palm plant was 670,852.22 ton/years and carrying capacity 204,208.59 animal unit.

Botanical Composition

The research showed there were different botanical/plant composition species between forage plant oil palm production and oil palm pre-production. Different plants species at oil palm pre-production site had much more species of plants compare those in the oil palm production site. The percentage of botanical/plant composition species from these two different sites of palm oil plant could be seen in Table 2. From this table, forage species that growth under pre production of palm oil plant site had more variance (20 species) compared to those growth under of palm oil plant production (15 species).

The variance species was caused by different of shading oil palm plant. The shading of crops/plant decreased of forage species variance. The shading of palm oil plant in production site had more shudder combined to palm oil plant in pre production site. According to Hutari (2006) shading effected forage species variance caused forage needs sunlight for forage metabolism. Similar to it, Reksohadiprodjo (1994) stated that the most of species forage did not resistent to shading. Human factor also effect on growth of forage under oil palm plant. Harvesting process of palm oil plant could distract forage under palm oil plant.

Dominant forage species that growth under palm oil plant at production site were *Paspalum conjugatum* 20.58%, *Asystasia gangetica* 17.47%, *Ottochloa nodosa* 15.40%.

Calopogonium mucunoides had better growth under palm oil at production site with 0.30%. *Calopogonium mucunoides* did not need full of sunlight to grow.

Forage species that growth under pre production site were *Asystasia gangetica* 23.19%, *Paspalum conjugatum* 11.95%. *Asystasia gangetica* did grow better than others, because it does resistant to shading. The least forage species that growth under pre production site was *Cleome rutidosperma* with 0.29%.

CONCLUSION

1. There were two different methods of farmer in handling their livestock by grazing system and housed system.
2. The grazing system was suggested for breeding of livestock.
3. Potentially of ability forage from palm oil in Lampung Province was 670,852.23 ton/years. The carrying capacity of the forage was 204,208.59 animals unit.
4. If the assumption of requirement of dry matter of cattle was 9 kg/day, so 1 ha of palm oil plant had 3 animals unit of carrying capacity. On the other hand if resource of forage only from of palm oil plants the carrying capacity was 2.2 animals unit.
5. Other plants composition of forage in palm oil plant that non production (young plant palm) site were 20 species, and 15 species in plant oil palm production site.

REFERENCES

Hutari, R.D. 2006. Retensi Hijauan di Bawah Naungan Kelapa Sawit di PTPN VII Unit Usaha Rejosari, Lampung Selatan. Skripsi. Universitas Lampung. Lampung

Parakkasi, A. 1999. Ilmu Gizi dan Makanan Ternak . Institut Pertanian Bogor. Bogor.

Reksohadiprodjo, S. 1994. Produksi Tanaman Hijauan Makanan Ternak. BPFE. Yogyakarta

Santoso, U. 1995. Tatalaksana Pemeliharaan Ternak Sapi. Penebar Swadaya. Jakarta

Table 1. Planting area of palm oil plant, forage production, carrying capacity of each district in Lampung Province

No.	**Districts**	**Total Planting area**	**Total forage production of palm oil plant**	**Total forage production of under palm oil**	**Total forage production (kg/years)**	**Total forage production (ton/years)**	**Total carrying capacity (AU)**
1	Lampung Barat	3052	8081252,605	16122922,48	24204175,09	24204,17509	**7368,09**
2	Tanggamus	0	0	0	0	0	**0,00**
3	Lampung Selatan	4169	11038906,33	22023743,06	33062649,39	33062,64939	**10064,73**
4	Lampung Timur	2805	7427232,49	14818085,7	22245318,19	22245,31819	**6771,79**
5	Lampung Tengah	11714	31016970,19	61882016,36	92898986,55	92898,98655	**28279,75**
6	Lampung Utara	8571	22694762,81	45278364,54	67973127,35	67973,12735	**20691,97**
7	Way Kanan	14872	39378895,4	78564909,28	117943804,7	117943,8047	**35903,75**
8	Tulang Bawang	10018	26526208,58	52922489,32	79448697,9	79448,6979	**24185,30**
9	Pesawaran	511	1353053,762	2699480,14	4052533,902	4052,533902	**1233,65**
10	Prengsewu	1005	2661093,994	5309153,7	7970247,694	7970,247694	**2426,26**
11	Mesuji	22231	58864458,28	117440592,9	176305051,2	176305,0512	**53669,73**
12	Tulang Bawang Barat	5612	14859760,69	29646736,88	44506497,57	44506,49757	**13548,40**
13	Bandar Lampung	24	63548,51328	126785,76	190334,2733	190,3342733	**57,94**
14	Metro	3	7943,56416	15848,22	23791,78416	23,79178416	**7,24**
15	**Provinsi Lampung**	**84587**	223974087,2	446851128,4	670825215,6	670825,2156	**204.208,59**

Table 2. Forage Species and percentage botanical composition of palm oil plant preproduction and Production

Code	Species Name	Local Name	Preproduction (%)	Production (%)
A	*Mucuna pruriens*	Kara benguk	2,66	7,31
B	*Ottochloa nodosa*	Rumput sarang buaya	5,34	15,40
C	*Centrosema pubescens*	Kakacangan	0,98	6,69
D	*Asystasia gangetica*	Ara sungsang	23,19	17,47
E	*Mikania micrantha*	Sembung rambat	8,23	2,80
F	*Paspalum conjugatum*	Rumput paitan	11,95	20,58
G	*Agrenatum conyzoides*	Babandotan	4,29	7,61
H	*Chromolaena odorata*	Kirinyuh	4,98	7,06
I	*Synedrella nodiflora*	Jotang kuda	0,98	1,46
j	*Eleusine indica*	Rumput belulang	2,83	3,34
k	*Cyperus kyllingia*	Rumput kenop	2,32	-
l	*Calopogonium mucunoides*	Kacang asu	11,25	0,30
m	*Acalypha australis*	Anting-anting	0,70	-
n	*Cleome rutidosperma*	Maman ungu	0,29	-
o	*Digitaria sanguinalis*	Genjoran	7,25	-
p	*Mimosa pudica*	Putri malu	0,70	3,47
q	*Cyperus rotundus*	Teki lading	4,00	-
r	*Oxalis barrelieri*	Belimbing tanah	2,43	-
s	*Eclipta prostrate*	Urang-aring	3,30	-
t	*Conyza sumatrensis*	Jalantir	2,32	-
u	*Lantana camara*	Saliara	-	0,61
v	*Imperata cylindrical*	Alang-alang	-	0,73
w	*Ipomoea triloba*	Katang-katang	-	5,17

BREAST ANTICANCER ACTIVITY OF BRUCEIN-A FROM MAKASAR FRUIT (*Brucea javanica*) AGAINST EXPRESSION OF GENE p53 IN RAT INDUCED DIMETILBENZAANTRAZENA

MUHARTONO[1] AND SUBEKI[2]

[1]Department of Medical Education, Medical Faculty, The University of Lampung
Jl. S. Brojonegoro No. 1 Gedung Meneng Bandar Lampung 35145
[2]Department of Agricultural Product Technology, Agriculture Faculty, The University of Lampung Jl. S. Brojonegoro No. 1 Gedung Meneng Bandar Lampung 35145

ABSTRACT

Breast cancer is the second leading cause of death after cervical cancer. Treatment of breast cancer is done with radiation, surgery, and chemotherapy which often cause side effects the spread of cancer cells, damaging healthy cells, and mutation. Therefore, it is necessary to find new drugs to treat breast cancer effectively and safely. Previous research showed that brucein-A from makasar fruit (*Brucea javanica*) had breast anticancer activity *in vitro* with IC_{50} 0.54 µg/L significantly different with standard drug of cisplatin (IC_{50} 0.43 µg/L). Encapsulation of brucein-A with liposomes enhance the anticancer activity (IC_{50} 0.39 µg/L). Giving encapsulation of brucein-A dose 10 mg/kg bw did not cause damage to the liver and kidneys of rats with SGPT 21.67 IU/L, SGOT 40.67 IU/L, and reduced breast cancer cells in rats. Therefore, the mechanism brucein-A to treat breast cancer cells need to be further investigated in order to develop brucein-A as drug. This study aims to determine the breast anticancer activity of brucein-A from makasar fruit against expression of gene p53 in rat induced dimetilbenzantrazena (DMBA). This research used 27 female rats which were divided into 9 groups. All groups were given the DMBA orally at a dose of 20 mg/kg bw twice a week for 3 weeks in order to form breast cancer in rat. Brucein-A was given orally to each group with dose 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, and 20 mg/kg bw once daily for 7 consecutive days. The rats were then maintained for 28 days and fed *ad libitum*. The results showed that giving brucein-A dose 0, 2.5, 5, 7.5, and 10 mg/kg bw in rats induced DMBA give score 1 of p53 gene expression (<25%) with differentiation degree of good. While, the giving of brucein-A dose 12.5, 15, 17.5, and 20 mg/kg bw showed score 3 of p53 gene expression (>75%) with differentiation degree of moderate to bad.

Keywords: brucein-A, *Brucea javanica*, gene p53, makasar fruit

I. INTRODUCTION

Cancer is a very dangerous disease number two cause of death after cardiovascular. According to WHO, in 2009 an estimated 1.2 million women with breast cancer and more than 700,000 die from the disease. Breast cancer is the second suffered Indonesian women after cervical cancer (Yayasan Kesehatan Payudara Jakarta, 2007). Breast cancer treatment can be done with radiation, surgery, and chemotherapy. However, these medications often cause side effects such as the spread of cancer cells to other parts, damaging healthy cells, and can cause cancer cells to mutate. Therefore, the discovery of new drugs that are effective, safe, and does not cause side effects is needed to treat breast cancer. One alternative is to use brucein-A compound isolated from makasar fruit (*Brucea javanica*).

Makasar fruit is a medicinal plant that is widely used to treat malaria, dysentery, dengue fever, and cancer. Several previous studies have shown that the compounds of quasinoid from these plants have antitumor activity (Lee *et al*, 1984; Fukamiya *et al*, 1992; Rachman *et al*, 2012). Quasinoid compound can induce apoptosis in the degradation of the DNA into the chain oligonukleosom (Subeki *et al*, 2007). Our previous studies showed that the compound brucein-A isolated from makasar fruit showed anticancer activity *in vitro* against breast cancer with IC50 values of 0.54 mg/L was not significantly different from the standard drug of cisplatin having IC50 values of 0.43 mg/L (Ningrum, 2010). Further studies of brucein-A encapsulated with liposomes showed increased anticancer activity with IC50 values of 0.39 mg/L (Subeki *et al*, 2011). Encapsulation brucein-A at a dose of 10 mg/kg bw did not cause damage to the liver and kidneys of rats with ALT levels of 21.67 IU/L, SGOT 40.67 IU/L. Encapsulation of brusein-A at a dose of 10 mg/kg bw can inhibit breast cancer cells in rats (Subeki *et al*, 2013).

In vitro assay of encapsulation of brucein-A have anticancer activity higher than the standard drug of cisplatin. *In vivo* assay of brucein-A can inhibit breast cancer cells in rats, so it needs to be studied further apoptosis mechanism of these compounds. Brucein-A is likely to be cytotoxic against breast cancer growth by inducing the expression of bax and bad, increases the activity of caspase 3, and causing apoptosis (Meergans *et al*, 2000). Brucein-A has the ability to enhance the expression of p53, Bcl-2, and increased the expression of Bax, which in turn induces apoptosis in cancer (Pardhasaradhi *et al*, 2005). Therefore, it is necessary to conduct further research using in vivo animal experiments to determine the mechanism of brucein-A in breast cancer cell. This study aims to determine the breast anticancer activity of brucein-A from makasar fruit against expression of gene p53 in rat induced dimetilbenzantrazena (DMBA). We hope this research will be known mechanism brucein-A compound in breast cancer cell death and can be made from raw material makasar fruit crops that grow in Indonesia.

II. METHODS

2.1. Place and Time Research

Research was conducted at the Laboratory of Bioactive Components, cage experiments, Laboratory of Medical Education, as well as the Hospital Blood Analysis Laboratory Urip Sumoharjo, Laboratory of Biochemistry, Puspiptek Serpong. The study was conducted in April to September 2015

2.2. Method

This study was conducted in a randomized block design complete with 3 replications. The study was conducted using 27 rats were divided into 9 groups. Each group consisted of three rats. Each group was administered with doses of brucein-A. The data obtained were analyzed descriptive.

2.3. Preparation of Test Compounds

This study begins with the production of brucein-A from *B. javanica* according to the procedure Subeki *et al*, 2007. Amount of *B. javanica* 10 kg soaked in 30 L ethanol solution for 28 days. The filtrate is filtered by the filter cloth and evaporated with a rotary evaporator up to 1 L. The filtrate was concentrated and then extracted with EtOAc to obtain water and EtOAc layers. EtOAc layer was evaporated to dryness and subjected into silica gel chromatography column and eluted with $CHCl_3$ (3 L), MeOH-$CHCl_3$ (3 : 97.3 L), and MeOH-$CHCl_3$ (1: 4.3 L), respectively. Fraction MeOH-$CHCl_3$ (1: 4) was evaporated to dryness and subjected into a silica gel chromatography column and eluted with hexane-EtOAc (1: 1) to be 3 fractions. Fraction 3th was evaporated to dryness and then crystallized with MeOH solvent to obtain compound of brucein-A. Furthermore, to prove that the compound obtained is brucein-A then performed spectroscopic analysis IR, MS, and NMR and compared with the standard brusein- A. Extraction and isolation of brucein-A from *B. javanica* can be seen in figure 1.

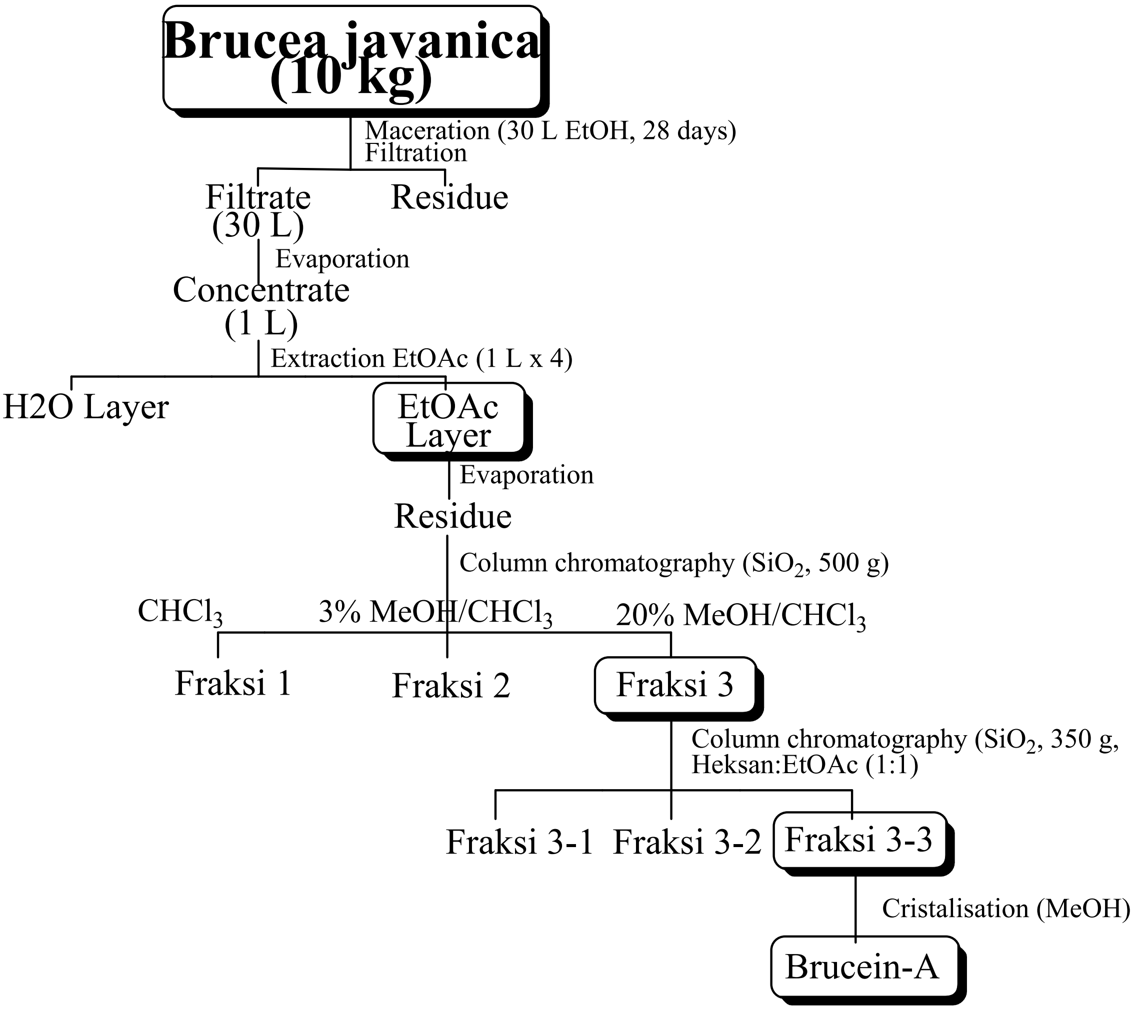


Figure 1. Extraction and isolation of brucein-A from *Brucea javanica*

2. 4. Test Compound Brucein-A against p53 Gene Expression

12 weeks old female rat were divided into 9 groups and each group consisting of 3 rat are placed in separate cages and fed *ad libitum*. Before being treated, rats adapted to the experimental environment for 3 days. All groups of rats were given the compound of DMBA (dimetilbenzantrazena) orally at a dose of 20 mg/kg bw twice a week for 3 weeks in order to form of breast cancer. Brucein-A was given orally to each group of rats with each dose of 0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, and 20.0 mg/kg bw once daily for 7 consecutive days. One group of rats was used as control without giving brucein-A. The treatments arranged in a completely randomized design with three replications. Furthermore, the rats maintained for 28 days and given feed and drink *ad libitum*. Giving brucein-A in rat induced DMBA can be seen in Figure 2. Expression of p53 is the number of breast cancer

cells that expressed p53 after giving brucein-A by observing the p53 immunohistochemical staining. Score 1 expressed <25%, score of 2 expressed 25-50%, and score of 3 expressed > 75%.

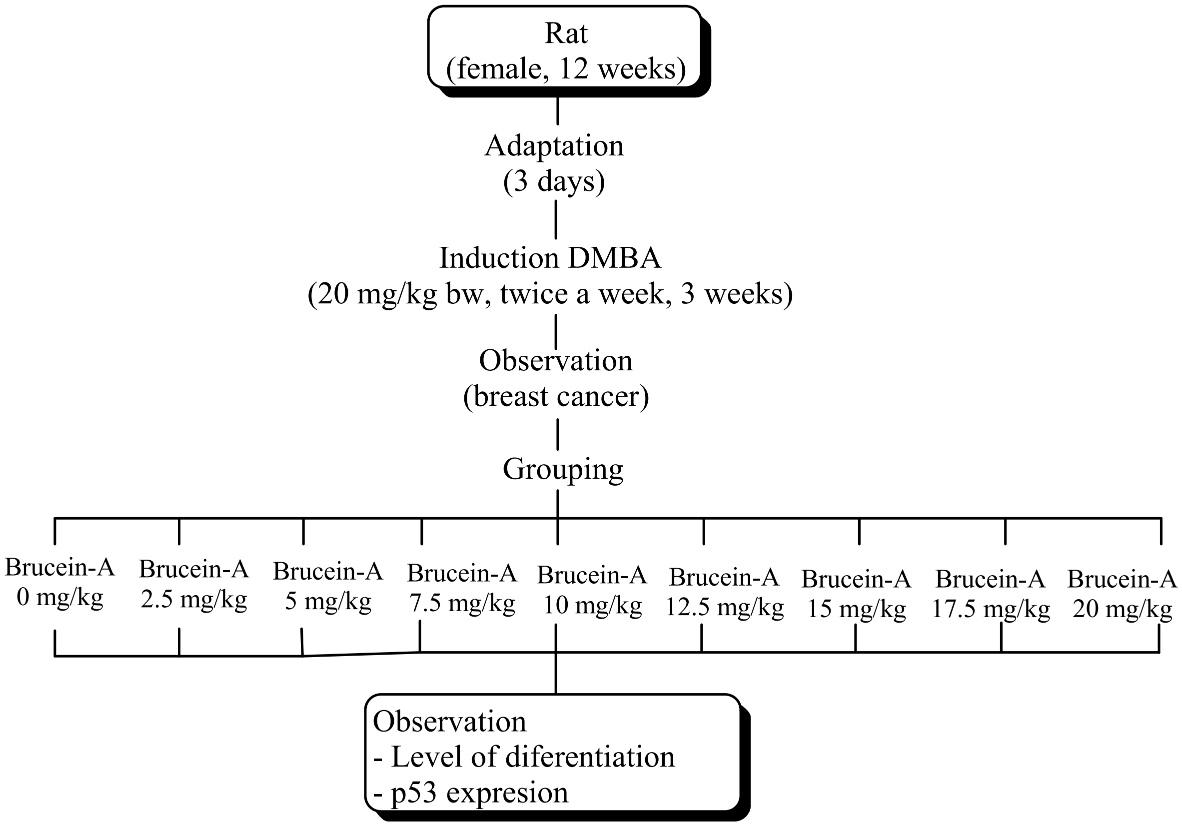


Figure 2. Giving brucein-A in rat induced DMBA

III. RESULTS AND DISCUSSION

3.1 Bruceine-A

A compound of brucein-A was isolated from *B. javanica* having amorphous powder with a melting point of 271-272 °C and optical rotation $[\alpha]^{20}_{D}$ -80.3° (*c* 0.8, piridin). IR analysis showed a hydroxyl group (3420 cm-1), δ-lakton and ester (1736 cm^{-1}), α,β-carbonil (1683 and 1640 cm^{-1}). Results Mass Spectrometer analysis of FD-MS: m/z 522 $[M]^+$ and HR-EI-MS m/z 522.2090 $[M]^+$ which showed the molecular formula $C_{26}H_{34}O_{11}$.

1H-NMR analysis showed proton resonance spectrum of a methyl tertiary (δ 1.22), two secondary methyl (δ 0.90 and 0.91), and a methyl olefinic (δ 1.72). 13C NMR analysis provides spectrum resonance at C-3 (δ 144.2), C-11 (δ 71.5), and C-12 (δ 74.7) indicating the hydroxy group attached to the carbon. Side chain group containing 3-methylbutanoyloxy related to C-15 is based on the δ 170.0, 42.6, 25.4, 22.3, and 22.4), The chemical structure of brucein-A isolated from *B. javanica* can be seen in Figure 3.

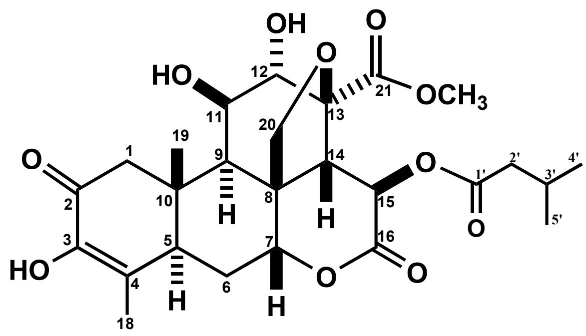


Figure 3. The chemical structure brucein-A from *Brucea javanica*

3.2. Score Cancer Cells that Expressed p53

The cause of breast cancer is still being debated. Some risk factors are thought to be a trigger of breast cancer include genetic factors, age, parity, race, and family history, history of use of therapy or hormonal contraception, and obesity (Granstrom, 2008; Miettinen, 2009; Fauzan, 2009).

Various genetic studies have been developed in order to understand the etiology and pathophysiology of breast cancer, either through direct examination of the gene mutation or indirectly through the abnormality expression of a protein produced by the mutated gene. One of the genes that play a role in the occurrence of breast cancer is p53, the gene which encodes or expresses the protein 53 (p53).

Gene of p53 has a very important role in controlling the cell cycle, apoptosis and maintaining genomic stability. Loss of p53 function as a result of mutations can cause malignant transformation, tumor spread, and tumor resistance to therapy that induces damage of DNA. p53 mutation would produce an abnormal protein with very long half-life that expression can be detected by immunohistochemistry (Choudhury *et al*, 2012).

In this research, immunohistochemical examination of the 9 samples of paraffin blocks of breast cancer. A total of 5 of the 9 samples obtained paraffin blocks were positive p53 expression, in which each of 4 samples with poorly differentiated degrees, 2 samples with the degree of differentiation medium, and 3 samples with a good degree of differentiation. The occurrence of these variations for the provision of compounds brucein-A in rats could inhibit cancer cell differentiation. The degree of differentiation in breast cancer cells in rats can be seen in Table 1.

Table 1. Scores of breast cancer cells that overexpressed p53 after giving brucein-A with immunohistochemical staining

No	Concentration mg/kg bw	Level cell differentiation	Expression p53
1	0	Good	1
2	2.5	Good	1
3	5.0	Good	1
4	7.5	Moderate	2
5	10.0	Moderate	2
6	12.5	Bad	3
7	15.0	Bad	3
8	17.5	Bad	3
9	20.0	Bad	3

anotation: scor 1 expressed <25%
scor 2 expressed 25–50%
scor 3 expressed >75%

3.3. Breast Cancer Cell Staining

This research with 9 groups of rats suffering from breast cancer used cell staining to identify the prognostic value of p53 expression against breast cancer. The results showed that doses of 0, 2.5, 5.0, 7.5 and 10 mg/kg bw experiencing positive p53 expression with good and moderate degree of differentiation. For a dose of 12.5, 15.0, 17.5, and 20.0 mg/kg bw showed positive p53 expression with degrees differentiate bad. The results of staining of breast cancer cells in rats can be seen in Figure 4.

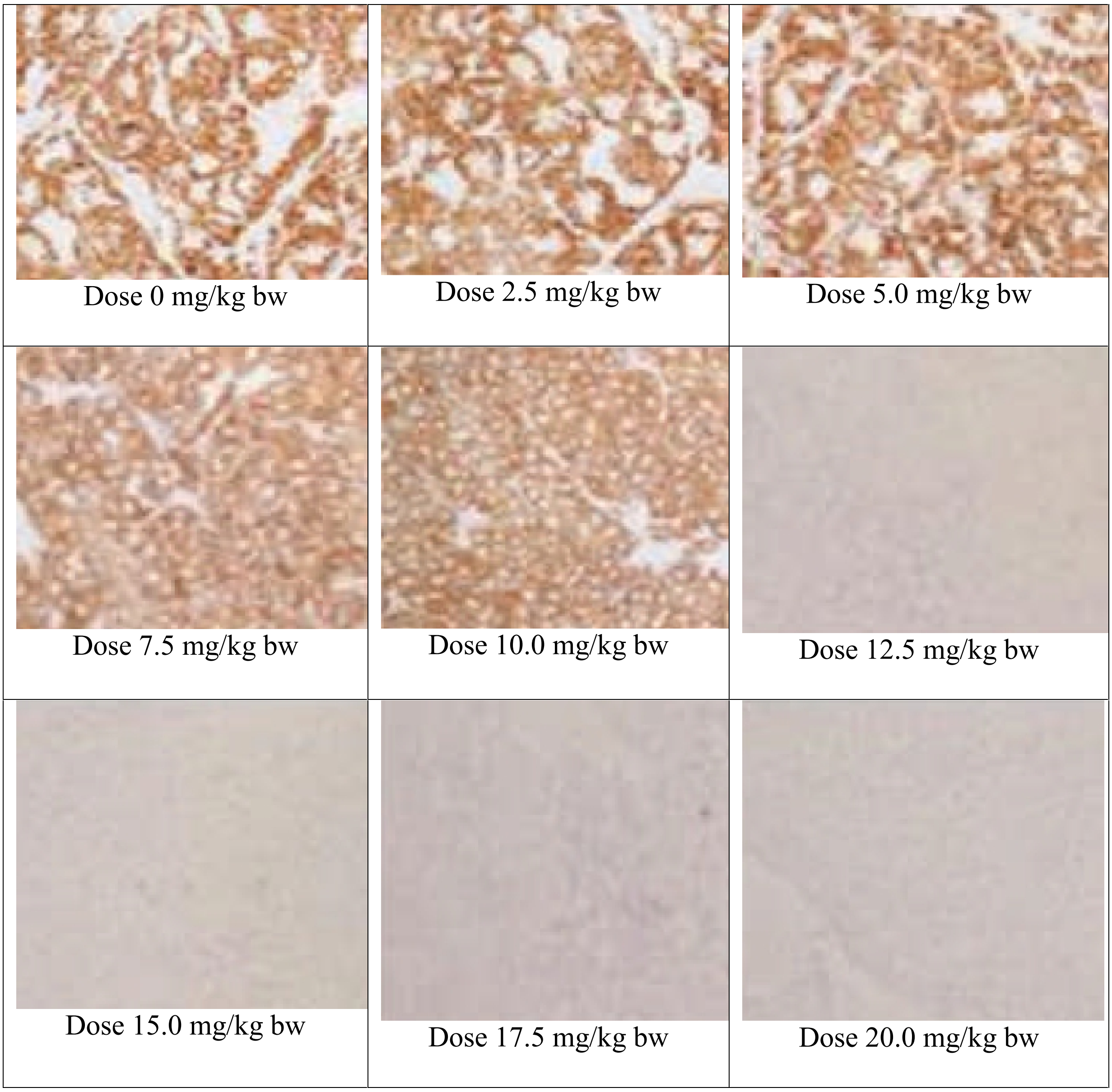


Figure 4. The results of immunohistochemical staining of breast cancer in rats

Graeff (2006) showed that increased p53 expression associated with tumor type serus. Serus type of carcinoma is more common with poor differentiation degree at an advanced stage, while in the mucinous and endometrioid type is more common with a good degree of differentiation at an early stage. Serus type of breast carcinoma more shows the degree of tumor differentiation ugly, while the opposite is the type mucinous and endometrioid more showed good tumor differentiation (Havrilesky, 2013).

Gene expression undergoes many stages ranging from DNA to become proteins. Some studies indicate that the neoplastic cells mutated p53 missense can be observed by immunohistochemical techniques. This is because the p53 mutation produces protein p53 stable and longer half-life. Type p53 mutations frame-shift or nonsense (chain termination/truncated protein) to produce the p53 protein unstable, easily degraded and is not detected by immunohistochemistry (Rauf and Masadah, 2009). This is the reason why the dosage of the compound brucein-A greater than 12.5 mg/kg bw showed p53 expression. These results require further research to identify the type of p53 mutation that occurs in rats as a result of administration of the compound of brucein-A.

Giving brucein-A dose 0, 2.5, 5.0, 7.5, and 10.0 mg/kg bw in rats induced DMBA give score 1 of p53 gene expression (<25%) with differentiation degree of good. While, the giving of brucein-A dose 12.5, 15.0, 17.5, and 20.0 mg/kg bw showed score 3 of p53 gene expression (>75%) with differentiation degree of moderate to bad.

REFERENCES

Choudhury, M., Seema, G., Mukta, P., Meenu, P. 2012. A Cytohistological study of p53 overexpression in ovarian neoplasm. *South Asian Jounal of Cancer.* Vo.1 :59-65.

Fauzan, R. 2009. Gambaran faktor penggunaan kontrasepsi terhadap angka kejadian kanker payudara di RSUPN Dr. Cipto Mangunkusumo Jakarta berdasarkan pemeriksaan histopatologik tahun 2003-2007. Tesis. Jakarta: Universitas Indonesia.

Fukamiya, N., Okano, M., Miyamoto, M., Tagahara, K., Lee, K.H. 1992. Antitumor agents. 127. Bruceoside C, a new cytotoxic quassinoid glucoside, and related compounds from *Brucea javanica*. *J. Nat. Prod.* 55: 468-475.

Graeff, P.D., Hall. J., Paul, J., Brown, R., Hollema, H. 2006. Factors Influencing p53 Expression in Ovarian Cancaer as a Biomarker of Clinical Outcome in Multicentre Studies. *British Journal of Cancer*. 95:627-633.

Granstrom, C. 2008. Population Attributable Fractions for Ovarian Cancer in Swedish Women by Morphological. htto://www.j acfaitilmnih.pov/pmc/articles/PMC23/. Cited 2010 october10.

Havrilesky. 2003. Significance of p53 Mutation and p53 Overexpression in Advanced Epithelial Ovarian Cancer-A Oncology Group Study. *Journal of Clinical Oncology*. 21(20): 3814-3825.

Lee, K.H., Imakura, Y., Sumida, Y., Wu, R.Y., Hall, I.H., Huang, H.C. 1979. Antitumor Agents, Isolation and Structural Elucidation of Bruceoside A and B, Novel

Antileukemic Quassinoid Glycosides, and Bruceine D and E from *Brucea javanica*". *Journal of Organic Chemistry*. 44: 2180-2185.

Meergans, T., Hildebrandt, A.K., Horak, D., Haenisch, C., Wendel, A. 2000. The short prodomain influences caspase 3 activation in HeLa cells. *Biochem J.* 349:135–140.

Millour, J., de Olano, N., Horimoto, Y., Monteiro, L.J., Langer, J.K., Aligue, R., Hajji, N., Lam, E.W.F. 2012. ATM and p53 regulate FOXM1 expression via E2F in breast cancer epirubicin treatment and resistance. *Mol Cancer Ther.* 10(6):1046–1058.

Miettinen, S. 2009. Targetting the Growth of Ovarian Cancer Cell (*dissertation*) Finland: University of Tampere.

Min, K.W., Park, M.H. 2007. The expression of c-erbB-2, EGFR, p53 and Ki-67 in ovarian borderline tumors and carcinomas of the ovary. *Korean J Pathol*. 41: 296-306

Ningrum, S.M. 2010. Kajian Aktivitas Antikanker Senyawa Brucein-A dari Buah Makasar (*Brucea javanica*) terhadap Sel Kanker Payudara (T47D). Skripsi. Fakultas Pertanian Unila. Bandar Lampung.

Pardhasaradhi, B.V.V., Reddy, M., Ali, A.M., Kumari, A.L., Khar, A. 2005. Differential cytotoxic effects of annona squamosa seed extracts on human tumour cell lines: role of reactive oxygen species and glutathione. *J Biosci*. 30(2):101-108.

Rauf, S., Masadah, H. 2009. The Prognostic Value of the p53 Gene Expression and Mutation in Ovarian Cancer. *Med J Indones*ia. 18:81-90

Subeki, Matsuura, H., Yamasaki, M., Yamato, O., Maede, Y., Nabeta, K., Takahashi, K., Katakura, K. 2007. Screening of Some Indonesian Medicinal Plants for Antibabesial Activity and Isolation of New Quassinoids from *Brucea javanica*. *J. Nat. Prod.* 70: 1654-1657.

Subeki, Setyaningrum, E., Rudiyanto, W. 2011. Aktivitas antikanker senyawa brucein-A buah makasar (*Brucea javanica*) terhadap sel kanker payudara (T47D). Seminar Nasional Sains dan Teknologi-IV. 865–77.

Subeki, Setyaningrum, E., Waluyo. 2013. Penggunaan brucein-A dari buah makasar (*Brucea javanica*) sebagai obat kanker payudara di Indonesia. Laporan penelitian Hibah Bersaing. Lembaga Penelitian Universitas lampung. Bandar Lampung.

Yayasan Kesehatan Payudara Jakarta. 2009. Sambutan Menteri Kesehatan Republik Indonesia dalam Peluncuran Unit Mobil Mamografi. http://www.pitapink.com/id/berita-detail.php?id=11. Diakses pada tanggal 26 Januari 2009.

Rachman, E. P.N., Suhesti, T.S., Widiastuti, R., Aditiyono. 2012. The breast of anticancer from leaf extract of Annona muricata against cell line in T47D. *International Journal of Applied Science and Technology.* 2(1):157-1

ACCESS TO BIODIVERSITY TO ENHANCE RESILIENCE AND FOOD SECURITY FOR LOCAL AND INDIGENOUS PEOPLE IN HEART OF BORNEO (HOB)

YUSURUM JAGAU[1], HASTIN ERNAWATI NUR CHUSNUL CHOTIMAH[1], ADRI ALIAYUB[2], CRISTINA EGHENTER[2], DIDIEK SURJANTO[2] AND ERI PANCA SETYAWAN[2]

[1]Faculty of Agriculture, University of Palangka Raya
[2]WWF Indonesia

ABSTRACT

The heart of Borneo (HoB) is not only rich in natural resources and biodiversity, but also in social capital of the practices and knowledge of indigenous and local communities. It is the latter who have used, managed and conserved many plants and species which have become important food sources and part of the agroecology and agrobiodiversity heritage of the people of the Heart of Borneo. WWF Indonesia together with the Faculty of Agriculture University of Palangka Raya has started a collaboration to map the food security in HoB and the role of biodiversity. The hypothesis is that in conditions of rich natural capital, and secure access to resources, local people enjoy food security and also quality and safe food, and culturally appropriate. This paper presents preliminary data and analysis from a food security and biodiversity survey conducted in 20 villages, in 8 districts and 4 provinces in Kalimantan. The protocol used for the survey was developed by the University of Palangka Raya. The data were collected by consultants. Results indicated that communities in the interior of Borneo still relied on a high number of species and varieties (wild and cultivated) for daily consumption. Several varieties of vegetables and cereals have been tested for nutritional values and found very rich and healthy alternatives to rice, for example. In some areas this is more evident. Data also show that dietary habits are shifting towards more processed food sold in stores and higher starch/sugar menus where these foods are available or access to market is easier. The results of the food security and biodiversity mapping aim to support policy recommendations to enhance food security and resilience by expanding the base of food crops, cultivating local varieties and wild cultivars, and preserving the rich agro-biodiversity and associated traditional knowledge.

Keywords: biodiversity, food resilience, food security, The Heart of Borneo

INTRODUCTION

Borneo (Kalimantan) is the world's third largest island and home to some of the world's largest remaining areas of tropical rainforest. Borneo holds an estimate 6% of global diversity; at least 13 primate species, 350 bird species and 15.000 plant species live in Borneo.

There are 18 million people who live in Borneo. Of these, the people with the closest connection with the environment are the Indigenous People of Borneo, commonly grouped as 'Dayak'. Many of them continue to practice swidden or cyclical cultivation primarily of rice. The continued close dependence on natural resources mean that rivers, land and forest hold an important part in Dayak identity and values (Sellato, 1994).

The Heart of Borneo (HoB) is an area at the center of Borneo (Kalimantan) which covers more than 22 million hectares of tropical rainforest across three countries, namely Indonesia, Malaysia and Brunei Darussalam. Comprising approximately 30 % of the Borneo land area, the HoB is the largest transboundary tropical rainforest expanse remaining in Southeast Asia. The HoB is the one of the planet's richest treasure, where at least one million people, the majority of whom is of Dayak origin, live within the HoB and directly depend on its forests for their food, livelihoods, income, water and culture.

Deforestation brought about by land conversion for oil palm plantations is probably currently the biggest threat HoB. The risk of more land clearing for more profitable cultivation of agricultural commodities with related biodiversity and ecosystem service loss is ongoing. Moreover, the increasing dominance of big estates and capital with related encroachment over traditionally used lands that are often the backbone of food security for indigenous communities in the Heart of Borneo. Mining has also been traditionally a major factor in forest and ecosystem services degradation. Both threats reduce the ecosystem and social values of the HoB where the linkages of people with natural resources and the forest are central to their food security, livelihoods, income and cultural identity. Exploitation of natural resources has also been exacerbated by social conditions of tenure insecurity, vulnerability, conflicts and unfair distribution of benefits and opportunities.

From the point of view of the nexus between ecosystem, biodiversity and livelihoods, the food security debate is a very relevant one in this context. Moreover, with climate change and existing pressures and threats, the risk of food vulnerability and decreased food sovereignty of the communities in the Heart of Borneo is real. Loss of biodiversity can also mean loss of a food and cultural/spiritual system, which is integral to the livelihoods of some communities. It represents also loss of traditional knowledge and practices associated with small agroforestry and traditional agricultural regimes.

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2016). This widely accepted definition points to the following dimensions of food security: food availability, access to food, utilization and stability, and quality. Sustainable Development Goal no 2 (End hunger, achieve food security and improved nutrition, and promote sustainable agriculture) also highlights the same dimensions.

WWF Indonesia as a conservation organization concerned with the protection of biodiversity is also interested in looking at the evolving dynamics between food, local varieties, and the diversity of natural resources. WWF Indonesia together with the Faculty of Agriculture, University of Palangka Raya has started a collaboration to map the status of food security and the role of biodiversity in the communities of the interior of HoB. The assumption is that in conditions of rich natural capital and biodiversity, and secure access to resources, local people enjoy food security and also quality and safe food, and culturally appropriate.

Many of the edible plants that we consume have originated from the forests and other ecosystems. They have been domesticated by the ancestors of local and indigenous farmers over time. It was the active experiments and practices of local people that have often shaped the variety of cultivars and diversity of food plants.

High biodiversity is a salient feature of traditional farming systems and it is what is referred to as agrobiodiversity. Agrobiodiversity, in the definition of FAO, encompasses all the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture. Agrobiodiversity as diversity within a particular crop (such as different varieties of rice) or among crops (such as adding other crops to rice fields) can be regarded as an important strategy of risk (food security) avoidance, There is also a strong gender component to agrobiodiversity because it is often women who grow native species as companion crops to the household’s cash crops.

METHODS

The survey took the approach of ‘*action survey*.’ The protocol used for the survey was developed by the University of Palangka Raya. The data were collected by consultants using questionnaires, transects, focused group discussions and in-depth interviews with various groups (women, men, elders, and youth). The protocol aimed to collect data on the following:

- Household consumption (including nutrition);
- Food security at household level;
- Food sources (cultivated and harvested/collected from the wild).

The survey was conducted in 20 villages, in 8 districts and 4 provinces in Kalimantan (North Kalimantan, East Kalimantan, Central Kalimantan and West Kalimantan) in the Heart of Borneo area. The survey was conducted during the period September 2015 – February 2016.

RESULT AND DISCUSSION

The preliminary results of the survey show people within or around the HoB area meet their dietary need from both their own food production (cultivation and husbandry), collecting food from the wild (forest, river, lake). Increasingly, their diets include processed food purchased in shops. In terms of food production, the people living within and around the HoB still practice shifting cultivation to grow rice as the main carbohydrate source. Although the productivity of local upland rice is still rather low, on average they produce enough rice for local consumption under normal conditions. Local rice shortages occurred and were usually caused by unusual weather patterns[1]. A growing concern is the availability and access to land for cultivation. People usually grow local varieties (5-6 months cultivation cycle) and plant several varieties, a strategy to mitigate the negative effects of drought and diseases. There are many local varieties grown by the people in the HoB area. In Central Kalimantan and West Kalimantan, for example, farmers know and use respectively 27 and 54 local varieties of rice. In North Kalimantan, farmers in Krayan use 34 varieties of rice (hill and wet rice varieties).

The rice production cycle usually starts in June for land preparation, August-September for planting, and January-March for harvesting. To meet their rice need per household for one year, the people need to calculate the extend of the planting area. In case in North Kalimantan, the average rice harvested per growing season per household was 1.735 kg unhulled rice (equal to 1.041 kg hulled rice). If the average member of the household is 5 and rice

[1] Food shortages were recorded in 13 out of 20 villages in the survey. The cause are 62% weather (long drought) and 46% plant disease. In case of shortages 23% rely on wild food sources gathered from forests, 15% rely on local reserve and 46% rely on reserve from neighbor villages.

consumption per capita per year is 114 kg, then the rice consumption per household would be 570 kg; therefore, the rice production is in surplus (usually sold across the border in Malaysia). But, in some villages in Central, West and East Kalimantan, rice production is in deficit due to lack of new rice field, pest outbreak, and weather patterns.

Table 1. Activities and Crop Calendar of local and indigenous people within and around the HoB area (compiled from some sample villages)

Activities	J	F	M	A	M	J	J	A	S	O	N	D
Subsistence Rice planting												
Growing vegetables												
Weaving or off-farm activities												
Hunting												
Collecting fruits												
Collecting vegetables/fishes												

Slash & burn   growing periode   harvesting time

During the period before harvesting rice, the people meet their dietary need by consuming rice from the previous harvest before, collecting vegetables from garden/field, buying vegetables/meat from market, or collecting vegetables/spices/fruits/meat from the forest, rivers and lakes. Table 2 indicates the number of food plants known and the number of plants used in sample villages in North and Central Kalimantan.

Table 2. Knowledge and use of food plants from the wild: a comparison

No.	Village	No of food plants known	No of food plants consumed
	Central Borneo		
1	Harowu	31	4
2	Hatung	14	4
3	Kuluk Leleng	20	4
4	Karuing	23	3
5	Muara Mea	19	1
6	Payang	15	3
	North Borneo		
7	Wa'Yagung	40+	8
8	Binuang	35+	5
9	Sempayang		6
10	Long Metun		13
11	Data Dian		12

While the dependency of local and indigenous people within and around the HoB area on food plant and protein from wild sources is still significant (as indicated in Table 3), another interesting trend emerges if we compare the number of food plants known which is higher than the number of food plants used or consumed. This is happening because of two main reasons: more difficult access to the forest (distance) and growing dependence on purchased food from stores. It is important to also note a possible bias because the data were collected for only a limited period in the year.

Table 3. Food sources (percentage[2] of the Food Recall, FGD, ESD survey menu)

No	Village	Food Source			
		Wild/Forest	Cultivation	Purchase (local)	Purchase (non-local)
	Central				
1	Harowu	43%	40%	35%	55%
2	Hatung	41%	37%	6%	83%
3	Kuluk Leleng	39%	44%	50%	58%
4	Karuing	36%	38%	43%	61%
5	Muara Mea	13%	57%	30%	35%
6	Payang	27%	67%	50%	50%
	West				
7	Labian	80%	10%	5%	5%
8	Labian	80%	10%	5%	5%
9	Nanga	20%	15%	5%	60%
10	Kabebu	40%	10%	10%	40%
11	Belaban	50%	20%	10%	20%
	North				
12	Wa'Yagun	100%	100%	24%	28%
13	Binuang	100%	100%	26%	40%
14	Sempayang	39%	80%	13%	35%
5	Long	100%	100%	37%	9%
16	Data Dian	100%	100%	39%	5%

Although the HoB area is rich in bio- and agro-diversity which can be used as the source of food, data from Food Recall indicate that Desirable Dietary Pattern (DDP) in the HoB area are still lower than ideal. Data from North Kalimantan (Table 4) show that in daily consumption, diets still lack in consumption of roots/tubers, nuts, pulses. Interestingly, and as postulated, in villages very close to the forest and land for cultivation (e.g., Long Metun, Data Dian, Wa Yagung and Binuang) intake of vegetables/fruits is adequate, but in a village (Sempayang) situated near the district capital and far from good forest the intake is much lower. The low DDP may be due to shifting dietary habits towards more processed food sold in stores and higher starch menus where these foods are available or access to market is easier.

[2] Percentage showed the proportion of respondents using the different food sources (under the 4 categories).

However, these are preliminary finding of daily consumption of the people, and require further analysis, especially during the dry season.

Table 4. Desirable Dietary Pattern (DDP) of local and indigenous people HoB area in North Kalimantan

Food groups	**DDP Score Max**	**Desirable Dietary Pattern Score**				
		Sempayang, NK	**Long Metun, NK**	**Data Dian, NK**	**Wa Yagung, NK**	**Binuang, NK**
Cereals	25,0	12,8	17,2	21,0	15,4	25,0
Roots & Tubers	2,5	0,9	0,1	0,7	0,0	0,0
Animal products	24,0	24,0	24,0	24,0	24,0	19,7
Added fats & oils	5,0	0,9	0,7	0,6	3,9	5,0
Nuts & oilseeds	1,0	0,0	0,0	0,0	0,0	0,0
Pulses	10,0	1,8	2,4	0,1	0,0	0,0
Sugar	2,5	0,4	0,5	1,0	2,5	2,5
Vegetables & Fruits	30,0	16,0	30,0	30,0	30,0	30,0
Other	0,0	0,0	0,0	0,0	0,0	0,0
DDP score	100,0	56,8	74,9	77,4	75,8	82,2

Note: Food recall conducted on rainy season 2015

In terms of balanced diet from all food groups, the results show that in the communities of the interior that the diet is not yet balanced in daily consumption for the short period recorded. Educational level and access to information and awareness campaigns by the government are low. Almost 80 per cent the people from sample villages have a low education level. It is important to strengthen the people knowledge on food and nutrition and the high nutritional value of the rich biodiversity around them.

The local and indigenous people within and around the Heart of Borneo area meet their dietary need by producing food from their traditional food production, collecting from the wild, and, to a lesser degree, import from outside the area. Biodiversity and access to a variety of food sources is still very important for food security and quality. As mentioned, in case of food shortages, villages still rely on wild food sources gathered from the forests (23%) to offset their vulnerability. Moreover, recent research indicates that the nutritional content of local vegetable species and wild plants can be compared with conventional ones. Vitamin C in some local vegetables are higher than in tomatoes. Many of the Dayaks traditional vegetables are good sources of iron and have great potential to overcome nutritional anemia among the Indonesian people, especially women (Chotimah, *et al.* 2013). However, the composition of food groups in the daily diet is still not balanced on average.

According to this preliminary survey, we recommend to enhance food security and resilience by expanding the base of food crops, cultivating local varieties and wild cultivars, and preserving the rich agro-biodiversity and associated traditional knowledge. Much remains also to be known and studied about the nutritional value of wild plants and local food sources and further the pioneering research conducted by the University of Palangka Raya.

Another interesting aspect is the potential of local food sources to support women small business ventures (market and food services) by selling alternatives vegetables to urban consumers increasingly keen to buy healthy and local.

The 'diversity' and 'locality' of cultivars and genetic resources is a way to build resilience, adaptability and reduce vulnerability by maintaining diverse and adaptive plants that can cope with climate and environmental crises. The rich agrobiodiversity of local traditions might store traits that will prove advantageous in changing environmental conditions. It is a bounty of plants that we need to maintain and protect as well as the traditional knowledge that helped create it.

ACKNOWLEDGEMENT

This research was supported by WWF Indonesia. We thank our colleagues and experts: Bibong Widyarti, Desfari Christiani, Intan, Mariaty A. Niun, Mastuati, Herculana Ersinta, and Fuad Wahyudi who conducted the field survey and collected and compiled field data.

REFERENCES

Chotimah, Hastin E.N.C., Susi K., Yula M. 2013. Ethnobotanical study and nutrient content of local vegetables consumed in Central Kalimantan, Indonesia. Biodiversitas, vol 4, n 2:106-111.

Dove, M. and D. Kammen. 1997. The Epistemology of Sustainable Resource Use: ManagingForest Products, Swiddens, and High-Yielding Variety Crops. Human Organization, vol 56, n 1 (Spring): 91-101.

Dove, M. 2011. The Banana Tree at the Gate: A History of Marginal Peoples and GlobalMarkets in Borneo.Yale Agrarian Studies Series.

Eghenter, Cristina. 2012. "Food Sovereignty for Food Security: How protecting traditional knowledge and agro-biodiversity can be part of the solution" Paper presented at the workshop co-organized by Biodiversity International and CIFOR, "Managing wild species and systems for food security," IUCN World Conservation Congress, Jeju (Korea), 6-15 September.

FAO. 2016. Food security. Policy Brief June 2016 Issue 2. FAO King, V.T. 1993. The Peoples of Borneo. Oxford: Blackwell. Sellato, Bernard. 1994. Nomads of the Borneo Rainforest: The Economics, Politics, and Ideology of Settling Down. Honolulu: University of Hawaii Press.

 ISBN 978-602-0860-10-7

FETAL SKELETON DEVELOPMENT OF MICE (*Mus musculus* L) THREATED WITH NUTGRASS (*Cyperus rotundus*) EXTRACT

NUNING NURCAHYANI, YAN WIRASTI, JAMSARI, DJONG HON TJONG AND HENDRI BUSMAN

ABSTRACT

Research on medical herbs have been done since the information related with their safetinesscan not be guaranted. Results of this research are used to reduce side effect of medical herbs without clinical analysis of its benefits for human. The nuttgrass*(Cyperus rotundus* L.) grows wildly in many places, can be used to treat high blood pressure, breast tumors, candida, colds, flu, and helps treat convulsions, moodiness and depression, premenstrual syndrome (PMS) and the pain and cramps associated with PMS, menopause, and antiestrogenic effects. This herb contains a volatile oil with b-pinene, cyperene, a-cyperone b-cyperone and a-cyperol as its main ingredients. It also contains alkaloids, flavonoids, triterpenes, etc. The aims of this research were to determine the effects of nuttgrass (*Cyperus rotundus* L.) given orally to pregnant mice (*Mus musculus* L) during organogenesis fase to skeleton development anatomically and histologically, by using structure of epifisialis cartilago as indicator. Research has been conducted using Complete Randomized Design. Twenty pregnant mices were devide into 4 groups: A (control with 0,4 ml aquabides), B (4,5 mg/40grBB nuttgrass extract in 0,4 ml aquabides), C(45 mg/40grBB nuttgrass extract in 0,4 ml aquabides), D (135 mg/40grBB nuttgrass extract in 0,4 ml aquabides). Data were analized with Analysis of Variance (ANOVA) to find the differences of each treatment, if there were significant differences, Least Significant Differences 5% will be done. The result showed, that nuttgrass extract given orally to pregnant mices did not cause malformations to fetal mice. It reduces fetal body weight and length. In addition, it gave effect on changing the histological structure of fetal epifisialis tibia, by reducing the thickness of proliferation zone, maturation zone, cartilage zone during mineralization processes.

Key Words: nuttgrass (*Cyperus rotundus* L.), mice (*Mus musculus* L.), epifisialis cartilage, contraception, fetus

INTRODUCTION

Nutgrass (*Cyperus rotundus* L) has been known as one of medicinal herbs and used widely by people in the world. However, until now the research has been conducted on nutgrass related to its function as medicinal herbs or traditional medicine is very few.

Recently, the nutgrass is used to treat poor appetite, diarrhea, dysentery, fevers, parasites, gastritis, indigestion, and sluggish liver (Sa'roni and Wahjoedi, 2002). Beside that, nutgrass can also be used to treat high blood pressure, vomiting blood, breast tumors, candida, colds, flu, and colic. It helps treat convulsions, moodiness and depression, premenstrual syndrome (PMS) and the pain and cramps associated with PMS, menopause. This herb contains a volatile oil with b-pinene, cyperene, a-cyperone b-cyperone and a-cyperol as its main ingredients. It also contains alkaloids, flavonoids, triterpenes. Its volatile oil has a mild estrogen-like action. The water solutions of its total alkaloid, glycosides, flavonoids and phenolic compounds have cardiotonic and hypotensive effects. Its extract can inhibit some fungi, potential antifertility plants, used in the treatment of cervical cancer (Anonim b, 2007). Based on the effect of nuttgrass to reproduction system, it may disturb the fertilization and inhibit the implantation process, inhibit intrauterine mortality, and fetuses growth retardation (Winarno and Sundari, 1997; Okfiyanti, 2008; Pasaribu, 2008).

The aims of this research were to determinethe effects of nutgrass (*Cyperus rotundus* L.) given orally to pregnant mice (*Mus musculus* L) during organogenesis period on growth and development of embryos and skeletal fetuses, anatomically and histologically,using structure of cartilage epifisialis as indicator.

METHODS

Research was conducted at Zoology Laboratory University of Lampung on April-November 2015. Nutgrass extract was made from *Cyperus rotundus* L of Lampung. Extraction of nutgrass was used for this research and it was gained by drying the nutgrass

, made to powder, diluted in methanol, and put into rotary evaporator in 35^{o} C with 60 rpm for about 1 hour. Its extract was ready to used.

Method used in this research was Complete Randomized Design. Twenty pregnant mices were devided into 4 groups and treated by gavage with A (control with 0,4 ml aquabides), B (4,5 mg/40gBW nuttgrass extract in 0,4 ml aquabides), C (45 mg/40gBW nuttgrass extract in 0,4 ml aquabides), D (135 mg/40gBW nuttgrass extract in 0,4 ml aquabides). The treatment were given from gestation day 6 to 17. On day 18 of pregnancy , fetuses were removed by caecarean section.

Parameters observed were skeleton development on fetal mices anatomically and histologically, by using structure of epifisialis cartilago as indicator. To observe development of fetal skeleton, fetuses were processed using Allizarin red S method. Observation of histological structure of the tibial group plate preparation by paraffin method (Hematoxylin-Eosin staining)(Mc Manus dan Mowry, 1960).

The thickness of tibial epifisialis cartilage were measured, such as chondrocyt zone, proliferation zone, maturation zone, calcification of cartilage zone mineralized.

Data were analized with Analysis of Variance (ANOVA) to find the differences of each treatment, followed by Least Significant Differences at 5%.

RESULTS AND DISCUSSIONS

A. Effects of nutgrass (*Cyperus rotundus* L.)extract on Morphology of fetal mice (*Mus musculus L*)

Based on result of the effect of nutgrass (*Cyperus rotundus* L.)extract to fetal mice (*Mus musculus* L), there were no morphological abnormalities. It was found that the fetuses body weight and length decreased in the treatment group compare to those of control.

Body weight and length of fetal mice

In this research, fetal mice body weight and length were measured and analized since congenital abnormalities may cause body weight and length decreasing. It indicated that the growth and development process has been corrupt because of external and internal factors, both on animal and human. Decreasing of fetal body weight and length were one of some parameters to examine the effect of teratogenic agents. It was sensitif parameters (Wilson, 1973).

Results of observation on the body weight and length of fetuses was shown at Table 1.

Table 1. The number, body weight, and length average of fetal mice from the pregnant mice treated with nutgrass extract (*Cyperus rotundus* L.) during organogenesis

Group	Dosage(mg/40g body weight/day)	number of mice	number of fetuses	body weight(g)	length (mm)
A	0	5	54	1,65a	16,22a
B	4,5	5	46	1,31a	13,47b
C	45	5	38	1,25b	9,13b
D	135	5	22	0,86c	5,71c

Difference alphabetics in the same column showed significant among treatment groups

Statistical analysis with Anova indicated that there were significance differences (P<0,05)between body weight and length of fetuses from control and those of treatment groups. Table 1 showed that the more increase dosage extract of nuttgrass (*Cyperus rotundus* L.) given to pregnant mice, the fetuses body decrease. In these results indicated that the growth and development process was inhibited. According to Wilson (1973); Sa'roni and Wahjoedi (2002), some chemical agents not only cause to death but also caused malformation and growth retardation on fetuses, depend on dosage and time given to the sample animals.

Results showed that fetuses got malformation from different dosage of nutgrass were smaller in body length compare to those of the normal one. Growth retardation indicates the abnormalities of development processes. Some teratogenic agents caused visceral and skeletal abnormalities can be also detected from the form and function, without showing the abnormalities morphologically.

Decreasing in fetal body weight may be relate to the teratogenics effects of nutgrass(*Cyperus rotundus* L.)extract given orally to the pregnant mice (*Mus musculus* L) during organogenesis. In this research, decreasing fetal size has been appeared in the lowest dosage of the nutgrass extract given. The negative effects of nutgrass (*Cyperus rotundus* L.) extract to fetal mice happened because of disturbance in fetal circulation processes. In addition to it, the fetuses did not have specific enzyme for conducting detoksification to break the nutgrass extract . It indicated that nutgrass extract may have embryotoxic effects.

B. Nutgrass (*Cyperus rotundus* L.)extract effect on tibial epifisial cartilage of fetal mice (*Mus musculus L)*

This research in which nutgrass (*Cyperus rotundus* L.) extract was given to pregnant mice caused some abnormalities in fetal development. In this research, number of fetuses, body weight and length of fetuses, as well as tibial epifisialis cartilage has been used to determine the fetuses development.

Chondrocyt zone

Results of examination on chondrocyt layer of control and treatment group. There were hyalin cartilage which contained roundshape chondrocyt called ovoid. This chondrocyt was in inactive condition. The results on the effect of nutgrass extract on chondrocyt cartilage can be seen in Table 2.

Table2. The thickness average of cartilage chondrocyt zone of tibial epifisialisof fetal mice from the pregnant mice treated with nuttgrass extract (*Cyperus rotundus* L.) during organogenesis

Group	Dosage(mg/40g body weight/day)	thickness of chondrocyt zone (μm)	total tibial length (μm)
A	0	285,22 a	5448 a
B	4,5	266,23 a	5332 a
C	45	246,18 a	5088 b
D	135	252,43 a	5004 c

Difference superscript alphabet in the same column showed statistical difference (p<0,05)

Statistical analysis using ANOVA showed there were no significance differences (p > 0,05) between the thickness of chondrocyt zone of control with the treatment groups.

Proliferation Zone

Observation on proliferation zone showed the chondrocyt cells were doing mitotic division and become a lot of cells closed each other, and formed cells population along the fetal skeletal body axis. Data was available at Table 3.

Table. 3. The thickness average of cartilage proliferation zone of tibial epifisialisof fetal mice from the pregnant mice treated with nuttgrass extract (*Cyperus rotundus* L.) during organogenesis

Group	Dosage(mg/40g body weight/day)	thickness of proliferation zone (μm)	total tibial length (μm)
A	0	588,42 a	5880 a
B	4,5	524,40a	5680 a
C	45	446,22 b	5133 b
D	135	422,12 b	5006 c

Difference superscript alphabet in the same column showed statistical difference (p<0,05)

Statistical analysis with ANOVA showed significance differencess among the treatment group. The next analysis showed there were significance differencess (p < 0,05) between treatment group 4 with 2 and 1, between treatment group 3 with treatment group 2 and 1. However, between treatment group 4 and 3, alsotreatment group 2 and 1, there were no significance differencess.

Maturation zone

Observation on maturation zone indicated that there were hyperthrope chondrocyt and some vacuolas in the cells. Result can be seen in Table 4.

Table 4. The thickness average of maturation zone intibial epifisialiscartilage of fetal mice From the pregnant mice treated with nutgrass extract (*Cyperus rotundus* L.) during organogenesis

Group	Dosage (mg/kg body weight/day)	thickness of maturation zone (μm)	tibial length (μm)
A	0	180,22 a	5880 a
B	4,5	167,90 a	5240 a
C	45	124,12 b	5124 b
D	135	91,88 c	5004 c

Difference superscript alphabet in the same column showed statistical difference (p<0,05)

Statistical analysis with ANOVA showed significance thickness differences (p < 0,05) between the maturation zone in control with the treatment group.

Calcification of the cartilage zone

Microscopis observation of the cartilage zone calcification in control and reatment group showed the appearance of some hyperthrope and dead chondrocyt layer.This zone was thin and close to diafisis. Cartilage matrix in this zone began to get calcification by forming hydroxiapatit so there was thiny layer surrounding the hyperthrope and dead chondrocyt

The results can be seen at Table 5.

Statistical analysis with ANOVA showed significance thickness differences (p < 0,05) between the calcification cartilage zone in control with the treatment group.

Table 5. The thickness average of cartilage zone calcification intibial epifisialisof fetal mice from the pregnant mice treated with nutgrass extract (*Cyperus rotundus* L.) during organogenesis

Group	Dosage (mg/kgbody weight/day)	thickness of calcification zone(μm)	total of tibial length(μm)
A	0	281,15 a	7880 a
B	4,5	273,55 a	7442 a
C	45	231,42 b	7124 b
D	135	214,11 c	7004 c

Different superscript alphabeth in the same column showed statistical difference (p<0,05)

Based on results, it seems that nutgrass extract may inhibit calcification endochondralis of tibial epifisialis cartilage on fetal mice. It was shown from the proliferation zone, maturation zone, cartilage zone mineralized become more thick. Data showed that the thickness of chondrocyt zone was the same between control and treated group after treatment with nutgrass extracts. It seems that nutgrass extracts affected directly to target cells which active doing mitotic division. Overall, nutgrass extract may give intervention on skeleton before DNA replication finish completely at cynthesis phase. Beside that, it also inhibited phosphodiesterase enzyme activity.

From microscopic observation on the thickness of proliferation zone, there were decreasing of proliferation thickness related to increasing of nutgrass extract dosage. At the highest dosage 135 mg/kg body weight, the structure of chondrocyt layer at proliferation zone was decrease in its thickness . In this layer the cells was unorganized and inconsistent line. The cells was not closed each other and did not formed straight line. Caused the nutgrass extract seems interact with mitotic processes by inhibiting the cells mitotic and finally inhibiting cells proliferation of the chondrocyt layer. According to Ham and Cormack (1979); Aulia, Sugianto, and Aida (2002), this zone undergo mitotic actively and playing a role as location to form new cells to substitute the damage hyperthrophy cells. At diafisis part, cells also started degenerating processes. Since nutgrass extract can inhibit cells proliferation at proliferation zone, it may affect to the next zone at tibial epifisialis cartilage. Finally, it may inhibit tibia calcification processes, so the total length of tibia decrease compare to the control. Sagi (1996) said that embryonic cells is very sensitive of the environmental effects so the mitotic division happened continuously. At mitotic phase, no membrane at the nucleus,while chromosomes spread, so nutgrass extracts will easily interact in it causing cells and tissue damage. Finally it causes malformation of growth and development. Observation on histological structure on chondrocyt layer at maturation zoneindicated decrease of the thickness of maturation zone related to increase on nutgrass extract dosage. The histological change may happen because nutgrass extract inhibit mitotic processes of chondrocyt at proliferation zone. It cause the zone below them become more thicker. The hyperthrope chondrocyt tissuewill substitute by the new chondrocyt from proliferation zone.

The result of this research showed that nutgrass extract given orally to pregnant mices did not cause malformations to fetal mice. However, it reduces fetal body weight and length. In addition, it gave effect on changing the histological structure of fetal epifisialis tibia, by reducing the thickness of proliferation zone, maturation zone, cartilage zone during mineralization processes

REFERENCES

Anonim b. 2007. *Teki (Cyperus rotundus* L.*)* http://www.asiamaya.com/jamu/isi/teki_cyperusrotundus.htm online pada tanggal 30 November 2007 pada pukul 13.00

Aulia *Y., Sugianto J.,Aida Y.* 2002. *Efek Korambusil Terhadap Perkembangan Fetus Tikus Putih (Rattus norvegicus* L.) *Galur Sprague- Dowley*. Biota VII (3): 101-108.

Ham, A.W.and D.H. Cormack. 1979. *Histology*. 8th ed. J.B. Lippincot Company, Philadelphia.

McManus , J.F.A. and R.W. Mowry. 1960. Staining Methods. Histologic and Histochemicals. Paul B. Hoeber, Inc.

Okfianti, R. 2008. *Pengaruh Pemberian Ekstrak Rimpang Rumput Teki (Cyperus rotundus L.) terhadap Jumlah, Panjang, dan Berat Embrio Mencit (Mus Musculus L.)* (Skripsi). Universitas Lampung. Hlm. 19.

Panjaitan, R. G. P. 2003. *Bahaya Gagal Hamil Yang Diakibatkan Minuman Beralkohol*.http://tumoutou.net/702_07134/ruqiah_gp.htm online pada tanggal 30 November 2007 pada pukul 13.00

Pasaribu, L. 2008. Malformasi Bagian-bagian Tubuh Embrio Mencit (*Mus musculus* L) Setelah Pemberian Ekstrak Rimpang Rumput Teki (*Cyperus rotundus* L). Skripsi. Jurusan Biologi FMIPA Universitas Lampung.

Sagi, M. 1996. Pengaruh Buprofezin terhadap perkembangan embrio dan anak ayam (*Gallus gallus*) dengan pendekatan in ovo, in vitro, dan in vivo. *Disertasi* (tidak dipublikasikan). Program Pascasarjana UGM, Yogyakarta.

Sa'roni and Wahjoedi. 2002. *Pengaruh Infus Rimpang Cyperus rotundus L (Teki) terhadap Siklus Estrus dan Bobot Uterus Pada Tikus Putih*. Jurnal Bahan Alam Indonesia. Jakarta. 1 (2) : 45-47.

Wijayakusuma, H. 2000. *Sehat dengan teki* http://wordpress.com/tag/tanaman/feed/online pada tanggal 30 November 2007 pada pukul 13.00

Wilson. J.G. 1973. *Environment & Birth Defects.* Academic Press Inc, London.

Winarno, W.M. and M. Sundari. 1997. *Informasi Tanaman Obat Untuk Kontrasepsi Tradisional.* Pusat Penelitian Dan Pengembangan Farmasi. Badan Penelitian Dan Pengembangan Kesehatan Departemen Kesehatan RI. http://www.kalbe.co.id/files/cdk/files/10InformasiTanamanObatuntukKontrasepsi120.pdf/10InformasiTanamanObatuntukKontrasepsi120.html on line pada tanggal 30 November2007.

PERFORMANCE OF REPRODUCTION AND PRODUCTION BUFFALO (*Bubalus bubalis*) IN TULANG BAWANG REGENCY LAMPUNG PROVINCE

M.DIMA IQBAL HAMDANI*, IDALINA HARRIS AND LIMAN

Department of Animal Husbandry, Faculty of Agriculture, University of Lampung
Jln. Prof. Soemantri Brodjonegoro No.1,Bandar Lampung 35415
Email : dima.iqbal@fp.unila.ac.id

ABSTRACT

The aim of this research was to get basic information about characteristic of buffalos which used as a standard for selection especially reproduction and production performance. This Research located in Manggala Gunung Sakti Village, Manggala District, Tulang Bawang Regency. The objects of the research were 134 Buffalo in Samsudin and Sampurna farmers Group. Methods used in this research was survey method and purposive sampling. Reproductive variables were first mating, pregnancy period, first parity, and calving interval. Productive variables were Body weight, Chest Circumference, length of Body, Height of Wither. Data Analyzed by Descriptive Analysis. The Result showed Reproduction performance of buffalo for first mating age, pregnancy period, post partus mating in both of them was same with standard selection. Calving Interval in Syamsudin farmer group was longer. Body weight and Body Measurement in Syamsudin Group were bigger than Sampurna Group. Production Performance in Syamsudin Group was better than Standard National Council.

Keywords : Performance of Reproduction and Production, Buffalo, Tulang Bawang Regency

INTRODUCTION

Lampung Province is one of Province in Indonesia which supporting meat with the large population of cattle. Data from The Council of Animal Husbandry and Animal Health in Lampung Province (2013) indicates that Lampung Province is in 14th position from 33 province in Indonesia for cattle population. Lampung Province has 34.836 buffalos (accounted for 2.53%) from total buffalo population in Indonesia which is as many as 1.378.153. From 22.577 buffalos, 22.627 buffalos belong to farmer and 50 buffalos belong to a company in West Lampung which has well management system especially for quality and quantity of feed. This condition is important, since farmers do not pay attention on the feed for their buffalo's need. Besides that, inbreeding among buffalos likely occur since they do not use any recording for their buffalo offspring and many of these buffalos are slaughtered more than their ability to reproduce. As consequence of it, the buffalo population decreases for about 1.30%/year (Murti, 2006). All of these conditions affect in decreasing of Performance of Reproduction and Production Buffalo Manggala Gunung Sakti Village of Tulang Bawang Regency.

Regency of Tulang Bawang as one of Lampung Province regencies is supported by geographical condition where provided the buffalos to life. The regency is supported with river and swamp areas which rich with plants needed for feeding buffalos. Since there is tendency of decreasing in buffalo population in this area, basic information about Reproduction and Production Buffalo is important to increasing their productivity.

MATERIALS AND METHODS

Material

This Research located in Manggala Gunung Sakti Village, Manggala District, Tulang Bawang Regency on July-October 2015. The object of this research are 134 Buffalo in Samsudin and Sampurna farmers Group. The equipment used in this research are a digital balance, a rondo tape, measuring sticks and writing tool.

Methods

Methods used in this research were survey method and purposive sampling. The primary data was collected from the field study by conducting observation, weighing, measurement and deep interview with the farmers. Reproduction variables were first mating, pregnancy period, first parity, and calving interval. While production variables were body weight, chest circumference, length of body, and height of wither. All collected data was compared to Standard National Council values and analyzed by Descriptive Analysis

Tabel 1. Data Standard for Buffalo according Standard National Council (2011)

Age Buffalo	Body Weight (kg)	Chest Circumference (cm)	Length of body (cm)	Height of Wither (cm)
Adults Buffalo Female (>36 month)	250	170	120	115
Adults Buffalo Male (> 36 month)	350	190	125	120
Young Buffalo Female (24-36 month)	200	160	105	105
Young Buffalo Male (24-36 month)	300	180	110	110

RESULT AND DISCUSSION

Performance of Reproduction

Tabel 2. Data Performance Reproduction of Buffalo in Manggala District, Tulang Bawang Regency

No	Reproduction Performance	Sampurna Group	Syamsudin Group
1	First Estrous (maturity)/ years	2-3	2-3
2	Estrous Interval (day/times)	24-26	24-26
3	Pregnancy period (month)	11,5	10,5
4	Post partus Mating (times)	>3 time estrous cycle or after weaning	3 times estrous cycle or after weaning
5	Calving Interval (month)	<12,5	>13,5

From Table 2, information about performance of reproduction was provided. From this table first estrous and interval estrous between Sampurna and Syamsudin groups did not show any big different. However, those in Sampurna group had pregnancy period longer than Syamsudin group, beside that Calving interval in Sampurna Group was shorter than those in Syamsudin group. Chandra (2011) informed that reproduction performance of Buffalo in Nagari Air Dingin, Solok Regency of West Sumatera such as: The average of first mating 34.50 ± 3.61 month, Pregnancy Period in first parity 10.50 ±0.73 month and second parity 10.70 ± 0.79 month, Service period in first parity 5.23±1.48 month and second parity 4.9 ± 1.58 month. Calving Interval in first parity 15.73 ± 1.48 month and second parity 15.63 ±1.45 month. Susilorini, *et al* (2008) also stated that performance of reproduction in Buffalo were puberty at 2- 3 years, estrous cycle 21-23 days, Pregnancy Period 10.5 month, and Calving Interval 14-20 month.

Reproduction Performance in this research for first mating, pregnancy period, and post partum mating were all related same with those purposed by Chandra (2011) and Susilorini, *et al* (2008). In the other case, calving interval in Sampurna Group was better than Syamsudin Group and also was better than those from Chandra (2011) and Susilowati, *et al* (2008). The longer Calving Interval in Syamsudin Group might cause silent heat. Murti (2006) said Buffalo was known as animal that have secret estrous, so the farmers difficult to detect when the female animal was in estrous period. Beside that the estrous period most of the time happened at night. Some information stated that the time of estrous on Egypt Buffalo happened at 18.00 p.m until 06.00 a.m. The difficulty of estrous detection makes

Buffalo service mating not easy. This Condition showing reproduction performance of Buffalo is not so good. It is influenced with the recovery in reproduction system.

The Observation research showed buffalo in Manggala District life by extensive-traditional system. It means the Buffalo's population growth is slow with low reproduction performance. This happened since the Buffalo only eat the grass, nothing else from the other feeding sources. Besides that, the female of Buffalo is only mating with the same male one. These conditions, according Talib *et al* (2013), indicates to slowly growth value of Buffalo, not enough nutritional feed and happen to be *inbreeding*. The solution for this case is by recovery or improving the dietary feed and using the good male Buffalo during *out-breeding*. This system hopefully will increase in productivity and reproductively, decrease in inbreeding level, eventually increasing in Buffalo population in the long run.

Performance of Production

Tabel 3. Data Performance Production of Buffalo in Manggala District, Tulang Bawang Regency

No	Farmers Group	Physiological condition of Buffalo	Body weight	Body Measurement		
				Chest Circumference	Length of body	Height of Wither
1	Sampurna	Adults Buffalo Female	320,10	156,60	125,91	128,73
		Adults Buffalo male	331,50	170,25	129,75	140,00
		Young Buffalo female	157,56	112,00	92,00	109,50
		Young Buffalo male	121,49	109,00	74,50	88,50
2	Syamsudin	Adults Buffalo female	321,14	166,82	135,00	130,00
		Adults Buffalo male	464,65	235,50	131,50	146,00
		Young Buffalo female	155,40	109,20	90,00	105,00
		Young Buffalo Male	287,10	174,00	110,00	116,00

Note :Adults Buffalo Female and Adults Buffalo Male = > 36 month
Young Buffalo female and Young Buffalo Male = 24 month –36 month

From Tabel 3, in which the production of Buffalo in this research with variables of Body Weight, Chest Circumference, Body Lenght and Height at wither from each of groups (Sampurna and Syamsudin) in Manggala District, Tulang Bawang Regency indicates that Body weight and Body Measurement for Buffalo in Syamsudin Group was bigger than those in Sampurna Group. Beside that, the Production Performance of Buffalo in Syamsudin Group was above than those in Buffalo Standard National (BSN).

It was concluded that reproduction performance of buffalo for first mating age, pregnancy period, post partus mating in both of them was similar to those in national standard. Calving Interval in Syamsudin group was longer compared to Sampurna groups. Body weight and Body Measurment in Syamsudin group were bigger than Sampurna group. Buffalo Production Performance in Syamsudin group was above than that stated in Standard National Council.

REFERENCE

Badan Standarisasi Nasional 2011. Bibit kerbau – bagian 1: Kerbau Lumpur. SNI 7706.1:2011. Jakarta

Candra, K 2011. Performans reproduksi Ternak Kerbau di Nagari Air Dingin Kecamatan Lembah Gumanti Kabupaten Solok. Skripsi. Jurusan Produksi Ternak Fakultas peternakan Universitas Andalas

Dinas Peternakan dan Kesehatan Hewan Provinsi lampung. 2013. Buku saku Peternakan 2013 Lampung.

Murti, TW. 2006. Ilmu Ternak Kerbau. Kanisius, Yogyakarta.

Susilorini, T.E., Sawitri, M.E, dan Muharlien. 2008. Budidaya 22 Ternak Potensial. Penebar Swadaya. Jakarta

Talib,C., Herawati, T., dan Hastono. 2013. Strategi Peningkatan Produktivitas Kerbau melalui perbaikan pakan dan genetik. Wartazoa Vol 24 No 2 tahun 2014 Halaman 83-96

STUDY OF PHYSICAL, CHEMICAL, AND SENSORY CHARACTERISTICS OF MIXED FRUIT LEATHER SNAKE FRUIT (*Salacca edulis*) AND JACKFRUIT (*Artocarpus heterophyllus*) WITH VARIATIONS ON ARABIC GUM CONCENTRATION

NUR HER RIYADI P[1*], ARDHEA MUSTIKA SARI[2] AND PALUPI D RESPATININGRUM[3]

[1,2,3]Faculty of Agricultural University of Sebelas Maret
Jl. Ir. Sutami 36 A, Jebres, Surakarta
*Telp (0271) 637457, Fak (0271) 637457.
Email : masnur_heri@yahoo.co.id

ABSTRACT

Fruit leather is a thin sheet of snack food processed from dried fruit puree. Snakefruit can be processed into leather to extend its shelf life. However, during leather processing, flavor and color of snakefruit is reduced, therefore, addition of another fruit as a mixture is needed. In this study, jack fruit was chosen as a mixture because of its distinctive flavor and attractive color. Beside fruit, hydrocolloid as a binder should be added in optimal portion in manufacturing fruit leather as it could affect the caharacterisitics of furit leather. The objective of this research was to determine the effect of arabic gum (0.9%; 1.2%; 1.5%), as hydrocolloid binder on the characteristics of the physicochemical and sensory of mixed fruit (snakefurit and jackfruit) leather, as well as to determine the best concentration of arabic gum addition. The research design used was Complete Random Design, with one-way analysis of variance, followed by Duncan's Multiple Range Test (DMRT) at significant level of 5%. The results showed that addition of arabic gum had no significant effect on the physicochemical characteristics, except on the tensile strenght (0.924 N - 1.9886 N) and on total dietary fiber (9.37% -14.31%). There was significant effect on the sensory of texture, while characteristics of the color, flavor, taste, and overall of fruit leather were not affected. The best selected concentration of arabic gum in the mixed fruit leather was 1.5%.

Keywords: Mixed fruit leather, snakefruit, jackfruit, Arabic Gum.

INTRODUCTION

Fruit leather is a thin sheet food product which has a different taste of fresh form. Fruits are a good raw material for making fruit leather because of its high fiber content (Raab and Oehler 2000). One of the potential fruits for fruit leather is snakefruit, a plant native in Indonesia, which is consumed in the fresh form. However, during leather processing, flavor and color of snakefruit is reduced, therefore, addition of another fruit as a mixture is needed. In this study, jack fruit was chosen as a mixture because of its distinctive flavor and attractive color, as well as sweet taste. In addtition, the fiber content in jackfruit can contribute to a high-fiber fruit leather product. According to Rahmaniar (2006), 100 grams of jackfruit contains 27.6 grams of carbohydrates, 7 mg vitamin C, 70 grams of water, 2.31% fiber, vitamin B1, protein, fat, calcium, phosphorus and iron.

In manufacturing of fruit leather, hydrocolloid Arabic gum as binder can be added. Arabic gum as hydrocolloid was reported in Aviany's research (2013) on jackfruit leather. However its effect on the mixed snakefruit and jack fruit leathaer has not been reported yet. This study was aimed to (1) determine the effect of arabic gum (0.9%; 1.2%; 1.5%) as a binder to the physic0chemical characteristics, as well as the sensory of mixed fruit leather snakefruit and jackfruit, (2) determine the best concentration of the arabic gum addition in terms of the mixed fruit leather characteristics.

MATERIAL & METHODS

Material

The main ingredients used were “pondoh”snakefruit and mature locally jackfruit. Additional materials used were Arabic gum and sorbitol, and some chemicals for fiber content analysis, included buffer Na-phosphate, thermamylenzyme, pepsinenzyme, hydrochloric acid (HCl), sodium hydroxide (NaOH), 95% ethanol, acetone$(CH_3)_2CO$. all of chemicals were pro analysis.

Tool

Cabinet dryer (70^0 -90^0)C, analytical scales (0-100)gr, digital scales (0-100)gr, pan (3x10)mm, blender (1500)cc, desiccator (standard), oven $(125)^0$C, furnace (standard), electric stove (standard), gas stove (standard), Lloyd's Testing Instrument (standard), aw-meters, pH-meters (standard).

Method

Manufactured of Mixed Fruit Leather Snakefruit andJackfruit

The first stage of the study was make snakefruit and jackfruitmix puree, with a ratio of 2: 1 (100 : 50)gr. The fruit was cleaned and blanched at 85ºC within 10 minutes, then crushed using a blender with water addition as much as half of the fruit weight (water: fruit = 1: 2) for 10 minutes. At the time of the fruit crushed, water, sorbitol, and arabic gum (0%; 0.9%; 1.2%; 1.5%) were added. The selected concentration of arabic gum was based on Aviany'sresearch (2013),that was above 0.9%. The use of this sorbitol as a sweetener was to support the healthy snack of mixed fruit leather, that were as a high fiber, hypoglichemic, and no cause dental caries in children. Sorbitol is used as much as 10% (w/v) or 15 ml of total ingredients (Rahmanto SA, et al (2014). Homogenized puree was then cooked for 3 minutes at 80°C, poured into the pan sized 26 cm x 26cm x 2 cm and covered with plastic wrap. The next process was drying fruit leather in a cabinet dryer at 70°C within 9 hours. A dried fruit leather was then rolled, cut and packaged (Ramadan, 2014).The study design was completely randomized design, with one treatment factor, 2 replications. Data was analyzed by one-way ANOVA, followed by real difference test, use Duncan's Multiple Range Test (DMRT) at significant difference $\alpha = 0.05$.

RESULTS AND DISCUSSION

Physicochmecal Characteristics of Snakefruit& Jackfruit Mixed FruitLeather

Table 1 shows the effects of Arabic gum concentration on physicochemical characteristics of mixed fruit leather of snakefruit and jackfruit. Addition of arabic gum had no significant effect on the physicochemical characteristics (moisture content, ash content, and water activities), except on the tensile strenght (0.924 N - 1.9886 N) and on total dietary fiber (9.37% -14.31%).

All of the mixed fuit leather had low misture content (7.359- 7.498%). According to Winarno (1996), the moisture content is closely related to the shelf life of the material. The lower moisture content caused the longer shelf life of the material. The table also shows that the addition of gum arabic has no effect on the water activity of mixed fruit leather snakefruit and jackfruit. Water activity (aw) is the amount of free water from a material that can be used microbes for growth. Objective measurement of water activity is to determine the activity of the water contained in a food that can be taken to reduce the possibility of microbial contamination. Aw value is an index for the stability and decay of food (Mulya, 2002). Sudarmadji (2010) explained that the high water levels do not necessarily provide high value aw, this is probably due to a material composed by materials that easily binds water so the water is relatively free to be smaller and have a lower aw.

Table 1. Effects of Arabic gum concentration on physicochemical characteristics Of snakefruit and jackfruit mixed fruit leather

Characteristics	Arabic Gum			
	0%	0,9%	1,2%	1,5%
Tensile strength (N)	0,924[a]	1,574[b]	1,798[c]	1,986[d]
Water % (wb)	7,498[a]	7,427[a]	7,377[a]	7,259[a]
Ash % (db)	2,580[a]	2,595[a]	2,666[a]	2,904[a]
Water activity (a_w)	0,481[a]	0,476[a]	0,468[a]	0,465[a]
Fiber total % (db)	10,13[a]	11,65[b]	13,51[c]	15,44[d]

Description: different notations on the same row indicate significant difference at a significance α = 0.05

Tensile strength is the force required to pull the object up to fracture (Fatima, 1987). The results of tensile strength measurements on mixed fruit leather in various concentrations of arabic gum is presented in Table 1 and Figure 1.

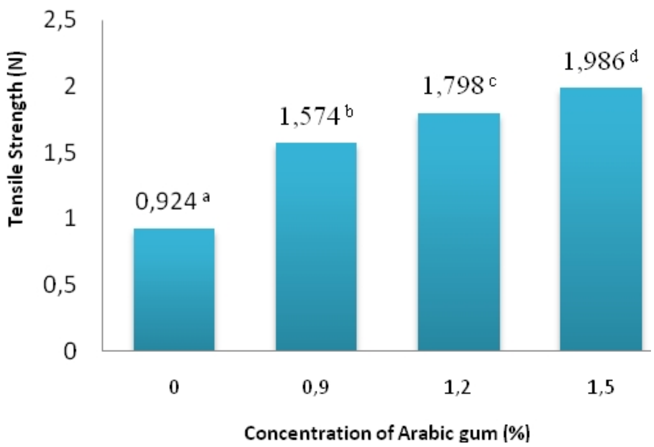


Figure1. Consentration of Arabic gum vs*Tensile Strength*

Based on this, it can be seen that the higher concentration of arabic gum, the higher tensile strength of snakefruit and jackfruit mixed fruit leather. The result is not in line with the texture sensory of fruit leather. Panelists tended to not like the product that produced a high tensile strength (Table 2). Tensile strength values of mix fruit leather that is still acceptable for panelists was amounted 1,574N, resulted from 0.9% Arabic gum concentration.

Having a fruit leather texture plastic is required in a fruit leather product so that it can be rolled up and not easily broken. Plastic texture is affected by the formation of a gel. Desroiser (1988) stated that fruit leather gel formation is influenced by a mixture of pectin, sugars, acids, and water. In this mixed fruit leather of snakefruit and jackfruit, gel formation was also influenced by the addition of arabic gum, the more gum is added to the mixed fruit leather, the texture becomes more plastic.

The test results on dietary fiber of mixed fruit leather (snake fruit and jackfruit) can be seen in Figure 2. Total dietary fiber of mixed fruit leather (snakefruit and jackfruit) showed significant differences among the Arabic gum concentrations. The higher Arabic gum concentration, the higher content of total dietary fiber mixed fruit leather. Total dietary fiber is the sum of soluble dietary fiber (soluble dietary fiber) and insoluble dietary fiber (unsoluble dietary fiber). (Winarno, 2008). Fibers of this mixture leather were derived from snakefruits, jackfruit, as well as from Arabic gum. The addition of Arabic gum in the manufacture of leather fruit mix improved functional properties, as well as to the source of soluble fiber. The amount of soluble fiber from different types of gum on average above 75% (Wade, 2005).

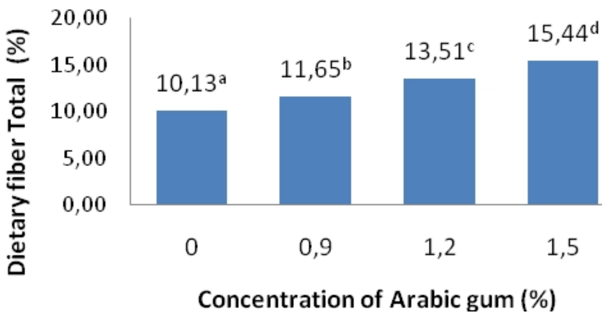


Figure 2. Consentration of Arabic Gum vs Dietary Fiber Total

This results is in line with those reported in Aviany (2016). In the jackfruit leather with the addition of gum arabic 0% -0.9%, the total dietary fiber increased by 4.16% -6.59%). According Glicksman (1996) Arabic gum consists of 36% galactose, arabinose 30%, 13%

rhamnose,19% glucoronic acid, and 2% protein. It is therefore, the higher the concentration of Arabic gum was used, the soluble fiber content increased.

Sensory Characteristics of Snakefruit& Jackfruit Mixed FruitLeather

The sensory analysis results of mixed fruit leather with arabic gum addition can be seen in Table 2. The results show that addition of arabic gum has no effect on the level of consumer acceptance in the color, flavor and taste attribute of mixed fruit leather snakefruit and jackfruit, except in texture attribute.

Table 2. Sensory Characteristis of *Mixed fruit leather* Snake & Jackfruitwith Arabic Gum addiction

Sampel	Parameter				
	Color	Flavor	Taste	Tekstur*	Overall
AG 0%	3,47a	3,47 a	3,47 a	2,40 a	3,30 a
AG 0,9%	3,50 a	3,33 a	3,50 a	3,13 b	3,60 a
AG 1,2%	3,37 a	3,53 a	3,57 a	2,77 ab	3,47 a
AG 1,5%	3,27 a	3,20 a	3,50 a	2,83 ab	3,30 a

Description: different notationscullomn indicate significantdifferenceatasignificanceα = 0.05
* texture when chewed, bitten, and rolled
1.Dislike 2. Rather 3.Neutral 4.Like 5. Liked Moore. AG = Arabic Gum

The range of likely score for color mixed fruit leather snakefruit and jackfruit was in 3.27 to 3.50 (moderate/neutral), while those in aroma and taste parameters were 3.20 to 3.53 and 3.30 to 3.57 resvectivley. . Arabic gum used in this study were flavorless powder form, and also colorless when dissolved in water. Therefore, the addition of arabic gum was not much affect to the aroma, color and taste of the original products.

Determination of the quality depends on several factors, including taste, color, texture, and nutritional value as well microbiological properties, visually appear first color factor and sometimes decisive (Cahyadi, 2008). Color with the smell, taste, and texture, plays an important role in the reception of food (de Man, 1997). In Table 2, it can be seen that the panelists preference level on mixed fruit leather texture is significantly different at the 0.05 level in texture parameter. Panelists gave highest score (3.13) on the texture of mixed fruit leather with arabic gum of 0.9%,mean while the lowest value (2.40) was raised in sample with no gum addition. .These results were in contrast to the texture of tensile strength, by using UTM (Universal Testing Machine), which showed that the best texture results was in sample with addition of 1.5% arabic gum. This probably the mixed fruit leather with addition of Arabic gum 1.5% could cause stuck to the teeth and tough when torn.

Selected Fruit Leather

Selected mixed fruit leather of snakefruit and jackfruit are based on the quality characteristics functional group, following (Muhandari and Kadarisman, 2008). Each type of food product must be specified to the nature of the most prominent in affecting the overall quality (Muhandari and Kadarisman, 2008). Table 3 shows that the mixed fruit leather with1.5% Arabic gum addition is selected. The results showed the mixed fruit leather with 1.5% Arabic gum addition was the best values when compared with others mixed fruit leather. Of the ten characteristics of the test, three of which showed the best values for this treatment, in particularlt the tensile strength, total dietary fiber and tecture.

Table 3. Characteristic of Mixed *Fruit Leather Selected*

Characteristic	Arabic Gum Addition			
	Contro l	0,9 %	1,2%	1,5%
Tensile stg	**0.924^{a}**	**1.574^{b}**	**1.798^{c}**	**1.986^{d}**
Moist content	**7.498^{a}**	**7.427^{a}**	**7.377^{a}**	**7.259^{a}**
Ash	**2.580^{a}**	**2.595^{a}**	**2.666^{a}**	**2.904^{a}**
Water Activity	**0.481^{a}**	**0.476^{a}**	**0.468^{a}**	**0.465^{a}**
Total Fiber	**10,13^{a}**	**11,65^{b}**	**13,51^{c}**	**15,44^{d}**
Color	**3.47^{a}**	**3.50^{a}**	**3.37^{a}**	**3.27^{a}**
Flavor	**3.47 ^{a}**	**3.33 ^{a}**	**3.53 ^{a}**	**3.20 ^{a}**
Taste	**3.47^{a}**	**3.50 ^{a}**	**3.57 ^{a}**	**3.50 ^{a}**
Tekstur*	**2.40^{a}**	**3.13 ^{b}**	**2.77^{ab}**	**2,83^{ab}**
Overall	**3.30^{a}**	**3.60^{a}**	**3.47^{a}**	**3.30^{a}**

Description: different notations on the same row indicate significant difference to the level of significance $\alpha = 0.05$
* Texture when chewed, bitten, and rolled
1.Dislike 2. Rather 3.Netral 4.Like 5. Moore Like

It was concluded that the arabic gum addition as a binder had significant effect on the tensile strength, total fiber and texture atrribute. The tensile strength, total fiber, and sensory score of texture of mixed fruit leather increased with higher arabic gum concentration. The best arabic gum concentration on mixed fruit leather was 1,5%.

ACKNOWLEDGEMENTS

Gratefulness to Mrs Dian RA on improving for this paper.

REFERENCES

Alinkolis JJ. 1989. *Candy Technology*. The AVI Publishing Co. Westport-Connecticut.

AvianyTP. 2016. *Kajian Karakteristik Fisio kimia dan Sensoris Fruit Leather Nangka (Artocarpusheterophyllus) dengan Penambahan Gum Arab Sebagai Upaya Diversifikasi Pangan*. Jurnal Teknologi Hasil Pertanian Vol IX No 1 Februari. Universitas Sebelas Maret. Surakarta.

Cahyadi W. 2006.*Analisis dan Aspek Kesehatan Bahan Tambahan Pangan*. Bumi Aksara. Jakarta.

Desrosier NW. 1988. *Teknologi Pengawetan Pangan.*.UI Press.Jakarta

Glicksman M. 1996. *Gum Technology in the Food Industry*. Academic Press, Inc. London.

Man dJM. 1997. *Kimia Makanan*. Institut Teknologi Bandung. Bandung.

Raab C and N Oehler. 2000. *Making Dried Fruit leather*. Oregon State University.Extension service.

Rahmanto SA, Nur Her Riyadi,Asri Nursiwi. 2014. *Pendugaan Umur Simpan Fruit Leather Nangka (Artocarpusheterophyllus) dengan Penambahan Gum Arab Menggunakan Metode Accelerated Shelf Life Testing (ASLT) Model Arehenius*. Jurnal Teknosains Pangan Vol 3 No 3 Hal 35-43.

Ramadhan K. 2015. *Kajian Pengaruh Variasi Penambahan Xanthan Gum Terhadap Sifat Fisik, Kimia Serta Sensoris Fruit leather Kulit Buah Naga Daging super Merah (Hylocereuscostaricensis)*. Jurnal Teknologi Hasil PertanianVol VIII No 2 Agustus.Universitas Sebelas Maret Surakarta.

Roiyana MI, Munifatul, P Erma. 2012. *Potensidan Efisiensi Senyawa Hidrokoloid Nabati Sebagai Bahan Penunda Pematangan Buah*. Buletin Anatomi dan Fisiologi Volume XX No. 2.Universitas Diponegoro. Semarang.

Rukmana R. 1999. *Prospek Agribisnis dan Teknik Usaha Tani*. Kanisius. Yogyakarta

Sudarmadji B,Haryono, Suhardi. 1997. *Prosedur Analisa untuk Bahan Makanan dan Pertanian Edisi Keempat. Liberty. Yogyakarta.*

Torio MAO, J Saez and FEMerca. 2006. *Physicochemical Characterization of Galaktomannan from Sugar Palm (ArengasacchariferaLabill.) Endosperm at Different Stages of Nut Naturity*.Philipine Journal of Science 135 (1) 19-30. *Compared with Modified Starch*. International Journal of Food Science and Technology 39 271-276.

Wade AM. 2005. *Ingredient challenges brushing up on gum*.BNP Media. https://www.PreparedFood.com/CDA/Articleinformation/feature/BNP.

Winarti S. 2008. *Pemanfaatan Buah Mengkudu (Morindacitrifolia) dan Kelopak Bunga Rosela (Hibiscus sabdariffa Linn) untuk Pembuatan Fruit Leather.* AGRITECH, Vol. 28 No.1.

THE ROLE OF *Trichoderma* spp. ON CORN DOWNY MILDEW (*Peronosclerospora maydis*)

J. PRASETYO
Department of Plant Protection Faculty of Agriculture
University of Lampung, Bandar Lampung Indonesia 35145
e-mail: jkdwiprasetyo21@gmail.com

ABSTRACT

In agriculture *Trichoderma* spp. plays important roles, especially for intergrated plant disease management. *Trichoderma* spp. affects corn health via some mechanisms, i.e. anthagonistic agents against corn pathogens, plant growth promoting fungi, and as inducer in inducing systemic corn resistance. It is known that *Trichoderma* spp. are able to decrease disease severity of some soil borne corn disease, such as sheath blight. It is also known that *Trichoderma* certain strain could increases corn growth. Some reseachers also showed that *Trichoderma* spp. certain strains involved in induce systemic resistance of corn diseases. Our works in recent time also showed that some isolat of *Trichoderma* spp. involved in corn resistance agaisnt downy mildew.

INTRODUCTION

Corn is the second most important comodity in Indonesia after rice based on total area for its production. According to Kasryno (2002) total area used in agriculture for corn production is about 19% and for rice production is about 61%, and the rest area for others, such as cassava, soybean, peanut, mungbean, and sweet potato. Before 2000, corn was especially used for human. The data from CBS (Central Beauro of Satatistics) showed that in 1998, corn used for human consumption is 69% (CBS, 1999). Erwidodo and Pribadi (2002) estimated that the use of corn for human consumption was 63%, while for feed was about 30.5%. After 2000, the use of corn changed steadily for feed. Kasryno estimated in 2001 the use of corn for food is 43% and 57% for feed. Now, Indonesia is the first corn producer in ASEAN, however, the consumption of corn continues to outspace of corn production (Tabel 1), resulting in a deficit.

 ISBN 978-602-0860-10-7

Corn Production & Consumption in ASEAN Region - 2013:

Country	Production	Consumption
Indonesia	18,510,400	20,828,000
Philippines	7,372,900	7,467,500
Vietnam	5,193,400	7,142,900
Thailand	5,065,000	4,716,000
Myanmar	1,525,700	1,356,400
Laos	1,018,200	797,300
Cambodja	911,100	204,500
Singapore	-	41,000
Brunei	-	4,500

Source: ASEAN Food Security Information 2013

Now, Asean Economic Community (AEC) is coming into affected and has transformed Indonesia to be a country characterized by the free trade of goods, services, investment, skilled labour, and a free flow of capital. Regarding food security, the blueprint of the AEC requires that production and trade of the corn is safeguarded in all ASEAN countries through increase information systems and smart solutions. Indonesian government has emphazised the important of self sufficiency in corn. Many efforts must be conducted to get the best solution.

Corn is susceptible to pests and diseases, particularly to downy mildew. Downy mildew is an important diseas of many cereals, such as corn. In Indonesia, downy mildew is a limiting factor in corn production (Iriany *et al.*, 2003; Budiarti *et al.*, 2002; Azrai *et al.*, 2003; Semangoen, 1968). Downy mildew was reported in 1897 and decreased yield to 90% (Semangoen, 1968; Semangoen, 1996; Semangun, 2004). In Lampung Province the loss for the disease could reach 100% (Subandi *et al.*, 1996; Wakman and Kentong, 2000; Wakman, 2004). Every year downy mildew attacts show steadily increase. In Indonesia, in 2004, downy mildew attacts reached 4837 ha, 563 ha among them were stated as total loss. In

2004, in Lampung, total area effected reached 2504 ha, and 548 ha stated as total loss (Direktorat Perlindungan Tanaman, 2006).

SYMPTOMS OF DOWNY MILDEW

The symptom of downy mildew is very complex. The symptom begins as local lesion, systemic symptom, to the malformation of cob. The pathogen can reached growing point and couses systemic symptom, chlorosis extends (Fig.1).

Figure1. Chlorotic symptom of corn downy mildew

The cobs malform, small leaves are formed on cobs, many small cobs are formed, or one long cob is formed (Fig.2). The cobs are not productive, corn seeds can be formed only few and small.

Figure 2. The malformed cob, the cob to be long Without seed.

PATHOGENS OF DOWNY MILDEW

In Indonesia, Downy mildew formally is caused by *Peronosclerospora maydis* (Rac.) Shaw and *P. phillipinensis* with its distribution area (George *et al.*, 2003; Bains and Dhahliwal, 1994; Semangun, 2004). In the recent time, it is known that there are some species attact corn in Indonesia. The genus of *Peronosclerospora* was characterized by the presence of special conidiophor (Fig.3a). Conidia and conidiophore can be found particularly on the lower leaves surface of corn (Gb.3b).

Figures 3.a Conidiophor with special branch
b. Fungal phialid
c.The white layer consisted of conidia and conidiophores

ISBN 978-602-0860-10-7

Now, it is known that there are three species of *Peronosclerospora* attact corn in Indonesia, i.e. *P. maydis* distributed in Java, Sumatra, Kalimantan, and Sulawesi; *P. sorghi* distributed in Sumatra and West Java; and *P. phillipinensis* distributed only in Sulawesi (Muis *et al.*, 2013; Rustiany, 2015). *Peronosclerospora* attacts corn in Lampung is suspected comprise of 3 species, i.e. *P.maydis*, *P. sorghi* dan *P. phillipinensis* (Rustiany, 2015).

Peronosclerospora spp are obligate, seed and air borne pathogens (Semangoen, 1970; Jones *et al.*, 1972; Subandi *et al.*, 1998). The infection through the seed is affected by the water content of the seed. Infection through the seed does not occur when the water content of the seed is 10-18,5% (Sommartaya *et al.*, 1975). The infection can occur via soil when the causal fungi form oospore as *P. sorghi*.

DOWNY MILDEW CONTROL

The control of downy mildew of corn usually is conducted by integrated management with the use of resistant variety and seed treatment (Iriany *et al.*, 2003; Semangun, 2004). The resistant hybreed of corn effectively control downy mildew (Singh, 1986). It seems that the control of downy mildew does not enough only with resistant variety, it needs effective synthetic fungicide. Untill now, the synthetic fungicide commonly used by the farmer is methalaxyl, the fungicide has been used more than 50 years. The results of many researches stated that the use of methalaxyl in the long time could induce the presence of resistant fugal variants. When the metalaxyl resistant variants present in the field, the effectivity of metalaxyl against the pathogens steadily decreases from time to time. Katan and Bashi (1981) and Bains and Dhalliwal (1994) stated that the long use of metalaxyl could induce the presence of resistant fungal variant against the disease. Recently, Some reports stated that the effectivity of metalaxyl to control downy mildew decreased. According to Isakeit and Juster (2005) metalaxyl was not effective anymore against downy mildew caused by *Peronosclerospora sorghi.* It is aledged that recent explosive of downy mildew is caused by the presence of resistant fungal variants of *P. sorghi*, *P. maydis*, and *P. phillipinensis*. The variants can adapt with metalaxyl well. In the host, the fungi have evolved to be new races with higher virulence (Perumal *et al.*, 2008). Thus many efforts have to be done to get a new alternative control free from the presence fungal resistant variants problem. One of the alternative way to manage downy mildew of corn is the use biocontrol agent, *Trichoderm* spp. Since *Trichoderma* spp. are a root colonist, only small amounts need to be applied to the seeds for long-term effects. It will be economic strategy to control downy mildew, it also will be a valuable addition to maize culture since foliar fungicides are generally too expensive for field maize.

It is known that *Trichoderma* spp. roles many functions in plant. *Trichoderma* spp. are antagonists against many pathogenic fungi, and has a role as biocontrol agents. The mechanisms of biocontrol consisted of mycoparasitism, toxin production, competitor for space and resource. *Trichoderma* spp. takes part in plant growth as plant growth promoting fungi. They are also known as inducer of plant defense system. Some researchers showed that *Trichoderma* systemically induced plant defense system. Djonovic *et al.* (2007) reported the identification, purification, and characterization of an elicitor secreted by *T. virens,* a small protein designated Sm1 (small protein 1), that induced systemic resistance in maize. Fungi such as *Trichoderma* spp. can stimulate plant growth by suppressing plant diseases (Van Wees *et al*., 2008). *Trichoderma* spp. can form endophytic associations and interact with other microbes in the rhizosphere, thereby influencing disease protection, plant growth, and yield.

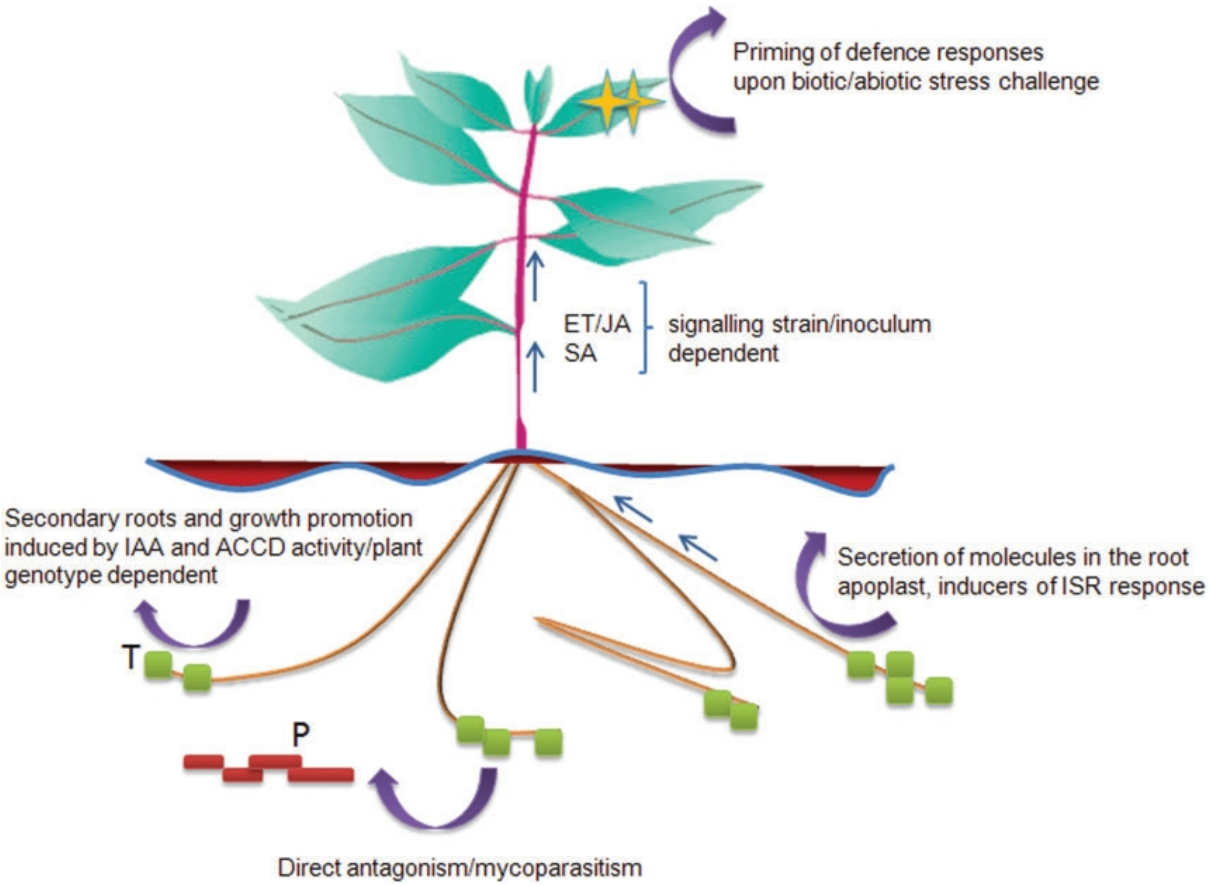


Fig. 4. Schematic representation of Trichoderma–plant interaction (Hermosa *et al.* 2012). T, Trichoderma; P, pathogen; IAA, indole-3-acetic acid; ACCD, ACC deaminase; ET, ethylene; JA, jasmonic acid; SA, salicylic acid; ISR, induced systemic resistance.

Some researches conducted in Lampung showed different results. Mujim *et al.* (2007) showed that the application of *Trichoderma* increase the incident of maize downy mildew. Mujim (2010) conducted the same field using some isolates of *Trichoderma* and some corn varieties showed that the different effects between isolates, but none of the isolates increased the downy mildew incidence

REFERENCES

Azrai, M., F. Kasim, Sutrisno, dan S. Moelyopawiro. 2003. Identifikasi lokus karakter kuantitatif ketahanan penyakit bulai pada jagung menggunakan marka RFLP. *Jurnal Bioteknologi Pertanian* 8(1) 8-14. <http://www.pustakadeptan.go.id/publication/bi081032.pdf.diakses tanggal 24 Maret 2007>

Bains, S.S. and H.s. Dhaliwal. 1994. Downy mildew of mays. Pages: 212-234. In: U.S. Singh, U.N. Mukhopadhay, J. Kumar, and H.S Chaube (eds.). *Plant Diseases of* *international Importance*. Vol 1: Diseases of cereal and pulses. Prentice Hall. Englewood Cliffs, NJ

Budiarti S.G., Sutoro, Hadiatmi, dan Purwanti. 2002. Pembentukan dan evaluasi inbrida jagung tahan penyakit bulai. *Prosiding seminar hasil ppenelitian rintisan dan bioteknologi tanaman* hlm 193-198. <http://www.indobiogen.or.id/terbitan/prosiding/fulltext_pdf/prosiding2002_193-198_srigajatri.pdf. diakses tanggal 24 Maret 2007>

Central Bureau of Statistics (CBS). 1970-1999. Food Balance Sheet. Jakarta, Indonesia:CBS.

——.1971-2001. Indonesian Statistical Year Book. Jakarta, Indonesia:CBS.

Constantino. N.N., F. Mastouri, R. Damarwinasis, E.J. Borrego, M.E. Moran-Diez1, C.M. Kenerley, X. Gao, and M.V. Kolomiets. 2013.

Direktorat Perlindungan Tanaman. 2006. Data luas serangan organisme pengganggu tumbuhan: Data OPT penting tanaman jagung. Derektorat Jendral Tanaman Pangan, Departemen Pertanian RI. <http//www.deptan.go.id/ditlintp/BASISDATA/DATA/_OPT/INDEX_DATA_0PT.html diakses tanggal 24 Maret 2007>

Djonovic, S., W. A. Vargas, M. V. Kolomiets, M. Horndeski, A. Wiest, and C. M. Kenerley. 2007. A Proteinaceous Elicitor Sm1 from the Beneficial Fungus Trichoderma virens Is Required for Induced Systemic Resistance in Maize. *Plant Physiol.* 145:875-889

Erwidodo and N. Pribadi, 2002. Produksi dan Permintaan Jagung di Indonesia: Perkembangan dan Proyeksi. (Production and Demand for Maize in Indonesia: The Progress and Projection). Presented at the Panel Discussion on “The Potential of Maize for Alternative Food, held by the Agency for Food Security, Ministry of Agriculture, 25 April 2002.

George, M.L. C., B.M Prasana, R.S. Rathore, L.A.S. Settlyt, E. Kasim, M. Azrai, S. Vasal, O. Balla, D. Haulea, A.Canama, E. Regalado, M. Vargas, M. Khairallah, D. Jeffers, and D. Hoisington. 2003. Identification of QTLs confering resistance to downy mildew of maize in Asia. *Theoritical and Applied Genitics* 107 (3): 544-551. <http/cat.inist.fr/?amodele=afficheN&cpsidt=15040773 diakses tanggal 24 Maret 2004>

Isakeit, T. and J. Jaster. 2005. Texas has a new pathotype of *Peronosclerospora sorghi*, the cause of sorghum downymildew. Plant Disease 89:529.

Iriany, M. R.N., A. Takdir, M. Muzdalifah, M.M. Dahlan & Subandi. 2003. Evaluasi daya gabung karakter ketahanan tanaman jagung terhadap penyakit bulai melalui persilangan diallel. *Penelitian Tanaman Pangan* 22 (3) .http://www.pempropsu.go.id/download.php?filename=Daya%20Gabung.pdf&id=KA-01. diakses tanggal 24 Maret 2007

Kasryno, F. 2002. The Progress of World Maize Production and Consumption for the Last Four Decades, and Its Implication to Indonesia. Presented at a one day seminar on Maize Agribusines. Bogor, 24 June 2002. AARD.

Katan, T & E. Bashi. 1981. Resistance to metalaxyl in isolates of *Peronosclerospora cubensis,* the downy mildew pathogen of cucurbites. *Plant Disease* (65): 798-800

Perumal, R., P. Nimmakalaya, S.R. Erattaimuthu, Eun-Gyu No, U.K. Reddy, L.K. Prom, G.O. Odvody, D.G. Luster, and C.W. Magill. 2008. Simple sequence repeat markers useful for sorghum downy mildew (*Peronosclerospora sorghi*) and related species. Research Article. BMC Genetics 9(77): 1-14.

Muis, A., MB. Pabendon, N. Nonci, dan WPS. Waskito. 2013. Keragaman Genetik *Peronosclerospora maydis* Penyebab Bulai pada Jagung Berdasarkan Analisis Marka SSR. *Penelitian Pertanian Tanaman Pangan* VOL. 32 (3): 139-146

Rifai, F. 2005. *Dasar-dasar Epidemiologi Penyakit Tumbuhan.* Yayasan Perguruan Tinggi Komputer. UPI Press, Padang

Semangun, H. 2004. Penyakit-penyakit Tanaman Pangan Di Indonesia. Gadjah Mada University Press, Yogyakarta. 449 hal.

Semangun, H. 1996. *Pengantar Ilmu Penyakit Tumbuhan*. Gadjah Mada University Press, Yogyakarta

Semangoen, H. 1968. *Penelitian tentang Penyakit Bulai* (P. maydis) *pada Jagung Khususnya mengenai Cara Bertahannya Cendawan.*Fakultas Pertanian UGM, Yogyakarta

Singh, D.P. 1986.*Breeding for resistance to diseases and insect pests.* Springer-Verlag. Berlin Hedelberg

Subandi, M.S. Sudjadi, D. Pasaribu. 1996. *Laporan hasil pemantauan penyakit bulai dan benih pada pertanaman jagung hibrida*. 5 hal.

Subandi, I.G.Ismail & Hermanto. 1998. *Jagung, Teknologi Pascapanen.* Pusat Penelitian dan Pengembangan Tanaman Pangan. Bogor 57 hlm.

Sommartaya, T., U. Pupitat, S. Intrama, & B.L. Renfro. 1975. Seed Transmission of *Scleroswpora sorghi* (Westo and Uppal) The Downy Mildew of Corn in Thailand. *J.Kasetsart* 9:12

Van Wees, S. C. M., van der Ent, S. & Pieterse, C. M. J. (2008). Plant immune responses triggered by beneficial microbes. Curr Opin Plant Biol 11, 443–448.

Wakman, W. 2004. Penyakit bulai pada tanaman jagung di Indonesia: masalah, penelitian dan cara mengatasinya. Prosiding Seminar Tahunan PFI Komda Sulsel.

EXPLORATION OF THE PREDATORSOF SUGARCANE SCALE INSECT (*Aulacaspis tegalensis* Zehntn) AND TESTING THE DURABILITY OF THE PREDATOR WITH ALTERNATIVE FEEDS *)

SUDI PRAMONO**) , FX. WAGIMAN, Y. ANDI TRISYONO AND WITJAKSONO***)

*) Part of disertation S3 Ilmu Pertanian UGM, Yogyakarta.
**) Departmen of Plant Protection, Faculty of Agriculture, Lampung University
***) Departmen of Plan Pest and Disease, Faculty of Agriculture, Gadjah Mada University

ABSTRACT

One of the important factors that could potentially lower the production of sugarcane plantations in Indonesia is the pest infestation. The mayor pest of sugarcane are sugarcane top borer (*Scirpophaga nivella*), sugarcane stem borer (*Chilo aurichilius*), rats and sugarcane scale insect (*Aulacaspis tegalensis*.). Scale pests of sugarcane in the last decade increased in areas of Sumatra. The attack of sugarcane scaleinsect on the sugarcane plantations of PT Gunung Madu Plantations, Central Lampung is almost evenly in estate area with a strike rate of over 18 percent. This research aimed to get potential predators forbiological control of sugarcane scaleinsect. The experiment was carried out in the sugarcane field and Entomology Laboratory of PT Gunung Madu Plantations (PT GMP),Gunung Batin, Lampung Tengah, in April 2015 until May 2016.

As many as 10 individuals of adult predators were placed in plastic jars, 9 cm in diameter. This experiment was arranged in a randomized Complete Design with six treatments and 3 replicates. Treatments were feeding in the form of P1 (100 individuals of sugarcane scale insect); P2 (200 individuals of sugarcane scale insect); P3 (300 individuals of sugarcane scale insect); P4 (100 individuals ofaphids); P5 (200 individuals ofaphids), and P6 (300 individuals ofaphids). The observation was done every day, when the remaining 50% of feed was replaced with the new feed.

One character of the predator was desired in that it had the ability to survive with both the original and alternative feeds. Predators that were found in sugarcane plantations, PT Gunung Madu Plantations were , among others,*Chilocorus*sp., *Telsimia*sp. and *Scymnus* spp.The experiment showed that when fed with sugarcane scale insect, *Chilocorus* sp. survivedfor 27.2 days, *Telsemia* sp. 4.1 days and *Schymnus* sp. 27.8 days. When fed with

alternative feeds (white sugarcaneaphids) *Chilocorus* sp was able survive for 7.1 days, *Telsemia* sp. survive 4.1 days and *Schymnus* sp. 8.1 days.

INTRODUCTION

Sugarcane scale(*Aulacaspis tegalensis*) had not previously been reported as an important pest of sugarcane plants but from 2002 to 2007 the population is very high in sugarcane plantation of Sugar Group Companies (SGC). The insect has been found to be more damaging than the stem borer and shoot-tip borer. The intensity of the attacks in sugarcane aged 4 months amounted to 58.34% and in sugarcane aged 6 months amounted to 63.34%, Couhault (2008) cit. Utomo (2010).

Observations on sugarcane plantations PT Gunung Madu Plantations, Central Lampung from April to October 2015 show the phenomenon that is not much different from the sugarcane plantation of Sugar Group. Attacts of sugarcane scale insect occurred in sugarcane aged 6 months to harvest. Sugarcane varieties are susceptible to attack lice shield include GMP 1 GMP 2, GM 23 and GM 25 population is very high even reached thousands of heads per stem.Sugarcane scale population continued to increase until the harvest resulting in a decrease yield and cause losses are relatively large (Research and Development PT. Gunung Madu Plantations, 2014).

To reduce the rate of loss used control is required, among others by means of biological control using predators. This was chosen because of a sugarcane scale is in the stem of sugar cane so that the necessary natural enemies that can get into the midrib and prey on fleas. Hopefully, sugarcane scale insect population could be controlled by the predator so that their population could be be reduced to the level that are not harmful

The problems arise how to provide a predator ready at any time given the presence of sugarcane scale on cane aged 6 months or more (Sunaryo and Hasibuan. 2003). Maintenance required for alternative feed predator shield is a type of mite aphids (*Ceratovacuna lanigera*) almost throughout the year. Characters potential predator is more like the main prey but can survive with alternative feed. Therefore in this study to test the durability of some types of predators using the main feed and alternative feed (Wagiman, 1996) .

MATERIALS AND METHODS

Tools and materials used jar of diameter 9 cm high 7 cm, gauze, tissue, brush, needle, handcounter, binocular microscope, petri dish, sugar cane attacked by sugarcane scale, predatoryinsects and mites sugarcane scale.

The experiment was conducted in the sugar plantations and in the Laboratory of Entomology of PT Gunung Madu Plantations (PT GMP), Gunung Batin, Central Lampung, from April 2015 to May 2016. All types of predators encountered at any point of the collection is taken and immediately put in a jar lice sugarcane scale.Imago form *Chilocorus* sp., *Telsimia* sp. and *Scymnus* sp. and used as feed sugarcane scale (*Aulacaspis tegalensis*) and aphids (*Ceratovacuna lanigera*).

Imago predator placed in plastic jars diameter 9 cm by 10 tails. The treatments were feeding in the form of P1 (100 sugarcane scale); P2 (200 sugarcane scale); P3 (300 sugarcane scale); P4 (100 aphids tail); P5 (200 aphids tail) and P6 (300 aphids tail). This experiment was arranged in a completely randomized design with 6 replications. Observations were made every day, when the remaining 50% of feed is replaced with a new feed, until all the imago predatorswho used to experiment die.

RESULTS AND DISCUSSION

Predatory sugarcane scale is found in many sugar cane plantations PT Gunung Madu Plantations Central Lampung there are 3 types of *Chilocorus* sp., *Telsemia* sp. and *Schymnus*sp. All three predators are found in groups. not all places are found predators, predators found in plants that are 6 months old or older and sugar cane crops attacked by sugarcane scale (*Aulacaspis tegalensis*). Predator*Chilocorus*sp. most often found in sugar cane plantations followed *Schymnus* sp. and *Telsemia* sp. The existence *Telsemia* sp. only brief, namely when old plants 6-7 months after that age is hard to find. The phenomenon is interesting to study further whether the shield predator mite infestation would prey on other types namely sugarcane aphids (*Ceratovacuna lanigera*). The results show very interesting results among the three predators and showed a different response when given prey mites and aphids shield cane sugar.

Chilocorus sp. very like sugarcane scale, is so fed only takes a few moments to locate and direct lice prey on the shield. In contrast with aphids seem less like even tend to shy away. Likewise for predators *Schymnus* sp., Imago insect infestation is favored prey sugarcane scale compared with sugarcane aphids. For predator *Telsemia* sp. fed sugarcane scale and aphids are less aggressive in prey.

Table 1. The average age of the predator to prey sugarcane scale and aphids

Prey	*Chilocorus* sp	*Telsemia* sp.	*Schymnus* sp.
Sugarcane scale	27,2 a	4,1 a	27,8 a
Sugarcane aphid	7,1 b	4,1 a	8,1 b

The average age of *Chilocorus* sp.*Chilocorus* sp. fed sugarcane scale age much longer with an average of 27.2 days, while those fed aphids on average only 7.1 days. This suggests that the beetle *Chilocorus* sp. more like sugarcane scale compared with aphids.In addition to longer life may also produce offspring that can be maintained as biological agents. Another advantage that is approaching prey monofag means other than cane shield lice only as an alternative if the original is not available prey. Characters like this is very good because if the field is expected to always find their prey, namely the original sugarcane scale.

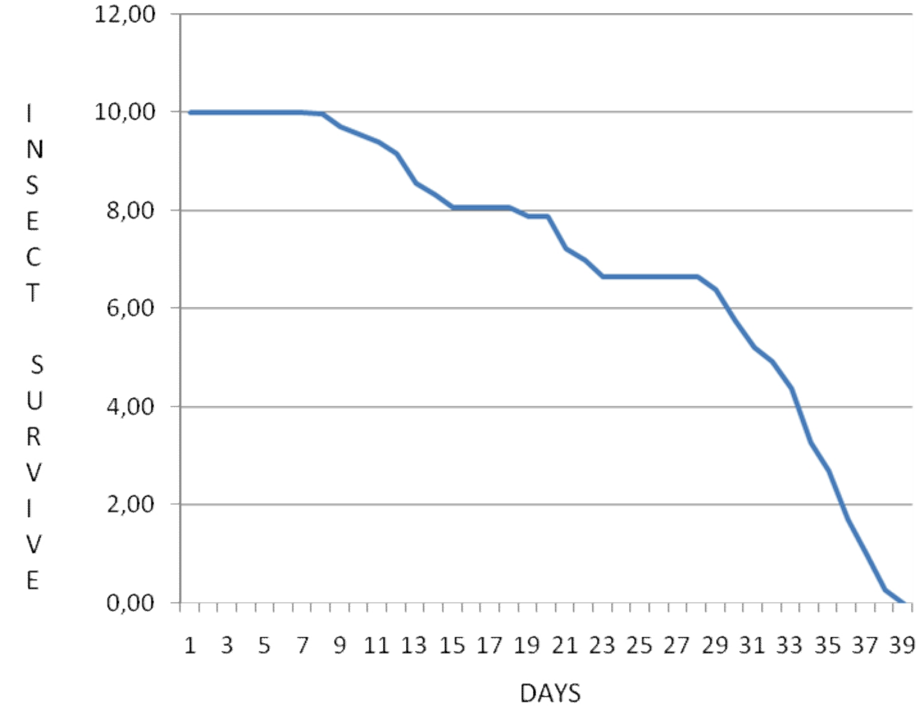


Figure 1. Lifespan of *Chilocorus* sp. with sugarcane scale insect as feed

In Figure 1 looks *Chilocorus* sp. survive long enough and the mortality rate is relatively slow. The first day until the seventh day there is no death, even do copulation. On the 8th day begin to occur death although not too much and the almost simultaneous deaths occurred on the 27th day. The results showed that predators *Chilocorus* sp. fed sugarcane scale can produce offspring although not much.

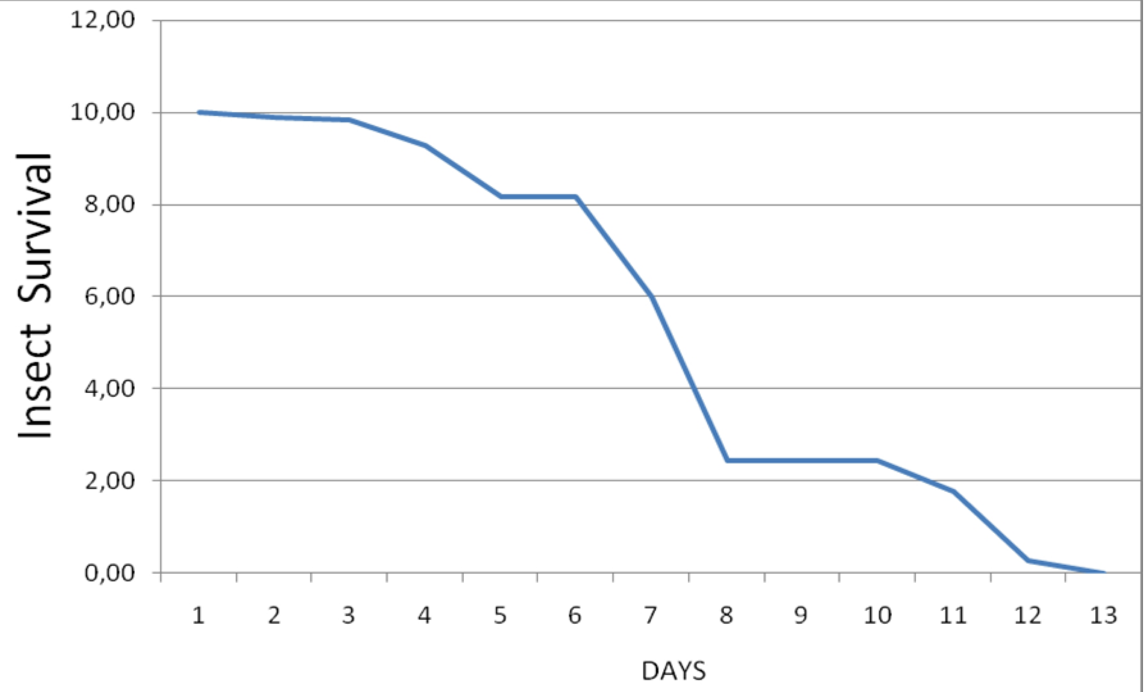


Figure 2. Lifespan of *Chilocorus* sp. with feed aphids

Figure 2 shows starting on day 3 already happened death and death take place very quickly.On the 8th day only about 20% of the test insects, on day 13 all *Chilocorus* sp. all dead. The observations further indicate that no imago that produce offspring, so that it can be said that the aphids feed not suitable for breeding predators *Chilocorus* sp.

The average age of *Telsemia* sp. Age *Telsemia*sp. average of only 4.1 days better preserved using the shield fleas feed sugarcane scale and aphids, the feed showed no difference. Imago that was fed with sugarcane scaleinsect and aphids produce no offsprings This means that *Telsemia* sp. could not adapt to an artificial environment, so it is difficult to breed. The death rate was relatively fast, as shown in Figures 3 and 4.

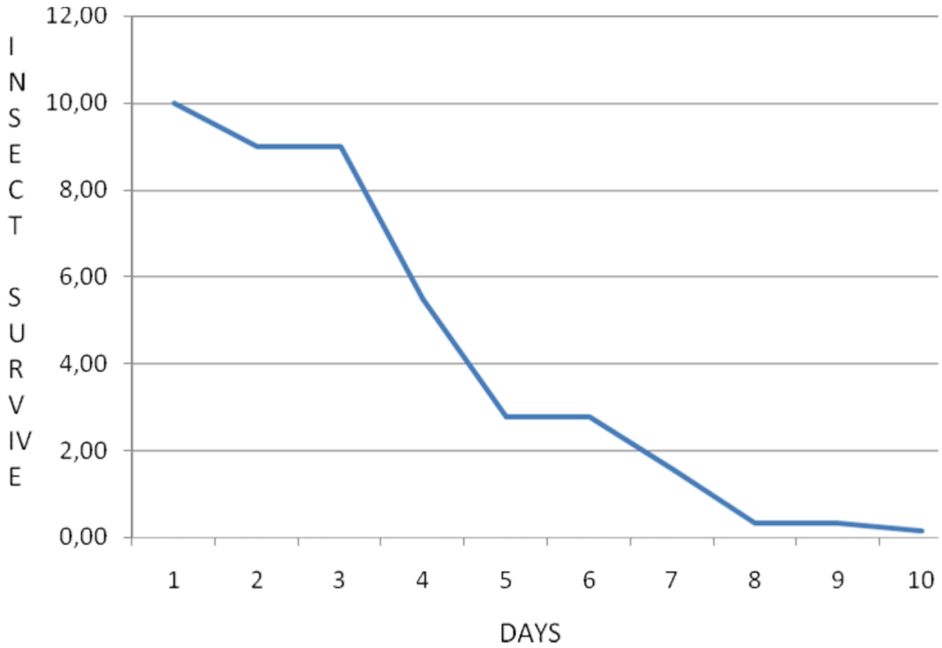


Figure 3. Lifespan of *Telsemia* sp. that was fed with sugarcane scale insect as feed

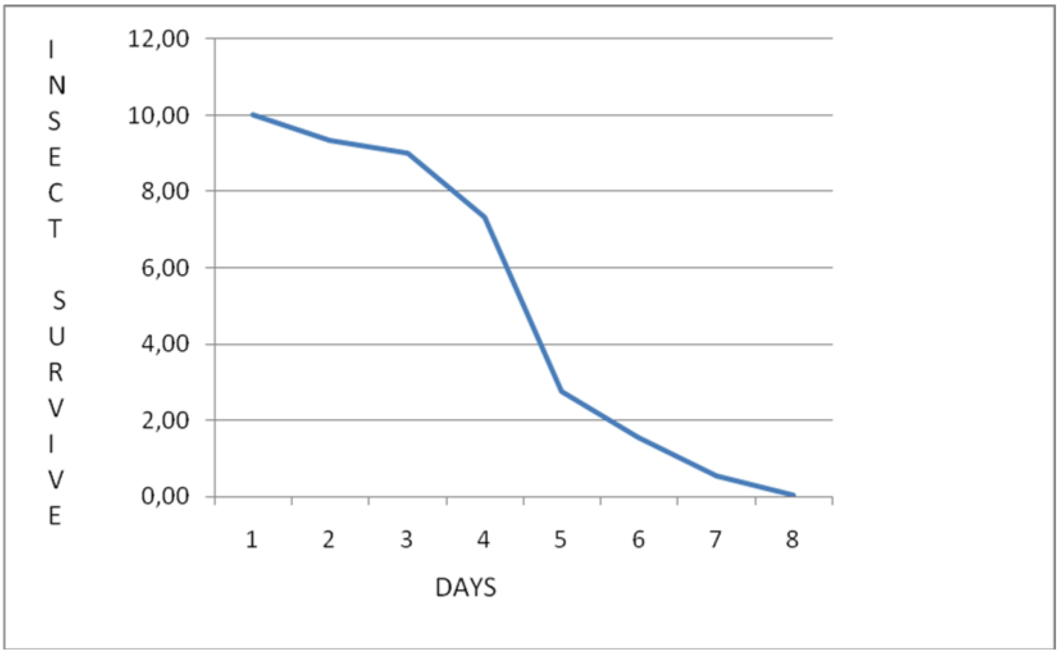


Figure 4. Lifespan of *Telsemia* sp. with aphids as feeds.

The average age of *Schymnus* sp. The average age of imago *Schymnus* sp. that was maintained with sugarcane scale insect as feed was 27.8 days, even some individualscouldreach 35 days. Those maintained with aphids as feeds had an average age of only 8.1 days. Based on observations at the end of maintenance with sugarcane scale insect as feed, only a few larvae of *Schymnus* sp. were found. The larvae were found to be less agile than those found in the field.

As a biological control agents such phenomena indicate that the predator *Schymnus* sp.could not adapt to the artificial environment. The observations further indicate that the resulting larvae molt failed and eventually died. As for the lifespan of*Schymnus* sp with sugarcane scale insect as feed was long enough, suggesting that they have the potential to become a biological agent. Lifespan of the predatory insect can be seen in Figure 5 and 6.

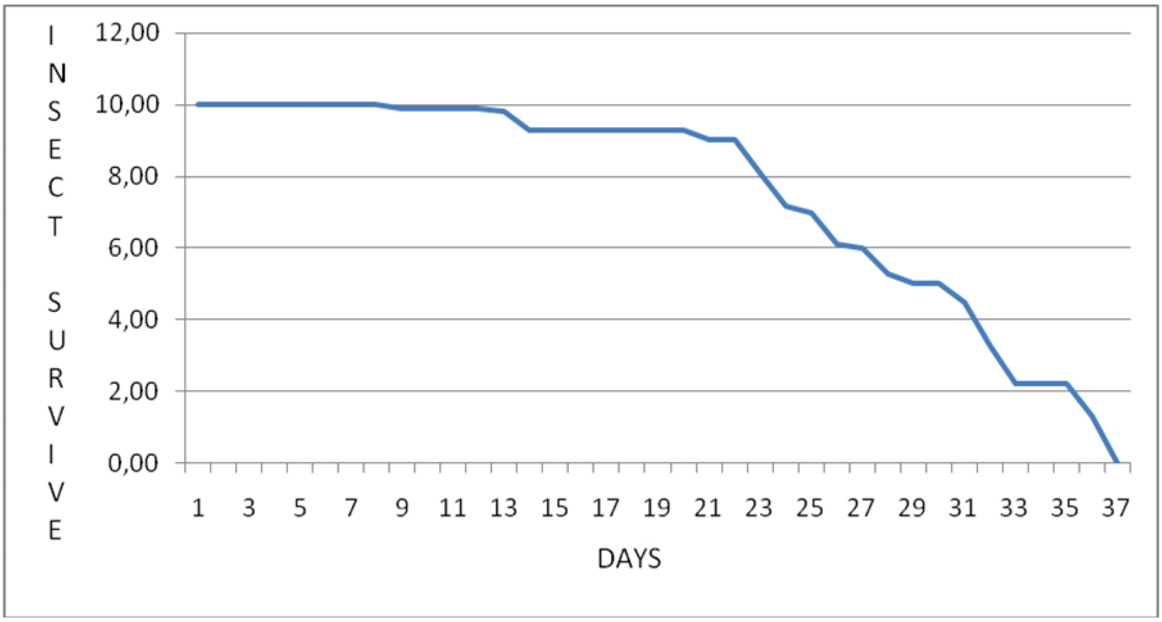


Figure 5. Long Lifespan of *Schymnus* sp. with sugarcane scale insect as feeds.

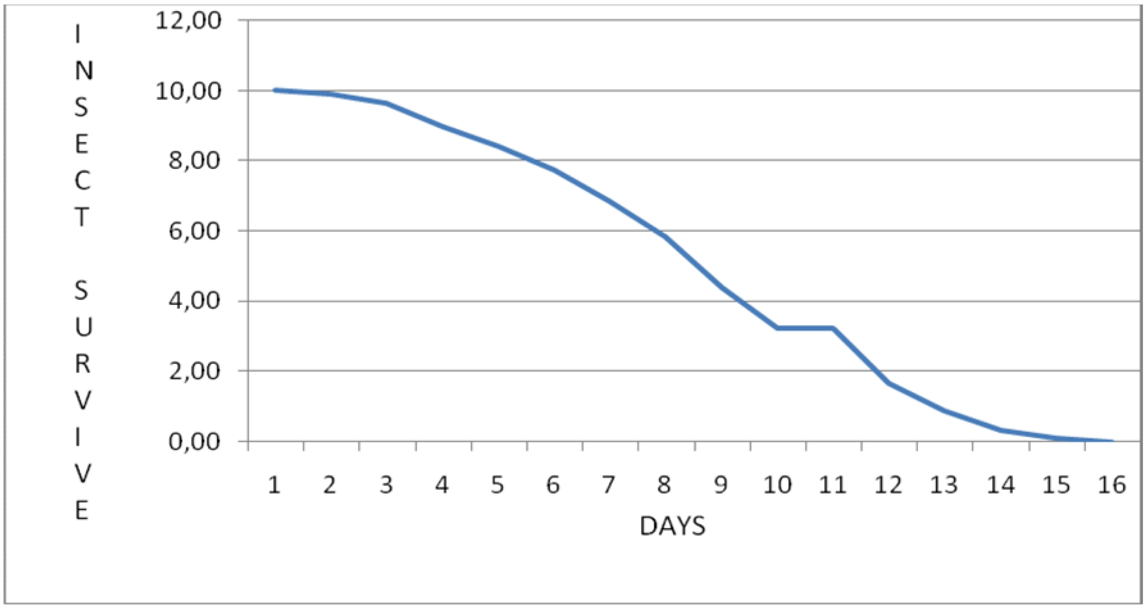


Figure 6. Lifespan of*Schymnus* sp. with aphids as feeds.

The third character of the predators showed that they responded differently to the original feed (sugarcane scale insect) and alternative feed (aphids). *Chilocorus* sp. and *Schymnus* sp. showed against alternative feed's favorite. *Telsemia* sp. was short-lived and do not produce offsprings. Chilocorus sp. with a cane scale insect as feed showed a relatively long lifespan and produce offsprings, while the imago Schymnus although had a relatively long lifespan but the offsprings are not agile and the larvae failed to change its skin (dead).

Chilocorus sp with sugarcane scale insects as feeds survived for an average of 27.2 days, *Telsemia* sp. 4.1 days and *Schymnus* sp. 27.8 days. While fed with alternative feed (aphids) *Chilocorus* sp survived 7.1 days, Telsemia sp 4.1 days and Schymnus sp 8.1 days.*Chilocorus* sp. is a predator that has the best and most potential characters bred as biological control agents.

REFERENCES

Research and Development PT Gunung Madu Plantations.2014.Kutu Perisai(*Aucalaspis tegalensis)*.Publikasi Intern Researchand Development PT Gunung Madu Plantations.

SAS Institute Inc. 1988.SAS/STAT User's Guide. Release 6.03 Edition. Cary, NC. 1028 pp.

Southwood, T.R.E. 1978. Ecological Methods with Particular Reference to the Study of Insect Populations . 2 nd ed. London: Chapman & Hall.

Sunaryo dan R. Hasibuan. 2003. Perkembangan Populasi Kutu Perisai *Aulacaspis Tegalensis* Zehnt dan Pengaruh Tingkat Serangannya terhadap Penurunan Hasil Tanaman Tebu di PT. Gunung Madu Plantation, Lampung Tengah. Jurnal Hama dan Penyakit Tropika. 3 (2) : 1 - 5.

Utomo, A.P. 2010. Populasi Hama Kutu Perisai (*Aulacaspis tegalensis*) pada Berbagai Klon dan Umur Tanman. Fakultas Pertanian Institut Pertanian STIPER. Yogyakarta.

Wagiman,F.X. 1996. Ecological Characteristics of Aphidophagous *Menochilus sexmaculatus* Fabricius and its Performance against Aphis gossypii Glover. Dissertation Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Agriculture, universiti Pertanian Malaysia.

Wagiman, F.X. 1996. Ecological Characteristics of Aphidophagous *Menochilussexmaculatus* Fabricius and its Performance against Aphis gossypii Glover. Dissertation Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Agriculture, universiti Pertanian Malaysia.

Wagiman, FX. 2010. Kinerja Predator *Chilocorus politus* Mengendalikan Eksplosi Hama Aspidiotuspada Kelapadi Kabupaten Lembata. Seminar HUT Perhimpunan Entomologi Indonesia (PEI) KE-40, 2 Oktober 2010 di Fakultas Pertanian UGM. Yogyakarta

Williams, J.R. 1970. Studies on the Biology, Ecology and Economic Importance of the Sugarcane Scale Insects *Aulacaspis tegalensis* Zehnt (Diaspididae) in Mauritanius. MSIRA. Reduit. Mauritanius. Bull. Ent. Res. 60: 61-95

POTENTIAL OF RICE ANALOGUES MADE FROM MODIFIED CORN FLOUR AND CASSAVA FLOUR PROCESSED BY GRANULATION METHOD AS FUNCTIONAL FOOD WITH LOW GLYCEMIC INDEX

BENI HIDAYAT[1)], SYAMSU AKMAL[1)], SURFIANA[1)]
AND BAMBANG SUHADA[2)]

[1)] Food Technology Studies Program, State Polytechnic of Lampung
Jln. Soekarno-Hatta No.10 Rajabasa, Bandar Lampung, Indonesia
[2)] Economy Faculty, Muhammadyah University of Metro
Jln. Ki Hadjar Dewantara No. 116 Iringmulyo, Metro, Lampung, Indonesia
*Corresponding email : beni_lpg@polinela.ac.id

ABSTRACT

Cassava-based rice analogues processed by granulation method characterized as a functional food that is reflected from low glycemic index (GI) value but has a lower protein content. Modified corn flour has the ideal characteristics to increase the protein content of rice analogues processed by granulation method (RAGM). The objective of this research was to evaluate the potential of the rice analogues made from modified corn flour and cassava flour as a functional food in terms of glycemic index values. The research was conducted in four stages: (1) preparation of modified corn flour and cassava flour, (2) making of rice analogues with granulation method on various formulations of modified corn flour and cassava flour, (3) analysis of functional components content, and (4) analysis of glycemic index value. The results showed that the RAGM made from modified corn flour and cassava flour has a low glycemic index value (29.47 to 30.26). The low glycemic index value is the contribution of the high content of dietary fiber (11.98% to 14.21%), resistant starch (4.13% to 6.12%), and the low digestibility of starch (10.23% to 10.37%).

Keywords: rice analogues, modified corn flour, glycemic index

INTRODUCTION

Rice analogues is processed products that can be made from partially or wholly non-rice ingredients. Rice analogues can be processed with various methods i.e. molding (Fitriana and Astuti, 2013), granulation (Hidayat et al., 2012), and extrusion (Noviasari et al., 2015; Mishra et al., 2012).

Hidayat et al. (2012) developed the rice analogues using granulation method known as *Beras Siger*. *Beras Siger* is cassava-based rice analogues which adopts the *Tiwul* (Indonesian

Traditional Rice Analogues) process but with better appearance (more uniform shape, brighter colors) and better flavor. *Beras Siger* is basically a instant *Tiwul* that has been modernized and processed mechanically using a chopper machine, grinding machine and granulator. According to Hidayat et al. (2016), cassava-based rice analogues processed with granulation method (RAGM) has characteristics as functional food, especially for consumers who undergo diabetic and cholesterol diet. Characteristics as functional food is especially apparent from the low glycemic index value of various variants of Beras Siger that are 34.21 to 37.50.

One of the limitations of cassava-based RAGM as a functional food is nutrient content particularly low protein. Corn starch is an ideal raw material to develop high-protein RAGM. The main problem of the corn flour usage in the manufacture of RAGM is difficult to form a homogeneous mixture.

According to Hidayat, et al. (2013), modified corn flour has the more ideal characteristics than conventional corn flour apparent from water absorption (2.58 g/g versus 2.24 g/g) and the solubility in water (0.58 g/ml versus 0.27 g/ ml).

The use of modified corn flour were able to increase the protein content of RAGM from 1.02% to 4.97% (Hidayat et al., 2015). Further research is needed to determine the potential of the RAGM made from modified corn flour and cassava flour as a functional food in terms of glycemic index values.

MATERIAL AND METHODS

Desain, Place, and Time

The experiment was conducted using a completely randomized design with 3 treatments, and each treatment was repeated six times. The experiment was conducted at the Process Engineering Laboratory, Physical and Chemical Analysis Laboratory of Department of Agricultural Technology, and Polyclinic of Lampung State Polytechnic. The experiment was conducted in October 2015 until May 2016.

Materials and Tools

The raw materials are yellow corn varieties Bisi II from Practice Gardens of Lampung State Polytechnic, harvested in July 2015; kasetsart varieties of cassava harvesting age 11 months was obtained from farmers in the Natar, South Lampung. The chemicals used include

DNS, maltose, α-amylase, glucoamylase, pepsin, pankreatin (Sigma Co., USA), as well as other chemicals.

The main tools were chopper (local product), wet grinder, disk mill grinder, sieve Tyler 20 mesh and 60 mesh, and granulator (local product). Some tools for analysis i.e. UV-Vis spectrometer (Shimadzu, Japan), glucometers "Easy Touch GCU" (CV Central Medika, Bandar Lampung), analitik scales, and other glass tools.

Stages of Research

The research consists of several stages : (1) production of rice analogues processed with granulation method (RAGM) on various formulations of modified corn flour and cassava flour, (2) analysis of the functional component of rice analogues, and (3) analysis of the glycemic index value of rice analogues.

Modified corn flour was prepared by the wet milling and pre-gelatinization method based on Hidayat et al. (2013), through the stages of sorting whole maize, coarse grinding (20 mesh), separation of the epidermis and core by soaking, wet milling, partial pre-gelatinization, drying followed by fine grinding (60 mesh). While cassava flour, obtained through the following stages: washing cassava, peeling, cutting in the form of chips with a thickness of ± 2 cm, soaking, drying, and grinding to obtain cassava flour 60 mesh. Production of corn rice analogues were done through the following stages: mixing corn starch modified with cassava flour according to treatment (amount of corn starch modification 0%, 50%, and 100% of the total mixture), granulating with granulator, steaming and drying to obtain instant rice analogues. Formulation of RAGM, are presented in Table 1.

Table 1. Formulation of RAGM made from modified corn flour and cassava flour

Formulasi	Modified Corn Flour (%)	Cassava Flour (%)	Water (%)
Modified Corn Flour 0%	0	100	45
Modified Corn Flour 50%	50	50	45
Modified Corn Flour 100%	100	0	45

Analysis of the functional component content included dietary fiber by enzymatic method and starch digestibility (Muchtadi et al., 1992), and resistant starch (Goni et al., 1996).

The tests of glycemic index value involving 10 volunteers who have been selected with the terms of healthy, non-diabetic, have normal level of fasting blood glucose (70-120 mg/dl) and value of Body Mass Index (BMI) in the normal range of 18.5 to 25 kg/m^2. The Tests was conducted based on the ethical clearance issued by the Faculty of Medicine, University of Lampung with number 1396/UN26/8/DT/2015.

Preparation of rice analogues were conducted by cooking using the rice cooker with ratio of rice analogues and water were 1 : 1. Measurement method of GI value of rice analogues was based on Rimbawan (2013) with some modifications, by providing rice analogues on an amount equivalent to 50 g of carbohydrates. Equality was calculated from the total carbohydrates by difference gained from the proximate analysis of rice analogues on various formulations (Table 2).

Table 2. Calculation of the amount per serving of rice analogues

Treatment	Carbohydrates content (%)	Amount per serving (gr)
Rice analogues from 0% modified corn flour and 100% cassava flour	79.4978	63 (rounding)
Rice analogues from 50% modified corn flour and 50% cassava flour	75.6463	66 (rounding)
Rice analogues from 100% modified corn flour and 0% cassava flour	71.2314	70 (rounding)

Before taking blood samples, volunteers were asked to fast for at least 10 hours in the evening except water. In the morning, as much as ± 5 ml of blood drawn through the fingertips volunteers to measure their blood glucose level using a Easy Touch GCU glucometer (*finger prick capillary blood sampel method*). Furthermore, the volunteers were asked to consume one portion of rice analogues and re-measured their blood glucose levels at minute 30, 60, 90, and 120 minutes after consumption. Measurement of blood glucose levels was done by a physician doctor of Polyclinic of Lampung State Polytechnic.

As standard testing, used 50 g of pure glucose. Blood sampling for determination of GI value of pure glucose performed on different days with a minimum interval of three days. Blood sampling for pure glucose made by the same procedure as the samples. GI value of each volunteer was calculated and averaged. The calculations of GI value is the division of the area under the glycemic response curve of samples with area under the glycemic response curve of standard glucose multiplied by 100%.

The data obtained is displayed in the form of average value ± standard deviation (Mean ± SD). Each analysis is performed six times repetition. Data analysis of dietary fiber, resisten starch and starch digestibility were Analyzed using ANOVA (analysis of variance) at α = 5%. While data of GI (glycemic index) value is the average value of the 10 volunteers.

RESULTS AND DISCUSSION

Dietary Fiber

The increasing of modified corn flour formulation will be significantly ($p < 0.05$) reduce the content of dietary fiber rice analogues processed with granulation method (RAGM) from 14.95% to 11.98% (Table 3). Reducing of the dietary fiber content is closely related to reducing of resistant starch content. The lower formation of resistant starch causes the lower amount of dietary fiber of RGM. According to AACC (2001), resistant starch is defined as the amount of degradation product of starch that can not be absorbed by the human intestine and are grouped into dietary fiber.

Compared to corn-based rice analogues processed by extrusion method, corn-based rice analogues processed by granulation method has higher dietary fiber content. Noviasari et al. (2015), reported that corn-based rice analogues use white corn as raw material which is processed by extrusion method has a total dietary fiber content of 5.35%. The decreasing of dietary fiber content of rice analog processed by extrusion method associated with the increasing of starch digestibility. According Budijanto et al. (2012), the perfection of gelatinization during the extrusion process will improve the starch digestibility of extrusion products.

Tabel 3. Functional components content of corn-based rice analogues on various formulations of modified corn flour

No	Functional components	Formulation		
		MCF 0%	MCF 50%	MCF 100%
1	Dietary fiber (%)	14.95 ± 0.90 a	14.21 ± 1.09 a	11.98 ± 0,81 b
2	Resistant starch (%)	7.78 ± 0.77 a	6.12 ± 0.44 b	4.13 ± 0.16 c
3	Starch digestibility (%)	17.65 ± 1.83 a	10.37 ± 0.73 b	10.23 ± 0.60 b

The number followed by the same letter are not significantly different at LSD, α = 5%

MCF = Modified Corn Flour

According to the CAC (2009), food can be referred to as a source of dietary fiber if it content at least 3% dietary fiber, and called high-fiber if it content minimum of 6% dietary fiber. Based on the statement, the RAGM from modified corn flour and cassava flour can be categorized as high-fiber foods. The high of dietary fiber content (11.98% to 14.21%) shows that RAGM from modified corn flour and cassava flour has the characteristics as functional food.

The Resistant Starch and Starch Digestibility

The increasing of modified corn flour formulation will be significantly ($p < 0.05$) reduce the resistant starch content of rice analogues processed with granulation method (RAGM) from 7.78% to 4.13% (Table 3). This is due to the formation of resistant starch in the cassava flour is higher than modified corn flour, associated with differences in the amylopectin content. The higher of the amylopectin content so the starch will be more difficult (resistant) to digest. According to Hidayat et al. (2015), modified corn flour has lower amylopectin than cassava flour i.e. 56.09% versus 84.68%.

Compared with corn-based rice analogues processed by extrusion method, rice analogues processed by granulation method (RAGM) made from modified corn flour and cassava flour has higher content of resistant starch. Noviasari et al. (2015), reported that corn-based rice analogues with white corn as raw material which is processed by extrusion method has a resistant starch content of 2.59%.

The high content of resistant starch (4.13% to 6.12%) shows that the RAGM made from modified corn flour and cassava flour has characteristics as functional food. Most of the resistant starch supposedly formed during the drying process stages after the cooking process due to starch retrogradation. Frederikson et al. (1998), reported that several types of starch has undergone retrogradation during storage after gelatinization process. According to Pereira et al (2014), resistant starch type 3 is the most important since their formation is a result of food processing. The amylose content, temperature, physical form, the degree of gelatinization, cooling, and storage affect its contents.

The increasing of modified corn flour formulation will be significantly ($p < 0.05$) reduce the starch digestibility of RAGM from 17.65% to 10.23% (Tabel 3). The lower of starch digestibility with higher modified corn flour formulation, related to the components of carotene in maize which act as antioxidants. According to Zeb and Mehmod 2004, carotenoids serve as a precursor of vitamin A, antioxidants, and increase endurance. Results of research Febrinda et al. (2013) showed that the extract antioxidant from onion bulbs Dayak has potential as an inhibitor of the enzyme alpha-glucosidase. Alpha-glucosidase is an enzyme that catalyzes the cutting glycosidic bonds in oligosaccharides. Glucosidase activity is fundamental for several biochemical processes such as the degradation of polysaccharides into monosaccharide units that can be absorbed and used by the body.

The Glycemic Index Values

The glycemic index is useful to determine the blood glucose response to the type and amount of food consumed (Rimbawan and Siagian, 2004). Low GI food has potential as a functional food to substitute rice as a staple food for diabetic mellitus patients whose the number are increasing day after day

The increasing of modified corn flour formulation will reduce glycemic index value of rice analogues processed with granulation method (RAGM) from 36.84 to 29.47 (Table 4). The lower glycemic index value with higher corn flour formulation related to the lower of starch digestibility, the higher of dietary fiber content, and the higher of resistant starch content.

Table 4. Glycemic index value of rice analogues on various formulation of modified corn flour

No	Formulation	The area of the glucose curve	The area of the sample curve	Glycemic Index Value
1	Modified Corn Flour 0%	760 ± 14.49	280 ± 16.14	36.84 ± 2.44
2	Modified Corn Flour 50%	760 ± 14.49	230 ± 15.27	30.26 ± 2.39
3	Modified Corn Flour 100%	760 ± 14.49	224 ± 10.98	29.47 ± 1.46

Based on Table 4, RAGM made from modified corn flour and cassava flour has a low of GI value (29.47 to 30.26), lower than paddy rice which has a moderate and high GI value/over 50 (Purwani et al., 2007), brown rice with a GI value of 59 and black rice with a GI value of 42.3 (Mahmud and Zulfianto, 2009), white corn-based rice analogues with GI value of 69 and white corn rice analogues with supplementation of soybean flour 10% with a GI value of 50 (Noviasari et al., 2015).

The content of dietary fiber, resistant starch, and starch digestibility are all factors that interact to cause the analog corn-based rice has a low glycemic index value.

Resistant starch is included in insoluble dietary fiber, but has properties such as soluble dietary fiber. Resistant starch has slow digest so that the release of glucose in slowdown process. According Sajilata et al. (2006), resistant starch metabolism occurs 5-7 hours after ingestion. Digestion of resistant starch for 5-7 hours will increase the period of satiety so can reduce the IG value.

According Elleuch et al. (2011), water-soluble dietary fiber can decrease the glycemic response through the mechanism of the formation matrix beyond the starch granules that can inhibit the digestion of carbohydrates. Dietary fiber, especially dietary fiber water soluble can reduce the response of blood glucose caused by (1) an increase in viscosity in the stomach thereby slowing down the emptying of the stomach or intestines and cause a decrease in the amount of carbohydrates that can be digested (barrier against the enzyme) and simple sugars that can be absorbed, (2) dietary fiber causes changes in hormone levels in the digestive tract, absorption of nutrients and insulin secretion, (3) dietary fiber helps improve insulin sensitivity, stabilize blood glucose levels thereby protecting complications from diabetic (Alvarez and Sanchez, 2006).

Rice analogues made from modified corn starch and cassava flour which processed by granulation method has a low glycemic index value (29.47 to 30.26). The low glycemic index value is the contribution of the high content of dietary fiber (11.98% to 14.21%), resistant starch (4.13% to 6.12%), and the low digestibility of starch (10.23% to 10.37%).

ACKNOWLEDGMENT

The authors would like to thanks to the Directorate of Research and Community Services, the Ministry of Research, Technology and Higher Education, for funding this research through the Higher Education Competitive Research scheme in 2015 and 2016.

REFERENCES

American Association of Cereal Chemist (AACC). 2001. The Definition of Dietary Fiber. Cereal Foods World.

Alvarez, E.E., and Sanchez, P.G. 2006. Dietary fiber. *Journal of Nutrition Hospital*, **21(2)**:60-71.

Budijanto, S., Sitanggang, A.B., Wiaranti, H., and Koesbiantoro, B. 2012. Pengembangan Teknologi Sereal Sarapan Bekatul dengan Menggunakan Twin Screw Extuder. *J. Pasca Panen*, **9(2)**: 63-69.

[CAC] Codex Alimentarius Commission. 2009. Appendix II. Report of the 30th Session of the Codex Committee on Nutrition and Foods for Special Dietary Uses. South Africa 3 – 7 November 2008]. Rome (IT): FAO. hlm 46. http://www.codexalimentarius.net. [diunduh 30 Mei 2016].

Elleuch M., Bedigian, D., Roiseux, O., Besbes, S. Blecker, C., and Attia, H. 2011. Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: A review. *Journal of Food Chemistry* **124:**411-421.

Febrinda, A.E., Astawan, M., Wresdiyati, T., and Yuliana, N.D. 2013. Kapasitas Antioksidan dan Inhibitor Alfa Glukosidase Ekstrak Umbi Bawang Dayak. *J. Teknologi dan Industri Pangan*, **24(2)**: 161-167.

Fitriani, A.A.N. and Astuti, N. 2013. Pengaruh Proporsi Tepung Jagung dan Mocaf Terhadap Kualitas "Jamof Rice" Instan ditinjau dari Sifat Organoleptik. *Jurnal Boga dan Gizi*, **2(3)**: 34-43.

Fredricson, H., Silverio, J., Anderson, R., Elliason, A.C., and Aman, P. 1998. The Influence of Amylose and Amylopectin Characteristic and Gelatinization and Retrogradation Properties. *J. Carbohydrate Polymers*. **35**:119-134.

Purwani, E.Y., Yuliani, S., Indrasari, S.D., Nugraha, S., and Tahir, R. 2007. Sifat Fisiko-Kimia Beras dan Indeks Glikemiknya. *Jurnal Teknologi Industri Pangan*, **18(1)**: 59-66.

Goni, L., Gracia-Diz, L., and Saura-Calixto, F. 1996. Analysis of Resistant Starch: Method of Food Product. *Journal of* Agricultural and Food Chemistry. **56(4)**: 445-449.

Hidayat, B., S. Akmal, dan B. Suhada. 2016. *Beras Siger (Tiwul/Oyek yang Telah Dimodernisasi) sebagai Pangan Fungsional dengan Kandungan Indeks Glikemik Rendah*. Seminar Nasional Pangan Fungsional dalam Rangka Memperingati Hari Tempe Sedunia. Bandar Lampung, 28 Mei 2016.

Hidayat, B., S. Akmal, and Surfiana. 2015. Kajian Potensi Beras Siger (Tiwul Instan) Fortifikasi sebagai Pangan Fungsional. *Prosiding Seminar Nasional Swasembada Pangan*. Politeknik Negeri Lampung 29 April 2015. ISBN 978-602-70530-2-1, halaman 467-473.

Hidayat, B., Nurbani Kalsum, and Surfiana. 2013. Karakterisasi Tepung Jagung Modifikasi yang Diproses Menggunakan Metode Pragelatinisasi Parsial. *Prosiding Seminar*

Nasional Sains dan Teknologi V "Satek dan Indonesia Hijau". Universitas Lampung, 19-20 November 2013, ISBN 978-979-8510-71, halaman 884-891.

Hidayat, B., Yatim Rahayu W., and Hertini Rani. 2012. *Kajian Ilmiah Peningkatan Kualitas Tiwul Tradisional*. Kontrak Nomor 800/893.1/II.05/2012. Badan Ketahanan Pangan Daerah Provinsi Lampung.

Mahmud, M.K. and Zulfianto, N.A. 2009. Tabel Komposisi Pangan Indonesia. Elex Media Komputindo. 64 halaman.

Mishra, A., Mishra, H. N., and Rao, P.S. 2012. Preparation of Rice Analogues using Extrusion Technology, Review. Int. J. of Food Science and Technology, **doi:10.1111/j.1365-2621.2012.03035.x**

Muchtadi, D., Palupi, N.S., and Astawan, M. 1992. *Petunjuk Laboratorium: Metode Kimia Biokimia dalam Evaluasi Nilai Gizi Olahan Pangan*. PAU Pangan dan Gizi Institut Pertanian Bogor. 246 halaman.

Noviasari, S., Kusnandar, F., Setiyono, A., and Budiyanto, S. 2015. Beras Analog sebagai Pangan Fungsional dengan Indeks Glikemik Rendah. J. Gizi Pangan, **10(3)**: 225-232.

Pereira, B.L.B. and Leoneli, M. 2014. Resistant Starch in Cassava Product. J. of Food Science and Technology, **doi:10.1590/fst.2014-0039.x**

Rimbawan, and Siagian, A. 2004. Indeks Glikemik Pangan, Cara Mudah Memilih Bahan Pangan yang Menyehatkan. Penebar Swadaya. Jakarta. 124 halaman.

Rimbawan. 2013. *Indeks Glikemik Pangan*. Makalah Kuliah Umum Staf Deputi III BPOM RI Tanggal 27 Desember 2013. 76 halaman.

Sajilata, M.G, Singhal, R.S., and Kulkarni, P.R. 2006. Resistant starch-a review. Comprehensive Reviews in Food Science and Food Safety, **5(1)**:1-17.

Zeb, A. and Mehmood, S. 2004. Carotenoid Contents from Various Sources and Their Potential Health Applications. Pakistan Journal of Nutrition, **3(3)**: 199-204.

PERFORMANCE OF SINGLE-CROSS MAIZE HYBRIDS FROM DIVERSE CROSS COMBINATION OF PARENTAL INBRED LINES IN ACID SOIL CONDITIONS

P.K. DEWI HAYATI *1), SUTOYO1) AND TEGUH BUDI PRASETYO2)

1Plant Breeding section, Department of Agrotechnology,
2Department of Soil Science, Faculty of Agriculture, Andalas University
*pkdewihayati@yahoo.com

ABSTRACT

Maize is one of the strategic commodities in Indonesia that receive special attention to be enhanced due to food security and sovereignty. Utilizing high yielding maize varieties along with sustainable agronomic practices offer an effective strategy for improving maize productivity in acid soils. Ten single cross hybrids derived from a diverse tropical inbred lines and two check varieties were evaluated in two locations with two acid soil conditions in order to obtain hybrids that produce high yield in acid soils. The evaluations were carried out in a randomized complete block design with three replications during 2014 – 2015. The locations were in Padang with two soil conditions, *i.e.* limed- and unlimed-acid soil with the order Ultisol and in West Pasaman with two soil conditions, *i.e.* a good soil with the order Andisol and natural acid soil with the order Ultisol. Data were subjected to the analysis of variance using the Proc GLM of the SAS software. Results showed that there was no hybrid that consistently produced high yield in all soil acidity conditions. The hybrids that produced high yields in acid soil conditions produced lower yields in a good soil compared to the commercial hybrid check variety.

Key words: maize, single-cross hybrid, inbred lines, acid soil tolerance

INTRODUCTION

Maize in an important commodity in the economy and national food security due to the high demand for it as human food, animal feed and raw materials for industrial products. The importation of grain maize kept increasing in the past one decade (Indonesia Investment, 2015). Hence, efforts to improve the productivity of maize become a necessity in order to attain national food security and sovereignty.

The extension of planting area and intensification efforts were needed to attain self-sufficiency of maize. However, the extension of planting area can only be practiced on marginal land such as acid soils. Acid soil which are classified as Ultisol are widespread in Indonesia (Subagyo *et al*, 2000), mainly in Sumatera and Kalimantan islands. This soil is highly weathered soil that have low pH, low cation exchange capacities, high soil solution aluminum (Al) concentration and low basic cations, mainly Ca and/or Mg (Shamshuddin and Ishak, 2010). Al toxicity is being a major constraint of maize production in acid soils if compared to other factors. Acid soil is being used extensively for oil palm and rubber plantations. However, maize as cash crop or intercrop during the early years of the crops, generally produces low yield in acid soil.

Although acid soil has potential in terms of the acreage, it also has low level soil fertility. Several management practices such as application of lime and organic matter are needed to make the soil become as productive as any other good soil (Shamshuddin dan Ishak *et al*, 2010). However, they also have several limitations in used as reported by Shamshuddin *et al* (1998) and Hede *et al* (2002). Planting maize hybrid varieties tolerant to acid soils along with the use of sustainable agronomic practices is one of the strategies for improving maize productivity in acid soils.

Hybrid is a first generation of cross between two parental inbred lines that have different genetic background. The hybrid variety produces high grain yield, possesses uniform plant and matures reasonably early as compared to the parental inbred lines and the open-pollinated varieties. Hybrids also perform high tolerance to environmental stress, including acid soil conditions (Dewi-Hayati *et al*, 2015).

A series of research which was an extensive maize breeding program have been done to obtain hybrids tolerant to acid soil. The program has been initiated by utilizing diverse tropical grain maize populations from open-pollinated and hybrid varieties, local cultivar and introduced lines as germplasm sources in the formation of base populations since 2008. Maize inbred lines obtained from the populations were screened for tolerance to acid soil to obtain inbred lines tolerant to acid soil (Dewi-Hayati dan Armansyah, 2011). The inbred lines then were crossed in a diallel mating scheme to produce single-cross hybrids (Dewi-Hayati *et al,* 2014). This research was the on-going program carried out to evaluate agronomic and yield performance of several single-cross hybrids in acid soil conditions and to obtain single-cross hybrids tolerant to acid soils.

MATERIALS AND METHODS

The research was carried out in two locations, namely Padang and West Pasaman during 2014 – 2015. Evaluation of the hybrids in Padang was conducted in two acid soil conditions, *i.e.* naturally acid soil with the order Ultisol and acid soil ameliorated by ground magnesium limestone at the rate of 2 t ha^{-1}. Meanwhile, the evaluations in West Pasaman were conducted in two different order of soil *i.e.* a good soil with the order Andisol and acid soil with the order Ultisol.

The genotypes evaluated were ten single-cross hybrids selected from 66 hybrids obtained from cross combinations of 12 maize parental inbred lines in the diallel mating scheme and the two check varieties, namely the composite variety Sukmaraga that was reported as acid soil-tolerant variety (ICERI, 2004) and one commercial hybrid variety (Table 1). The hybrids selected based on their good specific combining ability on grain yield evaluated in acid soil. The experiments were arranged in a randomized complete block design with three replications. Each genotype was planted as four 4-meter long rows with a spacing of 25 cm x 65 cm.

Table 1. The genotypes evaluated and their pedigree

No	Genotypes	Pedigree (Parental inbred lines)
1	H6	SgM9 x Gg4.1
2	H8	P1.2 x Gg4.1
3	H13	SgM6 x Lgu2
4	H16	SgM9 x Lgu2
5	H21	SgB3.3 x Lgu2
6	H31	SgB1 x SgM6
7	H34	BH 1 x SgM6
8	H35	P1.2 x SgM6
9	H45	SgB3.3 x SgB1
10	H51	SgB3.3 x Uq 3.1
11	Sukmaraga	
12	Commercial Hybrid	

Fertilizers were applied at the rate of 150 kg N ha^{-1}, 120 kg P_2O_5 ha^{-1} and 100 kg K_2O ha^{-1} in the form of urea, SP36 and KCl. Urea is applied in split at 14 and 30 days after planting, while SP36 and KCl fertilizers were totally given at 14 days after planting. The cultivation was conducted as standard cultural practices. The traits observed were plant height, ear height, 50% days of tasseling and silking and grain yield per hectare after being converted to 15% moisture content.

Data were analyzed using the variance F test, whereas the mean comparisons were performed using Duncan New Multiple Range test at 5% level. Various Selection indices were determined based on the formula suggested and calculated using Proc GLM of the Statistical Analysis System (SAS) computer software (SAS/STAT, 2003).

RESULTS AND DISCUSSION

Based on the chemical soil properties, there were four level of soil acidity conditions from both two locations *i.e.* high level soil acidity which was natural acid soil with the order Ultisol in each location and low level soil acidity which was limed Ultisol soil and a good soil as the order of Andisol (Table 2). Amelioration of acid soil with the ground magnesium limestone (GML) increased the soil pH and decreased the exchangeable aluminum in the soil solution, however, the application of GML at the rate 2 t/ha was not enough to alleviate total aluminum in the soil solution. Based on the criteria of the soil pH (Hardjowigeno, 2000), limed-acid soil is characterized as acidic with a higher pH than the initial soil pH that is characterized as very acidic. Meanwhile, the soil pH criteria for the Andisol order soil in the West Pasaman was less acidic eventhough the exchangeable aluminum was not detected in that soil.

Table 2. The chemical soil properties

Soil properties	Padang		West Pasaman	
	Limed Ultisol	Acid Ultisol	Andisol	Ultisol
pH $_{(H2O)(1:1)}$	5.30	4.50	5.83	4.90
CEC ($cmol_c kg^{-1}$)	20.30	20.03	37.53	20.01
P (ppm)	4.30	4.03	32.50	4.01
Ca ($cmol_c kg^{-1}$)	1.52	0.20	8.54	0.91
Mg ($cmol_c kg^{-1}$)	0.55	0.44	1.61	0.74
K ($cmol_c kg^{-1}$)	0.29	0.30	0.78	0.28
Na ($cmol_c kg^{-1}$)	0.43	0.41	0.21	0.49
Al ($cmol_c kg^{-1}$)	1.02	2.95	nd	1.37
Al sat. (%)	0.27	0.69	nd	0.36

nd: not detectable

The cation exhange capasity (CEC) of soil varied in each soil acidity. Amelioration of acid soil improved the CEC into 20.3 $cmol_c kg^{-1}$. However, the CEC of the Ultisol were in the criteria as moderate. Only Andisol showed high level of the CEC. Similar to the CEC, Andisol also contained higher phosporous and basic cation concentration in the soil. The phosporous criteria for Andisol was low, while another acid soils had very low of phosporous concentration. Calcium and magnesium concentrations were moderate which was better than low criteria for those in acid soil conditions. Meanwhile, the concentration of the aluminum in the soil solution was not detected, indicating that the soil has better chemical soil properties.

Results of the analysis of variance in each soil condition showed the effects of genotypes on yield, while the combined analysis showed the effects of soil acidity, genotype, and interaction between genotype and soil acidity. This indicated that the ranking of the hybrids varied with different soil acidity conditions. Since the error variance in each soil acidity conditions were not homogenous, the means of genotypes were performed in each soil condition (Table 3).

Table 3. Grain yields (tonnes/ha) of single-cross hybrid evaluated in two locations and two acid soil conditions

Genotypes	All location & condition	Limed Ultisol (Padang)		Acid Ultisol (Padang)		Andisol (WPasaman)		Acid Ultisol (WPasaman)	
	……………………………. t/ha …………………………….								
H6	4.91	5.74	ab	3.55	ab	7.06	d	3.31	d
H8	5.86	6.03	a	3.68	a	9.39	ab	4.38	abc
H13	5.34	5.88	ab	3.60	a	8.32	bcd	3.56	cd
H16	5.58	5.31	ab	3.59	a	9.44	ab	3.97	bcd
H21	5.63	6.10	a	3.49	ab	7.86	cd	5.09	a
H31	5.76	5.59	ab	3.20	abc	9.11	abc	5.15	a
H34	5.37	5.47	ab	3.30	abc	7.79	cd	4.93	ab
H35	5.61	5.65	ab	3.83	a	8.64	abc	4.32	abcd
H45	5.30	4.97	ab	2.46	c	8.75	abc	5.01	ab
H51	5.42	5.29	ab	3.38	abc	8.68	abc	4.33	abcd
Sukmaraga	5.14	5.16	b	2.62	c	7.85	cd	4.92	ab
Commercial Hybrid	5.75	6.05	a	2.47	c	9.89	a	4.59	abc
c.v.		7.70		14.90		8.20		12.80	

Grain yields of the hybrids varied greatly within acid soil conditions and locations, in which different hybrids were found to have high yield performance in the different acid soil conditions and locations. The grain yields of the hybrids on limed-soil condition and the Andisol generally higher than that on acidic soils. Grain yields of the hybrids in Andisol was the highest, indicating that the soil condition was considered optimum for growth and yield of maize.

The grain yield in each soil acidity condition decreased with the increasing amount of exchangeable aluminum. The reduction of grain yields in acid soil varied greatly within hybrids and acid soil conditions. The reduction of grain yield in Padang ranging from 32 to 51%, while that in West Pasaman ranging from 35 to 58%, indicating the high difference of soil acidity level in West Pasaman.

Hybrid H21, H31 and H45 produced higher yields around 5 t/ha in acid soil in Pasaman. However, their production was still similar to grain yield of the commercial hybrid and the composite variety Sukmaraga as the check varieties. On the contrary, even though several single-cross hybrids, namely H8, H16, H31 produced higher yields than those of other single-cross hybrids which exceeded 9 t/ha, there was no single-cross hybrids produced the highest yield in a good soil (Andisol). This indicated that the commercial hybrid produces high yield in a good soil.

Evaluation of hybrids in acid soil in Padang showed that several single-cross hybrids produced higher yields compared to the two check varieties, however only hybrid H21 that produced high yield consistently in acid soil in two locations. Meanwhile, only two hybrids, namely H8 and H21 produced high yields around 6 t/ha similar to yield of the commercial hybrid in limed-soil.

The good hybrids perform ear height in the middle of the plant height. The increasing of soil acidity reduced ear height and plant height (Table 4). The reduction of plant height in Padang ranging from 0 to 15 cm, while that of ear height ranging from 1 to 29 cm. Meanwhile, the reduction of plant height in West Pasaman ranging from 28 to 47 cm, while that of ear height ranging from 45 to 64 cm, indicating that the reduction of height in ear is higher than that in plant height. All hybrids and the two check varieties in acid soil in West Pasaman performed ear height was beneath the mid of ear height.

The anthesis-silking interval (ASI) is an important trait to ensure the synchronous of female and male flowering time, thus it is crucial to ensure the synchronous of pollination.

The increase of soil acidity prolonged the anthesis-silking interval that affected yields. Hybrids performed longer anthesis-silking interval in acid soil compared to that in a good soil.

Table 4. Plant and ear heights (cm) of single-cross hybrids evaluated in two locations and two acid soil conditions

Genotypes	Limed ultisol (Padang)		Acid ultisol (Padang)		Andisol (WPasaman)		Acid Ultisol (WPasaman)	
	PH	EH	PH	EH	PH	EH	PH	EH
	………………………….. cm ………………………………..							
H6	195.0	89.5	188.5	88.6	227.1	111.7	129.7	49.0
H8	171.0	72.0	156.2	66.6	217.9	104.6	121.1	43.5
H13	205.1	105.8	200.3	105.7	251.0	150.2	132.6	54.1
H16	188.6	86.5	168.2	72.4	226.3	115.4	145.1	59.1
H21	196.0	92.8	196.1	90.7	229.1	132.3	165.8	73.1
H31	203.0	102.9	176.0	79.9	230.1	126.3	151.7	66.7
H34	192.4	91.8	166.7	68.6	222.1	115.8	146.1	54.6
H35	198.6	94.2	194.9	88.8	222.4	122.4	146.8	60.7
H45	187.8	90.8	159.9	64.9	239.9	133.3	139.5	62.0
H51	183.5	87.5	172.0	75.8	235.5	130.2	148.3	62.6
Sukmaraga	187.2	82.8	157.2	56.2	237.3	133.1	155.6	71.9
Commercial Hybrids	175.5	71.4	175.4	58.2	226.6	123.7	123.8	54.3

PH = plant height and EH = Ear height

Table 4. Days to tasseling and days to silking of single-cross hybrids evaluated in two soil locations and two soil acidity conditions

Genotypes	Limed ultisol (Padang)		Acid ultisol (Padang)		Andisol (WPasaman)		Acid Ultisol (WPasaman)	
	DT	DS	DT	DS	DT	DS	DT	DS
H6	59.3	60.7	59.7	61.3	58.3	59.7	59.3	63.7
H8	59.0	59.0	64.3	67.3	56.0	57.3	62.3	66.0
H13	60.0	62.3	60.7	62.7	57.7	60.3	60.0	63.7
H16	63.0	64.3	64.3	66.3	57.0	59.7	59.3	63.7
H21	56.3	56.3	61.0	62.7	55.3	56.3	58.0	59.7
H31	56.7	57.3	65.3	67.3	56.3	58.0	60.3	62.3
H34	59.3	59.7	59.3	61.7	55.7	56.7	57.0	59.7
H35	60.7	61.0	62.7	65.3	56.7	58.3	63.7	66.7
H45	64.3	67.0	67.0	70.0	62.0	64.0	64.7	67.0
H51	61.0	64.0	63.3	67.3	59.3	61.3	62.0	65.0
Sukmaraga	61.0	64.3	69.3	71.0	59.3	61.3	61.7	65.0
Commercial Hybrids	61.0	64.3	69.3	71.3	59.7	61.7	65.0	66.3

It can be concluded that there was no single-cross hybrid that consistently produced high yield in all soil acidity conditions. The hybrids that produced high yield in acid soil conditions, produced lower yield in a good soil compared to the commercial hybrid. Among the single-cross hybrids, hybrid H21was consistently produced high yield in acid soil conditions.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the Ministry of Research, Technology and Higher Education, Government of Indonesia and The Research and Community Services Institution of Andalas University for PUPT scheme 2015 – 2016. The authors also thank Mr. Tatang Subianto for his excellent technical assistance.

REFERENCES

Dewi-Hayati, P.K. dan Armansyah. 2011. Evaluation of aluminum tolerance on maize inbred lines derived from sukmaraga variety. *J. Agrotropical* 1(2):1-9.

Dewi-Hayati, P.K., G. Saleh and J. Shamshuddin. 2015. Breeding of Maize for Acid Soil Tolerance: Heterosis, combining ability and prediction of hybrid based on SSR markers. Scholar's Press, OmniScriptum GmbH & Co, Saarbrucken, Germany. 173 pages.

Dewi-Hayati, P.K., Sutoyo, A. Syarif, and T. Prasetyo. 2014. Performance of Maize Single-Cross Hybrids Evaluated on Acidic Soils. J. on Advanced Sci.Eng. Information Tech.4(3):31-33

Hardjowigeno, S. 2010. Ilmu Tanah. Akademika Pressindo. Jakarta.

Hede, A.R., B. Skovmand, J.M. Ribaut, D. Gonzáles-de-León and O. Stølen. 2002. Evaluation of aluminum tolerance in a spring rye collection by hydroponic screening. *Plant Breeding* 121:241-248.

ICERI, 2004. *Innovation of Maize Technology. Indonesian Cereals Research Institute*. Maros, Sulawesi. Indonesia.

Indonesia Investments. 2015. Corn production and consumption in Indonesia: Aiming for self-sufficiency.www.indonesia-investments.com/news/news-columns/corn-production-consumption-in-indonesia-aiming-for-self-sufficiency/item5800 [10 April 2016]

SAS/STAT® User's Guide. Ver. 9.1. SAS Institute Inc. Cary, NC., 2003.

Shamshuddin, J., H.A.H. Sharifuddin an.d L.C. Bell. 1998. Longevity of ground magnesium limestone applied to an Ultisol *Commun. Soil Sci. and Plant Anal.* 26(9&10):1299-1313.

Shamshuddin, J and C.F. Ishak. 2010. Wheathered tropical soils. The ultisol and oxisol. UPM Press. 147 p.

Subagyo, H., N. Suharta, and A.B. Siswanto. 2000. *Tanah-Tanah Pertanian di Indonesia.* Pusat Penelitian Tanah dan Agroklimat, Bogor, Indonesia. 2000.

THE EFFECT OF MAGNETIC FIELD EXPOSURE TO MEDIUMON PROTEASE PRODUCTION OF *Bacillus* sp. IN QUALITATIVE TEST

AJENG PRATIWI[1], SUMARDI[2] AND ROCHMAH AGUSTRINA[2]

[1)]Postgraduate Student at Department of Biology, Faculty of Mathematics and Science, Lampung University
[2)]Lecturer at Department of Biology, Faculty of Mathematics and Science, Lampung University
Department of Biology, Faculty of Mathematics and Science, Lampung University.
Jl. Prof.Dr.SoemantriBrojonegoro No.1, Bandar Lampung, Indonesia,25145
ajengdewanto24@gmail.com

ABSTRACT

Protease enzyme is highly needed by various field in recent life, such as in food industry, textile industry, and health industry. Therefore, various efforts in order to improve the production of protease for more quantity and less time are worth it. One of environmental factors which can stimulate the Protease production is magnetic field. This research was purposed to understand the effect of 0.2mT magnetic field exposure treatment for 10 minutes toward medium components to the production of Protease in *Bacillus* sp. That magnetic field exposure treatment was given to 8 medium components namely Milk, Yeast, NaCl, KH_2PO_4, $MgSO_4$, $(NH_4)_2SO_4$, Nutrient Agar andAquadest. Proteolytic Index was used as the indicator for protease productivity in *Bacillus*sp.Data from Qualitative Proteolytic Activity test on*Bacillus* sp. indicated that in all treatment, the bacteria were able to produce the enzyme. The highest Proteolytic Index (IP) from all those treatments came from the magnetically exposed KH_2PO_4 which was 5.64 at the 10th incubation hour and 3.68 in the 18th incubation hour.

Keywords: protease, *Bacillus* sp., magnetic field

INTRODUCTION

Protease is an enzyme which catalyzes the process of breaking the peptides bond in protein in order to be amino acid so that it could be absorbed easier by the body. Amino acid which is soluble in water is also substrate for bacteria which produce acidogenesis andacetogenesis organic acid (Purwati et al., 2011). Commercially, protease gets the first highest rank among any other enzyme and gets more than 60% enzyme market share. Protease is hugely utilized in industries of pharmacy, detergent, dairy, bread and soy bean (Fuad et all, 2004).

Almost 100% Indonesia need of Protease is covered by imported product. The import quantity of protease also gets higher through the years. Several factors or conditions affect the growth of bacteria. Some of them are the minerals, the temperature and the time of incubation.

According to Baehaki (2011), *Bacillus* sp. is one among all kind of bacteria which is capable to produce Protease. *Bacillus* sp. plays a significant role in the development of enzyme production because of some reasons namely:

a) It is easy to breed and has various habitation such as psychrophilic, mesophilic, thermophilic, alkalophilic, neutrophilic, acidophilic, and
b) It is easy to be isolated from many environment and able to reproduce in synthetic medium.(Johnvesly and Naik, 2001).

Bacillus sp. which is bred in alkaline environment produces higher proteolytic enzyme rather than if the bacteria is bred in neutral environment (Soeka, 2011).

Magnetic field exposure to microorganism affects the growth characteristic and the amount of cells at stationary phase. Magnetic field can affect all components of the microorganism cell membrane which then interact to each other so that it can stimulate the enzyme activity (Muhammad, 1997). 60 minutes exposure of magnetic field with 50 Hz frequency and 10 mT strength affects the morphology of gram-negative *Escherichia coli* and gram-positive *Denitrificans Paracoccus* due to the size increment of those bacteria colony cells. The effect of magnetic field exposure is quicker to be observed in the treatment with nutrient agar medium rather than with liquid broth (Fojt et al., 2009). Treatment of 0.2 mT magnetic field increases the growth rate and affects *Magneto spirillum magneticum* AMB-1 strain in responding stimulus (Chen et al., 2010).

In thisresearch, the observation was purposed to understand the effect of exposing culture mediums with 0.2mT magnetic field to the size and the activity of *Bacillus* sp. in producing protease enzyme.

RESEARCH METHOD

Substance and Equipment

Bacillus sp. isolate was obtained from breeding collection in Laboratory of Microbiology Faculty of Mathematics and Science UNILA. The culture medium used in this research was modified Mendels medium Mendels and Elwyn, 1956). Other supporting substances in this research were Phosphate buffer, standard Tyrosine, Aquadest, TCA (Trichloroacetic Acid), Na_2Co_3, and Folin reactor.

This research used several equipment including glass-made equipment, Centrifuge Machine, Vortex Machine, UV Spectrophotometer, Incubator-Shaker machine, Laminar Air Flow machine, and a solenoid which produced 0.2 mT magnetic field.

Proteolytic Test in Solid Mendels Medium

a. Preparation of Medium which was Exposed by 0.2 mT Magnetic Field.

Modified substances of the solid Mendels medium consisted of: 1) Milk, 2) Yeast, 3) NaCl, 4) $KH_2PO_{4,}$ 5) $MgSO_{4,}$ 6) $(NH_4)_2SO_{4,}$ 7) Agar, and h) Aquadest. In this step, 8 different mediums were created and labeled with M_0 till M_8, as listed on Table 1. Every single medium, while being on its liquid state, was exposed by 0.2 mT magnetic field for 10 minutes, and then they were kept till they turned to solid state.

Bacillus sp. isolate was cultured in solid medium and incubated in 37^0 C temperature.

Table 1. Modified Mendels medium substances.

Treatment Sample	Magnetically Exposed Mendels Medium Substances
M_0	Control
M_1	Milk
M_2	Yeast
M_3	NaCl
M_4	KH_2PO_4
M_5	$MgSO_4$
M_6	$(NH_4)_2SO_4$
M_7	Agar
M_8	Aquadest

b. Proteolytic Test

To reach the main purpose of this research, this research used Proteolytic Index (IP) as the main indicator to quantify the productivity of *Bacillus* sp. in producing protease.

Proteolytic index was measured by comparing the diameter of Clear Zone area and Bacteria Colony area (Baehaki et al., 2011) with this following equation:

$$IP = \frac{B}{A}$$

where:

IP : Proteolytic Index

A : Diameter of Colony Area

B : Diameter of Clear Zone

(Sumardi et al., 2010)

The wider the Clear Zone means the more protease produced. While the wider the Colony Zone means the more *Bacillus* sp. exist. Comparing both value means measuring how much protease produced by each unit of *Bacillus* sp. which describes the Productivity level of *Bacillus* sp. in producing protease.

A high IP value (≥3) in the isolate indicated that the isolate had higher and maximum potential to be source of protease (Said et al., 2012).

RESULT AND ANALYSIS

Proteolytic Test to Modified Solid Mendels Medium

The medium on use in this research were modified Mendels medium which consisted of several substances namely: Milk, Yeast, NaCl, KH_2PO_4, $MgSO_4$, $(NH_4)_2SO_4$, Agar and Aquadest. Every single substance of the modified Mendels medium had significant role for bacteria growth.

Milk contains protein, lipid, carbohydrate, vitamin, and minerals in order to maintain H^+ ion in liquid culture remain unchanged (Makosim et al., 2011). Milk contains protein, lipid, carbohydrate, vitamin and minerals in perfect proportion (Abrar, 2013). Yeast extract contains glutamic acid which is the source of nitrogen for microorganism. Yeast extract also has carbon which can be used as energy source for Microorganism. Microorganism tended to utilize simpler carbon chain more from yeast extract rather than to break carbon chain from medium which contained cellulose (Fadillah et al., 2009).

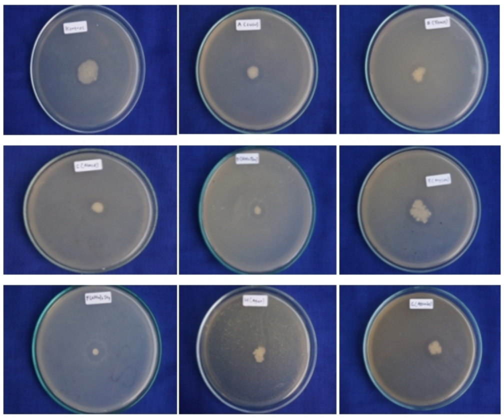
NaCl is a strong electrolyte which dissociates almost perfectly to form (ion) charged particles. Inside the medium, NaCl solution acts as buffer to maintain the medium pH at room temperature and isotonic. Inside the medium, it acts as the cell liquid and electron stabilizer properly (Rahardhianto et al., 2012).

$KH_2PO_4$is used as nutrient to support the bacteria cell growth (Rahmi et al., 2012). KH_2PO_4acts as Phosphor and Magnesium source, as well as Phosphate buffer which keep H^+ ion in liquid culture remain unchanged (Makosim et al., 2011). $MgSO_4$ is macro nutrient element which support cell growth (Rahmi et al., 2012).

Ammonium sulphate ($(NH_4)_2SO_4$) is very soluble. It can effectively sediment the protein and can be used in various pH and temperature. Ammonium sulphate is also known for its low cost that it is used as nutrient source in bacteria culture medium (Scopes, 1988).

Aquadest is distilled water which is commonly known as medium solvent of breeding bacteria. Aquadest was chosen as solvent due to its characteristic as the most polar compound among all other solvent (Umam et al., 2015).

Cultured bacteria from each treatment sample yielded Clear Zone area around the bred bacteria colony (Picture 1.a to Picture 1.h).



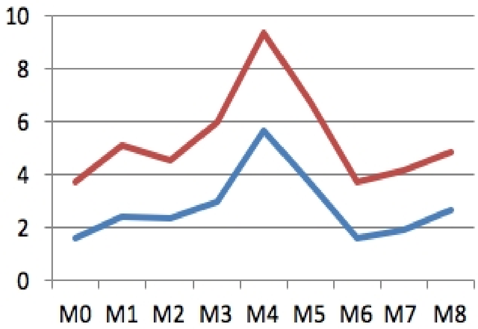
Picture 1. Area of bacteria colony and area of clear zone which were formed around the colony from each treatment. Exposure of 0.2 mT magnetic fields was given to medium components which are Milk (M_1), Yeast (M_2), NaCl (M_3), KH_2PO_4 (M_4), $MgSO_4$ (M_5), $(NH_4)_2SO_4$ (M_6), Agar (M_7), and Aquadest (M_8), whileM_0 was used as control.

In Picture 1. Clear Zone formed around the colony indicated the casein particle loss from skimmed milk components as the result of alkaline protease biosynthesis inside the cell. The cell then secretes them to its environment or the medium. In the medium, the secrecy process hydrolyzed milk protein to be amino acids which caused color to transform from brown-white to clear (Edlin et al., 2014).

Extracellular enzyme of *Bacillus* sp. is very efficient in breaking various long-chain carbohydrate, lipid and protein compound to be short-chain units or simpler compounds. According to Lehninger (2005), the growth of *Bacillus* sp. is affected by several factors such as temperature, substrate and enzyme concentration, as well as the presence of activator and inhibitor (Yusufa et al., 2013).

Proteolytic Index (IP) Calculation of each Treatment

Measurement of IP value was conducted twice along the *Bacillus* sp. culture incubation, which was at the 10th and the 18th incubation time. The result of measurement and calculation is presented by the following chart.



Picture 2. Proteolytic Index (IP) value of each treatment

Desc. : 18 hours IP value
10 hours IP value

Exposure of 0.2 mT magnetic field was given to Milk(M_1), Yeast (M_2), NaCl (M_3), KH_2PO_4 (M_4), $MgSO_4$ (M_5), $(NH_4)2SO4$ (M_6), Agar (M_7), and Aquadest (M_8), while M_0 was used as control.

From Picture 2, it can be informed that at the 10th incubation hour, the highest IP value was obtained from magnetically exposed KH_2PO_4 (M_4) which was 5.64. Meanwhile, the lowest IP value was obtained from control treatment (M_0) which was 1.56.

In the other hand, from observation at the 18th incubation time, the highest IP value was obtained from magnetically exposed KH_2PO_4 (M_4) which was 3.68. Meanwhile, the lowest IP value came from control treatment (M_0) which was 2.13.

Besides the M_4 treatment, high IP value also came from NaCl (M_3) treatment sample at the 10th hour which was 2.95 and at the 18th hour which was 3.03, as well as $MgSO_4$ (M_5) treatment sample which was 3.66 at the 10th hour and 3.08 at the 18th hour.

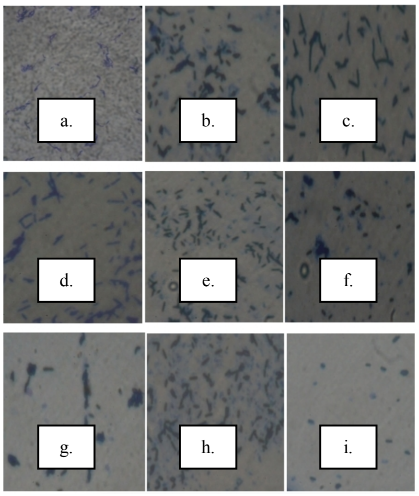
Hydrolysis activity in qualitative way is a representation of proteolytic bacteria isolate's capability in reorganizing protein by comparing the area size of Clear Zone and the Colony Zone (Naiola and Widhyastuti., 2002). Therefore, the IP calculation results in this research indicated that every single isolate has different enzyme activity in hydrolyzing protein which exists in skimmed agar medium (Edlin et al., 2014).

The Character of *Bacillus*sp. Cell

Bacillus sp. is rod-shaped bacteria, classified as gram-positive and motile bacteria, though non-motile reaction could also exist. *Bacillus* sp. produces spore which is usually heat resistant, aerobic (some species also facultative anaerobic) and has positive catalase activity (Dewi, 2014).

*Bacillus*microbe does not produce toxin, is easy to breed and does not require expensive substrate. Its capability to survive in high temperature, to produce no side metabolic result, and to produce large amount of extracellular protein, are good reasons to make *Bacillus* sp. be protease producer (Susanti, 2003).

Picture 3 shows the morphology of *Bacillus* sp. which was bred in each modified Mendels medium with 10 minutes 0.2 mT magnetic field exposure. Picture 3.a. shows *Bacillus* sp. which was bred in control medium had rod-shaped morphology. While in Picture 3f shows *Bacillus* sp. with round-shape morphology. Then in other medium components, the morphology of *Bacillus* sp. was rod-shaped. Research of Fojt et al., (2009) showed that exposure of 10 mT magnetic field caused mutation to the size of *E.coli* cell morphologically.



Picture 3. Cell Morphology of*Bacillus* sp. with 100xmagnification: a. Control (M_0), b. Milk (M_1), c. Yeast (M_2), d. NaCl (M_3), e. KH_2PO_4 (M_4), f. $MgSO_4$ (M_5), g. $(NH_4)2SO4$ (M_6), h. Agar (M_7), i. Aquadest (M_8)

1. The all eight compositions of the modified Mendels medium indicate that qualitative activity of Proteolytic (as the protease productivity indicator) from *Bacillus* sp. does exist.

2. From among the all eight *Bacillus* sp. isolates, the one which has the highest Proteolytic Index is KH_2PO_4 with 5.64 IP.

REFERENCES

Abrar, Khairul. 2013. *PembuatanNata De Artodari Floret Daging Buah dan Eksokarp Biji Nangka (Artocarpus heterophyllus) dengan Variasi Penambahan Air Kelapa.* Jurnal. Universitas Andalas.

Baehaki. A., Rinto dan B. Arif. 2011. *Isolasi dan Karekterisasi Protease dari Bakteri Tanah Rawa Indralaya, Sumatera Selatan. J.* Teknologi dan Industri Pangan, Vol. XXII (1) : 10-16.

Chen. Chuanfang, Quifeng Ma, Wei Jiang, Tao song. 2011. *Phototaxis in the magnetotactic Bacterium Magnetospirillium Magneticum strain AMB-1 is Independent of Magnetic Fields*. Appl. Microciol. Biotechnol.

Fadilah, Distantina S, Dwiningsih SR, Marifah DS. 2009*. Pengaruh penambahan glukosa dan ekstrak yeast terhadap biodelignifikasi ampas batang aren*. Ekulibrium 8 (1) 29-33.

Fojt. Lukas, PetrKlapetek b, Ludek Strasak dan Vladimır Vetterl. 2009. *50 Hz Magnetic Field Effect On the Morphology of Bacteria*. Jurnal homepage. Institute of Biophysics, Academy of Sciences of the Czech Republic, Kralovopolska 135. Brno 612 65. Czech Republic.

Fuad AM, R Rahmawati dan NR Mubarik. 2004. *Produksi dan Karakterisasi Parsial Protease Alkali Termo stabil Bacillus thermoglucosidasius AF-01*. Journal Mikrobiology Indonesia 9(1): 29-35.

Johnvesley, B and G.R. Naik. 2001. *Study on Production of Thermo stable Alkaline Protease from Thermophilic and Alkaliphilic Bacillussp. JB99 in a Chemically Defined Medium*. Journal Process Biochemistry. 37: 139-144.

Lehninger, A.L. 1990. *Dasar-Dasar Biokimia*. Jakarta : Penerbit Erlangga.

Makosim Syahril, Abu Amar dan Bambang Sukmadi. 2011. *Optimasi Media dan Isolat Bakteri Lokal dalam Produksi Fitohormon Indole-3-Acetic Acid (IAA)*. Seminar Hasil Rise*t*. Lembaga Penelitian dan Pengabdian Masyarakat. Institut Teknologi Indonesia.

Mendels Mary dan Elwyn T. Reese. 1956. *Induction of Cellulase in Trichorderma viride as Influenced by Carbon Source and Metals*. BiologyBranch, Pioneering Research Division. Ur. S. Army Quarter master Research and Development Center Natick. Massachusetts.

Muhammad. A.A, F.M. Ali, E.A. Gaafar, H.R. Magda. 1997. *Effects of Magnetic Field on the Biophysical. Biochemical Properties and Biological Activity of Salmonellatyphi*. Master thesis submitted for Biophysics department, Faculty of science. Cairo University. Egypt.

Naiola. E dan N. Widhyastuti. 2002. *Isolasi, Seleksi, dan Optimasi Produksi Protease dari Beberapa Isolat Bakteri*. Berita Biologi 6 (3) : 9-16.

Purwanti. Sri, Soetopo dan Idiyanti. 2011. *Aplikasi Protease dan Pengaruh Suhu pada Asidifikasi digestasi anaerobic dua-tahap lumpuripal biologi industry kertas*. PusatPenelitian Kimia LIPI, Serpong-Tangerang.

Rahardhianto, A., N. Abdulgani, dan N. Trisyani. 2012. *Pengaruh Konsentrasi Larutan Madu dalam NaCl F isiologis terhadap Viabilitas dan Motilitas Spermatozoa IkanPatin (pangasiuspangasius) selama Masa Penyimpanan*. Jurnal Sains danSeni ITS, Vol. 1 No. 1

Rahmi F.L, A. Dahliaty, S. Devi. 2012. *Optimalisasi Komposisi Media dan Konsentrasi Sumber Karbon Produksi Enzim Selulase Bakteri Selulolitil Strain Lokal*. Bidang Biokimia Jurusan Kimia. Kampus Binawidya Pekanbaru. Indonesia.

Said, M.I., dan Likadja, J.C. 2012. *Isolasi dan Identifikasi Bakteri yang Berpotensi sebagai Penghasil Enzim Protease pada Industri Penyamakan Kulit PT. Adhi Satria Abadi (Asa). Yogyakarta*. Makalah Ilmiah. Fakultas Peternakan, Universitas Hasanuddin. Makassar.

Scopes, R.K. 1988. *Protein Purification: Principles and Practice.*2^{nd} *ed*. New York: Springer Verlag; 40–71, 302–6.

Soeka. Yati. S, Sri Hartin. R, Ninu S, Elidar N. 2011. *Kemampuan Bacillus licheniformis Dalam Memproduksi Enzim Protease yang Bersifat Alkalin dan Termofilik*. Media Litbang Kesehatan Volume 21 Nomor 2 Tahun 2011. Puslit Biologi- LIPI Cibinong.

PHYSICAL, CHEMICAL, AND COLOR SCORE CHARACTERISTICS OF SLICED PAPAYA (*Carica papaya* L.) PROCESSED BY OSMOTIC DEHYDRATION AND CONTINUED BY CONTROLLED ATMOSPEHERE DRYING

ROFANDI HARTANTO[1*)], SISWANTI[1)] AND GAGAH ANALDI[2)]

[1)] Department of Food Science and Technology, University of Sebelas Maret, Surakarta, Indonesia
[2)] Alumnus of Department of Food Science and Technology, University of Sebelas Maret, Surakarta, Indonesia
[*)] corresponding author: rofandi_hartanto@yahoo.com (+628164272411)

ABSTRACT

The study was aimed to evaluate the physical, chemical, and organoleptic characteristics of papaya processed in osmotic dehydration pre-treatment and continued with controlled atmosphere drying. The sliced papaya (*Carica papaya* L.) of 15 mm x 15 mm x 15 mm was immersed in the osmotic solution of 60% sugar content (b/v) for 24 hour and stirred in 30 rpm, then dryed in the controlled atmospher cabinet dryer for 4 hour. There were two factors: drying temperatures (50°C, 60°C, 70°C) and controlled atmosphere gas compositions (CO_2:O_2:N_2 = 10%:5%:85%, CO_2:O_2:N_2 = 10%:12%:78%, CO_2:O_2:N_2 = 10%:15%:75%). Color score was evaluated by hedonic test. The data were analyzed by two way ANOVA procedure continued by Duncan Multiple analysis at significance level of α = 0,05.

The research results were the surface area shrinkage of 55,91% - 62,95%, the firmness of 8,41 N - 22,49 N, the water content of 23,94% - 28,49% (wb), the total acidity of 0,13%-0,18%, the vitamin C of 0,18% - 0,27%, and the total disolved solids of 29,78 - 36,70 °brix. The drying condition at 70° and controlled atmosphere drying condition of CO_2:O_2:N_2 = 10:5:85 was chosen as the most liked of color of sliced processed papaya.

Keywords: controlled atmosphere drying, osmotic dehydration, papaya.

A. INTRODUCTION

Papaya (*Carica papaya* L.) is one of tropical fruit commodities. Papaya is often named as the health fruit of the angels, because it seems to say as a taste of heaven. It also has good taste, because of the content of vitamins, minerals and fiber as well as convenient pH that is nutritious for health. Currently, papaya has been marketed in almost all important cities in the world. Indonesia is one of in the five major countries produces papaya. The huge size of production is mainly due to the land and tropical climate is suitable for growing and developing the fruit optimally. The data from The Central Bureau of Statistics of Indonesia in 2014 showed the production of papaya in Indonesia was 830,496 tonnes, while the Central Java Province in 2010, 2011, 2012 and 2013 produced of 43,006; 50,034; 78,292 and 152,867 tonnes, respectivelly.

The selling price of papaya in market is relatively fluctuative, especially in the harvest season, the selling price decreases. It is influenced by fluctuations in demand as well as the quality and quantity of production that is also fluctuated. Moreover papaya has a high water content so that papaya perishable and have a short shelf life. Of course, these things will inflict a financial loss of farmers so it needed an advanced processing technology in an effort to minimize the harm caused when the peak harvest season comes.

Those were many kinds of papaya fruit processing methods in the effort to preserve them. According to Chavan (2012), processing technologies in an effort to preserve fruits and vegetables by drying method is one of the efforts of the most important and most widely used for reasons of ease in packaging and storing. Drying is an effort to reduce the water content of a material to a certain extent. The purpose of drying is to inhibit the activity and growth of microorganisms and activity of enzymes that can cause damage to food product (Jaya et al, 2012). Fruits were stored at room temperature can only hold on for up to seven days, while the dried fruits can be stored for more than 360 days (Muchtadi, 2008). Osmotic dehydration is a technique of reduction of water content by soaking in a solution of high concentration. Osmotic dehydration is usually used as a pre-treatment prior to conventional drying.

Osmotic dehydration has received much attention in recent years as an effective method for preserving fruits and vegetables. An easy process, facilitates the processing of fruits and tropical vegetables like banana, sapodilla, pineapple, papaya, and leafy vegetables with fruits and vegetables early retention characteristics, namely, color and nutritional compounds (Pokharkar and Prasad, 1998).

In previous similar studies, however, the water content of the product that was the result of osmotic dehydration remains high that, the product could not be stored in a long time. Therefore, for example, advanced processing performed on dried mango was needed after osmotic dehydration treatment. Air drying was one of the advanced treatment efforts that could be used to reduce the level of water content in mango (Sophia, 2011). According to Momenzaded et al (2011), Funebo and Ohlsson (1998), Drouzas et al (1999) and Yousefi-sh et al (2013) stated that the reduction of water content can be more efficient by combining methods of osmotic dehydration with hot air drying or by microwave. Foods, such as fruit and vegetables are have high levels of water, carbohydrates, and high vitamins. The content of the compound could be changed at a high temperature drying conditions treatment, and it could also decrease the quality of the foods (Sokhansanj and Jayas, 1987).

Foodstuffs can be dried in the air, the superheat steam, in vacuum, in inert gas, and with the application of direct heat. The modified atmosphere drying is how to reduce moisture content of the material using modified gas omposition such as carbon dioxide and nitrogen gas. Controlled atmosphere drying as well as modified atmosphere drying technology has being developed in recent decade (Rahman, 2007). The development of this technology was already widely applied in a variety of fruits and vegetables. Controlled atmospheric air is now also used in frying and drying for the positive effects, such as to maintain the quality and intensity of the color. As well as on the findings Perera (2001) on dried apples, guava, apples, and potatoes (Hawlader et al, 2005), guava and papaya (Min, 2005), which shown the quality of the fruits and vegetables that could be maintained during the drying process with using controlled atmospheric technology. In this study we combined osmotic dehydration pre-treatment and a controlled atmosphere drying in processing of sliced papaya.

This study aimed to assess the characteristics of the chemical, physical and organoleptic of sliced papaya processed in osmosis dehydration and continued by drying in various controlled atmosphere conditions.

B. MATERIALS AND METHODS

Materials used in this research were unripe papaya Bangkok from Pasar Gedhe Surakarta market, sucrose in technical quality, distilled water for pro-analysa standard from Lab. of Food Process Engineering of Sebelas Maret University, 0.01 N Iodine, 0.01 N NaOH, the PP indicator, and aquadest.

The equipments used in the osmotic dehydration pretreatment process of sliced papaya were knife, chopping board, pan, wooden stirrer, buckets, basins, analytical balance, mixer, 500 ml beakers, scales . The equipments used in the controlled atmosphere drying process were a ‘modified’ dryer cabinet of CO_2:O_2:N_2 gas compositions. Below cabined dryer was added additional pipes to flow O_2 and N_2 gas from the compressor and CO_2 from

CO_2 tube. The gas mixture would be blowed by the blower in constant speed. The flowing speed of both from the compressor and CO_2 tube was using flow controller.

The equipments used in chemical and physical analysa were the cup, erlenmeyer, oven, clamps, analytical balance, pipette 10 ml, pipette 1 ml, propipette, burette, static, funnel, beaker, calipers, Hand refractometer Atago, fruit hardness tester Lutron FR-5105.

Experimental Set Up

This experiment consisted of two steps that was osmotic dehidration pre-treatment step and controlled atmosphere drying step.

The early stage of dehydration firstly, the unripe papaya fruit was peeled and sliced into cubes of 15 mm x 15 mm x 15 mm. The next step was to make sucrose solution concentration of 60 % (v/v) by mixing sugar with distilled water heated on the stove until fully dissolved, then cooled in room temperature. The osmotic solution was poured into a bucket and placed in the mixer. The sliced papaya, then, was inserted into osmotic solution and stirred at a speed of 30 rpm for 24 hours. The last step was draining the sliced papaya in ambient temperature.

After osmotic dehydration process was completed, then it was dryed in controlled atmosphere cabinet dryer for four hours. The gases composition of controlled atmosphere drying was CO_2:O_2:N_2 as to 10:5:85, 10:12:78 and 10:15:75. The constant CO_2 concentration and different concentration of O_2 was to evaluate the use of oxygen in controlled atmosphere drying, whereas N_2 concentration was as rest. The temperature treatment of drying was at 50, 60 and 70 °C .

The physical, chemical and organoleptic characteristics of sliced papaya processed by osmotic dehydration and controlled atmosphere drying then were performed. The physical characteristics were surface area shrinkage and firmness. The chemical characteristics were water content, totoal dissolved solids, total acid, and vitamin C. The color of sliced papaya using hedonic test .

The data were analyzed by two way ANOVA procedure continued by Duncan Multiple analysis at significance level of $\alpha = 0,05$.

C. RESULTS AND DISCUSSIONS

a. Chemical characteristics

Table 1. Influence of temperature on chemical characteristics of sliced papaya processed on osmotic dehidration on 60% sucrose solution and controlled atmosphere drying

Temp. (°C)	Moisture Content (%wb)	Total Acid (%)	Vitamin C (%)	Total Dissolved Solid (°Brix)
50	$27{,}35^{c}$	$0{,}13^{a}$	$0{,}21^{b}$	$29{,}78^{a}$
60	$24{,}95^{b}$	$0{,}14^{a}$	$0{,}27^{c}$	$36{,}70^{c}$
70	$23{,}94^{a}$	$0{,}18^{b}$	$0{,}17^{a}$	$32{,}23^{b}$

Different superscript letter at the columns means 'significantly different' of the treatment.

Table 2. Influence of combined gas composition on chemical characteristics of sliced papaya processed on osmotic dehydration on 60% sucrose solution and controlled atmosphere drying

Gas Composition	Moisture Content (%wb)	Total Acid (%)	Vitamin C (%)	Total Dissolved Solid (°Brix)
Control	$20{,}61^{a}$	$0{,}12^{a}$	$0{,}23^{b}$	$32{,}24^{ab}$
CO_2:O_2:N_2 (10%:5:%:85%)	$28{,}49^{c}$	$0{,}13^{a}$	$0{,}18^{a}$	$30{,}70^{a}$
CO_2:O_2:N_2 (10%:12%:78%)	$27{,}87^{c}$	$0{,}18^{c}$	$0{,}21^{b}$	$34{,}17^{bc}$
CO_2:O_2:N_2 (10%:15%:75%)	$24{,}68^{b}$	$0{,}16^{b}$	$0{,}25^{c}$	$34{,}51^{c}$

Different superscript letter at the columns means 'significantly different' of the treatment
.

Moisture Content

Water is a very important characteristic on foodstuffs because water can affect the appearance, texture and flavor of food. The water content in foodstuffs played in determining acceptability, freshness and shelf life of food. The water content also greatly affect the physical, chemical, microbiological and enzymatic on foodstuffs. The high water content in food causes the durability of foodstuffs and vice versa (Winarno, 2002).

Based on the results showed in Table 1 showed that the higher the drying temperature the greater the reduction in the moisture content of sliced papaya dried by drying at controlled atmosphere conditions. Based on the statistical results showed the drying temperature significantly affect moisture reduction of sliced papaya dried in various controlled atmosphere conditions. This was due to the higher temperature, the more water molecules that evaporate from the product.

Table 2 showed the decline of moisture levels in various increased of oxygen concentration and decreased of nitrogen concentration. This might occur because the event of case hardening during the drying process. The combination of CO_2:O_2:N_2 as to 10:5:85, 10:12:78, and 10:15:75 were presumed had specific heat which getting down along with nitrogen concentration decreased and oxygen concentration increased. According to Hawlader et al (2006), the greater value of specific heat the greater absorption of heat during the drying, so that the greater energy of heating process. The greater specific heat obtained the greater energy or heat. This excessive heating was lead to case hardening on the sample. The hardening of the sample surface was blocking the discharge of water from the sample during drying. In the control samples showed significant difference to the treatment of gas combination samples. Control treatment was a treatment without giving gas combination during of drying of sliced papaya.

Total Acid

Level of total acid is one of the important analysis performed to determine the quality of processed food products containing acid. This parameter is useful to know the quality of papaya products and also preference by consumers (Brishti et al**,** 2013). In Table 1 showed the tendency of increasing level of total acid as the drying temperature rises. This was due to loss of water content coincide increase in temperature would increase the concentration levels of total acid in dried fruit products.

Table 2 showed that as the nitrogen concentration decreased and oxygen concentration increased. As we knowed that the combination of CO_2:O_2:N_2 of 10:5:85 have a tendency to absorb greater heat because it had a specific heat greater than the combination of

CO_2:O_2:N_2 of 10:12:78 and a combination of CO_2:O_2:N_2 of 10:15:75. Thus allowing the heating process occurs more. According to Rumahorbo et al (2015) the heating process caused a reaction by acid hydrolysis of sucrose to form fructose and glucose; the reaction caused a decrease in total level of acid. That was to say that as the concentration of nitrogen decreased and the concentration of oxygen increased on a controlled atmosphere condition would increase the value of the total acid concentration. In the control samples showed significant difference to the treatment sample gas combination except in the combination of CO_2:O_2:N_2 of 10:5:85.

Vitamin C

Vitamin C is a vitamin that is unstable, easily damaged by heat, easily oxidized accelerated by contact with air and light, a metal catalyst such as Fe and Cu. Table 1 showed that the levels of vitamin C tended to fall in line with the higher temperatures. This was because vitamin C was unstable and easily damaged due to high temperature.

In Table 2 shows that the level of vitamin C was increased in line with variations in gas combinations that had a nitrogen concentration was decreased and oxygen concentration was increased. This happened because of the physical nature that was specific heat on a combination of gas that the concentration of nitrogen decreased and the concentration of oxygen increased was able to absorb excess heat (Min, 2005), and was also known that vitamins were not stable against heating, so with the concentration of nitrogen gas increasingly lowered and the concentration of oxygen gas was enlarged on a combination of gas, the vitamin C would be more awake.

In the control samples showed significant difference to the treatment combination of gas samples except the sample gas combined of CO_2:O_2:N_2 of 10:12:78.

Total Dissolved Solids

Total dissolved solids were calculated using refractometer that showed dissolved solid as a sugar content. Determination of total dissolved solids made against invert sugar directly after the material has inverted. Conversion of sugar into invert sugar had increased dissolved solids that indicated in brix degree of reading. So that, the total dissolved solids can indicate sugar content of products. Sugar content is closely related to quality standards and the level of sweetness of the product.

Table 1 showed that the total dissolved solids increased in line with the higher temperatures. This was because the higher the heating temperature, the moisture content in the product is getting smaller, so the total dissolved solids were read higher.

In Table 2 also showed that the total dissolved solid in the variation of the gas combination showed an increase in total dissolved solids along with a variety of combinations of oxygen gas was enlarged and nitrogen gas was minimized. This wa because the water content in the osmotic dehydration of sliced papaya with advanced process of drying in the controlled atmosphere conditions showed a decrease in water content as a variation combination of oxygen was enlarged and nitrogen gas was reduced. As we know that the total dissolved solids was closely linked to its water content, the higher the water content, the lower the total dissolved solids.

In the control samples showed significant difference to the treatment of samples combination gas except on sample combinations of CO_2:O_2:N_2 of 10:12:78 and sample a combination of CO_2:O_2:N_2 of 10:12:78 which showed no significant difference with the control.

b. Physical characteristics

Table 3. Influence of temperature on physical characteristics of sliced papaya processed on osmotic dehidration on 60% sugar solution and controlled atmosphere drying

Temperature (°C)	Remaining Area (%)	Firmness (N)
50	62,94^{b}	19,16^{b}
60	59,72^{a}	21,32^{c}
70	57,97^{a}	15,12^{a}

Different superscript letter in the columns means 'significantly different' of the treatment.

Table 4. Influence of gas combination on physical characteristic of sliced papaya processed on osmotic dehydration on 60% sugar solution and controlled atmosphere drying

Gas Combination	Remaining Area (%)	Firmness (N)
Kontrol	70,63[b]	23,35[c]
CO_2:O_2:N_2 (10%:5:%:85%)	58,41[a]	8,41[a]
CO_2:O_2:N_2 (10%:12%:78%)	55,91[a]	22,49[c]

Different superscript letter in the columns means 'significantly different' of the treatment.

Shrinkage

The shrinkage of sliced papaya processed in osmotic dehydration solution and continued by controlled atmospere drying was calculated in percent. The remaining of the area was defined as shrinkage, so the higher means the lesser of shrinkage. In Table 3 showed that the shrinking surface area on osmotic dehydration of papaya with advanced process controlled drying atmosphere decreases with rising temperatures. According to Del Valle, et al (1998), McMinn and Magee (1997), Wang and Brennan (1995) and Major and Sereno (2003) the higher the temperature during drying produces more shrinkage. Otherwise, sometimes occured that there were shell formation on the outer surface of the sample during the early stages of the drying process and resist shrinkage (Mayor and Sereno, 2003).

In Table 4 showed the variation of the combination treatment of gas between the sample did not show any significant difference. Depreciation surface area in the control treatment i.e. drying without gas combinations showed remaining surface area was higher compared with gas combination treatment in general. This might be due to hardening of the surface during the drying process so that the water content in the sample could not get out properly or not perfectly dryied. According to Rahman (2007) case hardening can lead to lower shrinkage due to the drying process. The water content of the control was lower than the water content of a combination of gas in general, while the specific heat the control (1kJ/kg.K) was known to be lower than the combination of gas specific heat in general (1.01435 kJ/kg.K, 1.00588 kJ/kg.K, 1.00225 kJ/kg.K). As we know, the greater the specific heat value, the greater the heat absorption. So it is suspected that the sample experienced in case hardening.

Firmness

Texture is the sensation of pressure that can be observed with the mouth (when bitten, chewed and swallowed) or touching with a finger. Texture will affect the assessment of the perception of such products. The sweets included into foodstuffs with the type of texture important because the texture has a dominant role to influence the quality of food products. Among the many parameters characteristic of texture, firmness parameters of a product is a major consideration in the selection of products by consumers (Hawlader et al, 2006). Table 3 showed that the there was decrease in the level of firmness of dried sliced papaya as the temperature increased. According to Bourne and Comstock (1986) suggested that the degree of firmness in most fruits and vegetables decrease with raising the drying temperature. This happens due to case hardening process resulting in drying results on the outer surface dry but still moist inside (Hastuti et al, 2013) which causes the product becomes softer texture.

The results in Table 4 showed that the level of firmness tended increased by increasing of oxygen concentration and decreasing of nitrogen concentration in the controlled atmosphere conditions. This is presumably because the water content of the samples from these conditions declined during drying. As we knowed that according to Winarno (2004) that water content could affect a food texture. Miranda et al (2011) stated that the reduction of the water content affected the increased hardness texture of a food.

In the control samples showed significant difference to the gas combination treatment samples except in the combination of CO_2:O_2:N_2 of 10:12:78.

c. Color score

Table 5. Influence of temperature to the color score of the dried sliced papaya processed in osmotic dehydration of 60% sugar solution and controlled atmosphere drying based on consumer perception

Temperature (°C)	Color score
50	$4{,}03^{a}$
60	$4{,}42^{b}$
70	$4{,}66^{b}$

Note: Color score 1: very do not like, 2: do not like, 3: rather do not like, 4: neutral, 5: rather like, 6: like, 7: very like
Different superscript letter indicates different level of color score.

Table 6. Influence of gas combination to the color score of the dried sliced papaya processed in osmotic dehydration of 60% sugar solution and controlled atmosphere drying based on consumer perception

Gas Combination	Color score
Control	4,97[b]
CO_2:O_2:N_2 (10%:5:%:85%)	4,81[b]
CO_2:O_2:N_2 (10%:12%:78%)	3,97[a]
CO_2:O_2:N_2 (10%:15%:75%)	3,72[a]

Note: Color score 1: very do not like, 2: do not like, 3: rather do not like, 4: neutral, 5: rather like, 6: like, 7: very like Different superscript letter indicates different level of color score.

The colors in foodstuffs is one important factor in the quality of foodstuffs. Aside from being a factor that will determine the quality, the color can also be used as an indicator of freshness or maturity. Whether or how the mixing or processing methods can be characterized by an uniformity and equality of the color (Winarno, 2004).

Table 5 showed that the level of color preferences based on its brightness by panelists were increase as temperatures increase as well. As it was known that the higher the drying temperature decreases brightness level or the sample was being darker (Akoy, 2014). From the results of the organoleptic test of color score, according to the level of brightness, was known that in the temperature treatment variation the panelists tended to choose of not bright color or of rather brown color. In the treatment of temperature variation the color score test results were known that the brightness in the most preferred level was at a temperature of 70 C deg. and in not preferably was at a temperature of 50 C deg., although the score was from of neutral to rather like only.

Table 6 showed that there were decreased score of panelist perception of the brightness color due to increased of oxygen concentration and decreased of nitrogen concentration in the controlled atmosphere gas mixing. This indicated that when the oxygen concentration increased in the mixing gas the panelists would put down the brightness perception of the color of the product. As we knowed that browning was caused by the four kinds of different components, those were oxygen, enzymes, copper, and the substrate

(Langdon, 1987). So the increasing of oxygen concentration in gas mixing would lead to reduced levels of color brightness. In the treatment of variation of the combination of atmospheric gases the test organoleptic results of color was known that level of birghtness of the most preferred was the combination of CO_2:O_2:N_2 of 10:5:85 and the least preferred was the combination of CO_2:O_2:N_2 of 10:15:75.

In the control treatment or drying with normal gases of drying showed that there were real difference to the treatment of variation of combination of atmospheric gases in a general, except the treatment of combination of CO_2:O_2:N_2 of 10:5:85 that showed no difference with control.

It could be concluded that temperature variations and combinations of gas mixing in a controlled atmosphere drying affected on the chemical characteristics of sliced papaya in the form of a decrease in moisture content due to increased temperatures and greater of nitrogen concentration and lesser of oxygen concentration (ranging of 23.94%-28.49 % wb), an increase in total acid with increasing temperature drying, as well as smaller of nitrogen concentration and higher of oxygen concentration (ranging of 0.13%-0.18%), a decline in vitamin C along with the increase in temperature and an increase in vitamin C along with lesser of nitrogen concentration and larger of oxygen concentration (ranging of 0.18%-0.27%), an increase in total dissolved solids along with increasing the drying temperature as well as minimized the concentration of nitrogen gas and inflated the concentration of gas oxygen in the gas mixing (ranging of 29.78-36.70 ^{o}Brix).

Temperature variations and combinations of gas mixing in a controlled atmosphere drying effected on physical characteristics such as remaining surface area of sliced papaya i.e. the smaller the drying temperature (ranging of 55.91%-62.95%), a decline in the level of firmness due to the temperature rise and an increase in the level of firmness due to the concentration of nitrogen gas decreased and the concentration of oxygen increased (ranging of 8.41 N-22.49 N).

Based on the color score, the most preferred by the panelist based on the parameter level of brightnees color the temperature treatment was at 70 ^{o}C and the most not preferably was at a 50 ^{o}C. While the gas mixing combination treatment the most preferred was gas combination of CO_2:O_2:N_2 of 10:5:85 and the most disliked was gas combination of CO_2:O_2:N_2 of 10:15:75.

REFERENCES

Akoy, E. O. M. 2014. Effect of Drying Temperature on Some Quality Attributes of Mango Slices. *International Journal of Innovation and Scientific Research*: 2(4): 91-99.

Central Bureau of Statistics of Indonesia. 2015. http://www.bps.go.id/site/resultTab. accessed on April 4, 2015 at 1.03 AM o'clock, local time.

Brishti. F. H., M. Jawadul, and S. Ayesha. 2013. Effect of Biopreservatives on storage life of papaya *(Carica papaya* L.*). International Journal of Food Studies*, 2: 126-136

Bourne, M.C. and Comstock, S.H. 1986. Effect of Temperature on Firmness of Thermally Processed Fruits and Vegetables. *Journal of Food Science* 51(2): 531-533.

Chavan, U. D. 2012. Osmotic Dehydration Process for Preservation of Fruits and Vegetables. *Journal of Food Research,* 1(2): 202-209. Poland.

Del Valle, J. M., Cuadros, T. R. M., and Aguilera, J. M. 1998. Glass transitions and shrinkage during drying and storage of osmosed apple pieces. *Food Research International*, 31(3): 191–204.

Drouzas, A. E., Tsami, E., & Saravacos, G. D. 1999. Microwave/vacuum drying of model fruit gels. *Journal of Food Engineering*, 39: 117-122.

Funebo, T., & Ohlsson, T., 1998. Microwave-assisted air dehydration of apple and mushroom. *Journal of Food Engineering*, 38: 353-367.

Hawlader, M. N. A. Perera, C. O. Min, T. 2005. Properties of Modified Atmosphere Heat Pump Dried Fruits. *Journal of Food Enginnering* 74: 392-401.

Langdon, T.T. 1987. Preventing Browning in Fresh Prepared Potatoes Without the Use of Sulfiting Agents. *Food Technology*, 41: 64-67.

Mayor, L., Sereno, A.M. 2003. Modelling Shrinkage during convective drying of food materials: a review. *Journal of Food Engineering,* 61 : 373--386.

Mcminn, W. A. M., and Magee, T. R. A. 1997. Physical characteristics of dehydrated potatoes—Part I. *Journal of Food Engineering*,33: 37–48.

Min, T. 2005. *Food Quality in Modified Atmosphere Heat Pump Drying*. [Thesis] Submitted for the Degree of Master of Engineering, Department of Mechanical Engineering, National University of Singapore.

Miranda, G., Berna, A., Gonzalez, R.and Mulet, A. 2011. Evolution of Moisture Content and Texture During Storage of Dried Apricots. *11th International Congress on Engineering and Food Papers*. Athena. Greece.

Momenzadeh, L., Zomorodian, A., and Mowla, D., 2011. Experimental and theoretical investigation of shelled corn drying in a microwave-assisted fluidized bed dryer using Artificial Neural Network. *Food and Bioproducts Processing*, 89: 15-21.

Muchtadi TR. 2008. *Food Process Technology*. Bogor Agricultural University. Bogor. Indonesia. (Indonesian).

Perera, C. O. 2001. Modified atmosphere heat pump drying of food products. In *Proceeding of the Second Asia-Oceania Drying Conference* (pp. 469–476). Penang, Malaysia.

Pokharkar, S. M., and Prasad, S. 1998. Mass trasfer during osmotic dehydration of banana slices. *Journal of Food Science and Technology* 35 (4): 336-338.

Rahman, M. S. 2007. *Handbook of Food Preservation Second Edition*. CRC Press. Florida.

Rumahorbo, Princen. Karo-karo, Terip. Julianti Elisa. 2015. Influence of Sorbitol Concentration and Soaking Time to The Quality of Dry Sweets. *Journal of Food Engineering and Agriculture*. 3(1): 63-70. (Indonesian).

Sokhansanj, S. dan D.S. Jayas. 1987. *Drying of Foodstuffs In Handbook of Industrial Drying*. Marcel Dekker. New York.

Sophia, Mila. 2011. *Drying Characteristics and Quality Evaluation of Sliced Mango (Magnifera indica.* L*) var. Arumanis with Oamotic Dehydration Treatment.*. Undergraduate Thesis, Faculty of Agricultural Technology, Bogor Agriculture University. Bogor. Indonesia. (Indonesian).

Wang, N., and Brennan, J. G. 1995. Changes in structure, density and porosity of potato during dehydration. *Journal of Food Engineering*, 24(1): 61–76.

Winarno, F.G. 2002. Chemical Food and Nutrient. PT. Gramedia Pustaka Utama. Jakarta. Indonesia. (Indonesian).

Yousefi-sh, A.R. Aghdam, K. C. and, M. Pourafshar, N. M., 2013. The Kinetics of Forced Convective Air-drying of Papaya (Carica papaya L.) Slices Pretreated in Osmotic Solution. *Iranian Food Science and Technology Research Journal*: 9(3)270-278.

ANALYSIS OF ENERGY INPUTS IN RICE PRODUCTION OF VARYING YIELD LEVELS AMONG SELECTED MUNICIPALS OF LAGUNA, PHILIPPINES

GYAW SHINE OO

Crop Science Cluster, College of Agriculture, University of the Philippines Los Banos, Philippines
Kyi Gyone Village Chaung, Chaung U Township, Sagaing Divison, Myanmar
karyanlay.gso@gmail.com

ABSTRACT

Rice is an important staple food crop in Philippines. This study was conducted to determine any variation in energy usage in different rice yield levels in the three municipals, Pila, Pagsanjan and Sat. Cruz, Laguna province of Philippines. Primary data were gathered from 167 farmers through field surveys by using pre-tested structured questionnaire during May, 2016. Three farmer groups were identified based on their average yields level of the last three cropping seasons for each municipal. Specifically, these are (a) Low Yield Group (LYG): 3.0-4.0 ton ha^{-1} (b) Average Yield Group (AYG): 4.5-5.5 ton ha^{-1} and (c) High Yield Group (HYG): 6.0-7.5 ton ha^{-1}. The research results revealed the total energy input used and energy outputs were significantly different among the municipalities as well as between the three groups. The parameters of energy analysis such as energy use efficiency, energy productivity and specific energy, were only significantly different among the three municipalities. The energy use efficiency of Pila (6.37) was approximately 0.55 higher than Sta. Cruz and 0.71 higher than Pagsanjan. Also, the values of energy productivity (kg MJ^{-1}) for Pagsanjan, Sta. Cruz and Pila were found to be 0.34, 0.35 and 0.38, respectively. On average 90.53% of total energy input used in rice production was indirect energy, while the contribution of direct energy was 9.47%. The result showed that the average total energy input for rice production was 14, 314.10 MJ ha^{-1}, where in inorganic fertilizer (62.44%) was the highest energy use of total energy inputs used. Chemical such as pesticide and herbicide was 10.22% and fossil fuel was 9.47% of total energy inputs used. In addition, the multiple liner regression model was applied to test the variable affected on energy output of rice production. The finding showed that inorganic fertilizer, chemical and machinery input significantly affected energy output.

Key Words: energy use efficiency, rice, energy input, energy productivity and fertilizer

INTRODUCTION

Energy consumption in agriculture has been increasing in response to the limited sources of arable land, increasing population, technological changes, and a desire for higher standards of living (Kizilaslan, 2009; Safa*et al*., 2011). The agricultural modernization of the last several decades has been largely a process of putting greater amount of energy to increase yields. But most of this additional energy input comes directly or indirectly from non-renewable fossil fuel (Gliessman, 2015). Agriculture uses energy directly as fuel or electricity to operate machinery and equipment, to heat or cool buildings, and for lighting on the farm, and indirectly in the fertilizer and chemicals produced off the farm (Schenpf, 2004 as cited in Kazemi*et al*., 2015).

In the developing countries, energy consumption has raised rapidly as a result of economic growth and with the introduction of high-yielding varieties, mechanized crop production practices and pumping water for irrigation. In view of these, concerns regarding the sustainability of agricultural production systems have been raised. There must be a balance between environmental and energy effects with production (Moreno *et al*., 2011). To increase crop yields, the main strategy is to use more agricultural inputs, mainly chemical fertilizer (Safa*et al*., 2011).Many studies have been conducted to determine the energy efficiencies of crop production systems. Mendoza (2005) conducted an energy-based analysis of organic, low external input sustainable agriculture (LEISA) and conventional rice production in the Philippines and found that non-use of any agrochemical inputs in organic farming made it four times more energy efficient than conventional farming and twice more efficient than LEISA. Organic farming was not only energy efficient, it was also found to be equally or slightly more productive. Eskandari*et al*. (2011) as cited in Kazemi*et al*. (2015) considered the energy consuming process and factors influencing rice production in semi-mechanized and traditional systems in Mazndaran province located in north of Iran. They found irrigation and fertilizer energy use are the most energy consumers in rice production. In lowland rice-based cropping system of Malaysia Bockari-Gevao (2005) found out that the energy consumption was highest for tillage, followed by harvesting and planting.Verman*et al*. (2005) studiedthe energy requirements of the field. They found out that theenergy requirements puddling the field was highest (2390 MJ ha^{-1}) for rotavator.

The inputs' energy requirement of rice production in different catregories of farms in Bangladesh (Iqbal, 2008 as cited in Kazemi*et al*., 2015)showed that small farms (0.61-1.00

ha) had the highest energy use efficiency in comparison with other groups. In another study, Nassiri*et al.* (2009) determined energy use efficiency of paddy crop and disclosed that small farmers had high energy ratio and low specific energy requirement as compared to larger paddy farms. Pimentel (1980) reported that irrigation rice and more intensive cultural practice, had energy efficiencies (output / input ratios) declined to about 3.4 in Laguna Province in the Philippines. As to production factors and inputs, Ren*et al.* (2012) reported nitrogen fertilization contributed the highest proportion to the total energy consumption, that compared with the seed, labour, machinery, diesel fuel, phosphorus and potassium fertilizers, irrigation water, plastic film pesticides in sweet sorghum production as bioenergy crop in coastal saline-alkali site in Sandong province, China. Minimum tillage technology reduced working time, fuel consumption and CO_2emission in maize cultivation (Sarauskis*et al.*, 2014). In West Java, Indonesia the ratio of output to input energy was higher in greenhouse production than open field vegetable production for tomato, chilli at medium land (201-800 mabsl) and chilli at highland (>800mabsl) but in lettuce open field production was twice as that of greenhouse vegetable production (Kuswardhani*et al.,* 2013).

Rice (*Oryzasativa L.)* is one of the most important primary crops in the world. About three billion people, nearly half of world's population, depend on rice for survival. In Asia majority of the population consumes rice in every meal. In many countries, rice accounts for more than 70% human caloric intake (Pishgar-Komleh 2011; Singh 2002). Rice production in the Philippines is important as it is the staple food of around 80 million Filipinos(Mendoza, 2005).While energy-related studies in rice production in the Philippines had been done (Nguyen van Nguu, 1976; Soriano, 1982; Mendoza, 1991; Mendoza, 2005), the energy use of rice produced in different yield levels is yet to be conducted. A correlation analysis between energy use and rice yields at different levels (low, average, high) is an important technical input that will guide farmers, researchers , policy makers and executives involved in agriculture to achieve medium to long term rice security in the country.

Increases in crop yields had been achieved through the application of inputs. Yields (low, average, and high) are dependent on the level of input application. Chemical fertilizers particularly contribute to the highest energy bill in production.

Concerns have been raised on the excessive use of fossil fuels in various farming systems that will eventually lead to environmental degradation and depletion of natural resources. On the other side, not enough input will directly affect grain yield. Previous studies delved more into the financial side of adoption without looking into the energy efficiency of the production.

This study was conducted to determine any variation in energy usage in different rice yield levels in Pagsanjan, Sta. Cruz and Pilaof Laguna province, Philippines. Specifically, the study was conducted to (a) determine the direct and indirect energy usage in rice production of thethree yield levels, (b) determine any influence that can contribute to differences in energy usage in the three yield levels and (c) determine the energy use efficiency, energy productivity and specific energy: energy use per unit of rice in the three yield levels.

MATERIALS AN METHODS

The study was carried out in three municipals, Pagsanjan, Pila and Sta. Cruzof Laguna Province, Philippines. These municipals are the most rice production area of the province and livelihood of the most of the farmers in the study area relies on the rice production. In the area, rice is sown in two seasons a year, the dry and wet season. The crop is sown during the months of December and January for the dry seasonand during the month of May and June for wet season. The crop is harvested during March-April for the dry season and during June-August for the wet season.

Primary data were gathered from 167 farmers through field surveys by using pre-tested structured questionnaire during May, 2016.Three farmer groups were identified based on their average yields level of the last three cropping seasons for each municipal. Specifically, these are (a) Low Yield Group (LYG): 3.0-4.0 ton ha^{-1} (b) Average Yield Group (AYG): 4.5-5.5 ton ha^{-1} and (c) High Yield Group (HYG): 6.0-7.5 ton ha^{-1}. For this study the farmers were selected using simple random sampling method. All data detail information of the questionnaire were computed for hectare basis, averaged and arranged. First, all inputs and outputs for rice production were determined, quantified and entered into Microsoft Excel spread-sheets (var.2010), and then transformed into energy units and expressed in MJ ha^{-1}.

The energy use efficiency of rice production in the three farmer yield groups and three municipals has been evaluated by energy ratio between output and input. Human labour, machinery, diesel fuel, inorganic fertilizers, chemicals, animal labour, manure and seed amounts and output yield values of rice crop have been used to estimate the energy use ratio. In the present study, irrigation water was not included for estimating energy input. Energy equivalents shown in Table 1were used to estimate the input and output energy. The quantity of inputs in three municipals and three yield level group is demonstrated in Table 2. The sources of machinery energy used on the rice production included hand tractor, floating power tiller,thresher without built-in blower, and blower and this included embodied-energy. The energy value of the machinery used was calculated per hour basis. The fuel energy computed on the basis of total gasoline and diesel consumption (L ha^{-1}) in different operation such as land preparation, threshing and cleaning. The energy value for a given item will be obtained by simply multiplying the unit or amount used and the corresponding energy equivalents of a given input, e.g., seeds have 16.75 MJ kg^{-1}. Thus, the energy input (MJ) of 60 kg seeds = 60 kg x 16.75 MJ kg^{-1} = 1005 MJ.The total energy input of rice production (MJ ha^{-1}) will be calculated by adding up the energy equivalences of all inputs in mega-joule (MJ). It is expressed in the equation below:

TEI= FEI+CPEI+ FEI+MEI +AEI + SEI+HEI(1)

Where:

TEI = Total Energy Input (MJ ha^{-1})
FEI = Fertilizer EnergyInput (MJ ha^{-1})
CEI = ChemicalEnergy Input (MJ ha^{-1})
FEI = Fossil fuel Energy Input (MJ ha^{-1})
MEI = Machinery Energy Input (MJ ha^{-1})
AEI = Animal Energy Input (MJ ha^{-1})
SEI= Seed Energy Input (MJ ha^{-1})
HEI= Humus Energy Input (MJ ha^{-1})

Based on the total energy equivalents of the inputs and output,the energy use efficiency, energy productivity and specific energy were calculated using the following equations (2) – (4):

Energy Efficiency = Total energy output (MJ ha^{-1}) ÷ Total energy input (MJ ha^{-1}) (2)

Energy productivity = Grain yield (kg ha^{-1}) ÷ Total energy input (MJ ha^{-1}) (3)

Specific energy = Total energy input (MJ ha^{-1}) ÷ Grain yield (kg ha^{-1}) (4)

Table1. The energy equivalent of various inputs in agricultural production

Form	Unit	Energy equivalent (MJ per Unit)	Source
Seed	kg	16.75	Gliessman (2015), Mendoza (2005), Heiche (1980)
N	kg	78.1	Mudahar and Hignett, (1987), Fluck, 1992
P_20_5	kg	17.4	Mudahar and Hignett, (1987), Fluck, 1992
K_2O	kg	13.7	Mudahar and Hignett, (1987), Fluck, 1992
Sulphur	kg	6.28	Pimentel (1980)
Herbicides	kg	418.2	Pimentel (1980)
Insecticide	kg	363.8	Pimentel (1980)
Fungicides	kg	271.7	Pimentel (1980)
Machinery	h	2.37	Kazemi (2015), Banaeian*et al.* (2011), Alipour*et al.* (2012)
Gasoline	L	42.32	Cervinka (1980)
Diesel	L	47.78	Cervinka (1980)
Fuel Oil	L	47.78	Cervinka (1980)
Manure	kg	8.37	Gliessman (2015)
Labour	h	1.96	Kazemi*et al.* (2015), Saraukis*et al.* (2014), Alipour*et al.* (2012), Nassiri*et al.* (2009) and Verma (2005)
Animal	h	10.10	Verma (2005), Nassiri*et al.* (2009) and Gliessman (2015)

The energy output for each group of three municipals was obtained by multiplying the grain yield by their energy equivalents.The energy inputs were classified into direct and indirect energy use, renewable and non-renewable energy. Direct energy input includes gasoline, diesel to run the machines (tractors, thresher and blower) during land preparation to harvesting. Indirect energy includes: 1) animal and human labour in land preparation, management and control, harvesting, etc., 2) energy embodied in machines, fertilizer, and other agrochemical inputs (herbicide, insecticide, and pesticide), 3) seeds – concern the energy cost of seed used in production. Energy from fossil fuel, chemical, fertilizer and machinery are non-renewable, while energy from human, animal, seed and manure are renewable. The Least Significant Different test ($P<0.05$) was used to analyse different between values in three different yield level of farmer group of three municipals and in three different municipals by using SAS software. In addition, the multiple liner regression analysis was applied to test the variable affected on energy output of rice production and Pearson's correlation analysis was done on all energy use parameters, total energy inputs and energy output by using SPSS.

Table2. Amounts of inputs and output of rice production in different yield level groups and different municipals.

Items	Unit/ha	Yield Level Groups			Locations		
		LYG	AYG	HYG	Pagsanjan	Sta. Curz	Pila
Seed	kg	**64.52**	**60.45**	**64.62**	**56.98**	**64.81**	**67.79**
Labour	h	**417.08**	**471.98**	**522.96**	**490.18**	**455.68**	**466.16**
Animal	h	**8.76**	**10.81**	**10.97**	**27.81**	**2.73**	**0.00**
Manure	kg	**37.08**	**48.22**	**46.69**	**40.93**	**39.81**	**51.25**
N	kg	**63.93**	**106.60**	**140.34**	**114.91**	**102.27**	**93.70**
P_2O_5	kg	**10.55**	**16.88**	**26.26**	**20.11**	**17.19**	**16.39**
K_2O	kg	**10.95**	**17.67**	**27.55**	**19.26**	**17.86**	**19.03**
Sulphur	kg	**10.67**	**17.10**	**19.73**	**21.48**	**11.93**	**14.10**
Pesticide	kg	**1.44**	**1.88**	**2.89**	**1.83**	**2.32**	**2.07**
Herbicide	kg	**1.14**	**1.82**	**2.18**	**0.96**	**2.77**	**1.40**
Diesel	L	**18.17**	**19.39**	**19.13**	**18.63**	**16.64**	**21.41**
Gasoline	L	**9.36**	**11.94**	**11.03**	**11.76**	**10.03**	**10.54**
Machine	h	**27.10**	**31.86**	**31.11**	**29.88**	**27.88**	**32.31**
Yield	kg	**3372.11**	**4931.73**	**6196.34**	**4775.23**	**4839.12**	**4885.83**

RESULTS AND DISCUSSION

In Table 3, the energy equivalences of various energy inputs used in the rice production of different municipals and yield level groups are given. Also, in Table 4, distribution of the different energy input ratios in the rice production are given.

Table3. Energy equivalent of input and output of rice production in different yield level groups and different municipals

Item	MJ ha^{-1}			MJ ha^{-1}			
	Pagsanjan	Sta. Cruz	Pila	LYG	AYG	HYG	Mean
Seed	935.85	1086.04	1146.24	1081.90	1014.25	1066.37	1055.11
Labour	964.60	889.15	941.80	826.33	919.88	1029.85	928.60
Animal	279.89	26.49	0.00	95.63	92.68	124.33	103.17
Manure	376.82	335.17	466.33	310.16	418.12	439.35	390.99
Fertilizer	10184.25	8365.69	8192.04	5303.87	8736.45	12029.78	8802.01
Chemical	1065.48	1941.50	1421.54	1023.06	1439.85	1837.81	1454.87
Fuel	1371.28	1208.43	1478.83	1239.30	1435.52	1379.76	1352.18
Machine	69.86	65.76	77.51	63.37	75.35	73.69	70.92
Total	15248.02	13918.22	13724.28	9943.61	14132.09	17980.93	14157.86

The results showed that the average total energy equivalent of fertilizer consumption was highest component among energy inputs and constituted 8802.01 MJ ha^{-1} of the total energy input (14157.86MJ ha^{-1}). The total energy input of rice production in Pagsanjan municipal was 15,248.02MJ ha^{-1} and higher than in the other municipals. The highest inputs contributed of total energy inputs was fertilizer (10184.48 MJ ha) as 66.79%. Also, in other municipals, the contribution of highest energy input in rice production belonged to fertilizer energy input which accounted about 60.11% (8365.69 in Sta. Cruz) and 59.69% (8192.04 in Pila) of total energy consumption (Table 4).

Table4. Distributions of energy from different sources for rice production of different yield groups and locations

Item	% of energy contributions			% of energy contributions			Mean
	Pagsanjan	Sta.Cruz	Pila	LYG	AYG	HYG	
Seed	6.14	7.80	8.35	10.88	7.18	5.93	7.71
Labour	6.33	6.39	6.86	8.31	6.51	5.73	6.69
Animal	1.84	0.19	0.00	0.96	0.66	0.69	0.72
Manure	2.47	2.41	3.40	3.12	2.96	2.44	2.80
Fertilizer	66.79	60.11	59.69	53.34	61.82	66.90	61.44
Chemical	6.99	13.95	10.36	10.29	10.19	10.22	10.33
Fuel	8.99	8.68	10.78	12.46	10.16	7.67	9.79
Machine	0.46	0.47	0.56	0.64	0.53	0.41	0.51
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Based on the yield level groups, the fertilizer energy inputs used in rice production were 5303.83 MJ ha^{-1}, 8736.45 MJ $ha^{-1}$and 12029.78 MJ ha^{-1} in LYG, AYG and HYG, respectively. It contributed as 61.82 % in LYG, 61.82% in LYG and 66.90% in HYG of total energy input (Table 4). Among the fertilizers energy input of nitrogen fertilizer has the highest share within the all chemical fertilizers. The amount of this fertilizer used for rice production was 114.91, 102.27 and 93.70 kg ha^{-1} in Pagsanjan, Sta.Cruz and Pila, respectively, and was 63.93, 106.60 and 140.34 kg ha^{-1} in LYG, AYG and HYG, respectively (Table 2).The results suggest that fertilizer inputs were excessive for Pagsanjanand HYG; chemical fertilizer should be reduced or optimized.It has been reported that the energy input of chemical fertilizer has the highest contribution of total energy input in crops production.For example, Pishgar-Komleh et al. (2011) reported that fertilizer and diesel fuel were the highest energy consumers and fueland machinery had the most significant impact on rice production in Guilan province. In general, reducing chemical fertilizer and fossil fuel consumption, mainly nitrogen, is important for energy management in this group and municipal. Reducing chemical fertilizer use in rice production, not only having high energy use efficiency but also, can reduce environment degradation. Nabavi-Komlehet al. (2014) mentioned that fertilizer management, integrating a legume into the crop rotation, application of composts, chopped residues and other soil managements can be reduce the chemical fertilizer energy requirements.Mendoza (2005) also stated that organic farming was about 4.4 times more efficient than conventional farming and 1.8 times more energy efficient than low external input sustainable agriculture rice production in the Philippines.Therefore, it is necessary to focus more on finding alternative fertilizers and nutrient managements than other factors to effectively reduce energy inputs in rice production.

According to the data gathered from all surveyed fields, average chemicals energy inputs consumption was ordered as second component among energy input and constituted 1454.87 MJ ha^{-1} of the total energy input (14157.86 MJha^{-1}).It is varied in three studied municipals and three yield level groups. The energy input for chemicals in Pagsanjan (1065.48 MJ ha^{-1}) and Pila (1421.54 MJ ha^{-1}) were lower than in the Sta. Cruz (1941.50 MJ ha^{-1}) due to reduction in herbicides consumption and use of human labour for weeding. Chemical contributed as 6.99%, 13.95% and 10.36% of total energy inputs for rice production in Pagsanjan, Sta. Cruz and Pila, respectively. Based on yield level groups, chemical energy inputs was 1023.06 MJ ha^{-1} for LYG, 1439.85 MJ ha^{-1}for AYG and 1937.81 MJ ha^{-1}for HYG. Also, it contributed as 10.29%, 10.19% and 10.22% of total energy inputs for rice production in LYG, AYG and HYG, respectively (Table 4). In this study, the total input energy was higher in rice production in High Yield Group (HYG) than in other groups, resulted from more fertilizers inputs and consequently of chemicals and labours.

Fuel energy input was the highest average energy consumption of total energy input after chemical input in rice production. The average energy input for fuel in the field was 1352.18MJ ha^{-1} and contributed as 9.79% of total energy input. Fuel contributed as12.46% (1239.03 MJ ha^{-1}), 10.19% (1435.52 MJ ha^{-1}) and 7.67% (1379.76 MJ ha^{-1}) of total energy input for rice production in LYH, AYG and HYG, respectively (Table 3 and 4). Fuel input mainly consumed in tillage, threshing and blowing than in other operation. The result of

Kazemi et al (2015) study indicated the highest energy use in rice production belonged to fuel consumption. And also Chauhan et al. (2006), Eskandari et al. (2011) and Pishgar-Komleh et al. (2011) stated that fuel input plays a vital role in energy input for rice production. In general, there is considerable high fuel consumption in rice production: Old machineries and weedy land to be tillage. In order to optimize fuel energy consumption and to reduce fuel consumption efficient machineries should be used, especially hand tractor, tiller, thresher and blower. Reducing fossil fuel consumption can improve energy use efficiency but also reduce GHG, CO_2 emission into the atmosphere.

Seed is one the most important inputs in the rice production. As the result of this study, the average contribution of seed energy input was higher than labour energy input of total energy input. It shared about 7.71% of total input (Table 4). The amountof seed was used 64.52, 60.45 and 64.62 Kg ha^{-1} in LYG, AYG and HYG, respectively (Table 2). Table 3 shows the energy equivalent of seed was 1081.90 MJ ha^{-1}, 1014.25 MJ ha^{-1} and 1066.37 MJ ha^{-1}, in LYG, AYG and HYG, respectively. It accounted of total energy input for 10.88% in LYG, 7.18% in AYG and 5.93% in HYG (Table 4). The result of Bautista et al. (2010) reported that N, fuel and seeds contributed around 80% of the total energy inputs in all faming system of rice production in the Philippines. However, the result of Kazemiet al. (2015) reported that the seed energy input accounted for about 2% of the total energy inputs in rice production of Iran.

Results revealed that 470.67 h of human labour and 30.02 h machine power were required per hectare in rice production of studied area. Among the studies yield level groups, HYG showed the highest use of human labour. Energy share from human labour for rice production of LYG, AYG and HYG were as 8.31%, 6.51% and 5.73%of related total energy inputs (Table 4). The majority of human labour in rice production was used in the land preparation, transplanting, weeding and harvesting. The source of human labour in the surveyed rice productions is either family members or mainly from hired (contract) labours. In general, there is scarcity of labour during peak time of transplanting and harvesting in the study area. The input of machinery consumed 27.10 h, 31.86 h and 31.11 h for rice production of LYG, AYG and HYG, respectively. The majority of machine power was used in the land preparation, seedbed preparation, and threshing and blowing.

Except for irrigation water, all other inputs were considered for energy input in the three yield level groups and the three municipals. Irrigation usually was done by gravity water using cannel through the whole season in the study area. However, some of the farmers use pumping water when the water was needed to irrigate the field during the lack of source of gravity water. Rice framer need to pay money the national irrigation committee for irrigation water by volume. This study did not concern it in term of energy cost.Kazemi et al. (2015) stated that high precent of energy consumption was irrigation water due to being pumped from the tube well. Thus, these areas are suitable for the rice production in term of availability of irrigation water resources.

Table 5 displays the mean comparison of total energy input, energy output, yield, energy use efficiency, energy productivity and specific energy for rice production in different municipals and different yield level groups. The results of the study revealed a clear variation of yield, Total Energy Input (TEI), Energy Output (EO), Energy Use Efficiency (EUE), Energy Productivity (EP) and Specific Energy (SE) among the different municipals. However, Energy Use Efficiency (EUE), Energy Productivity (EP) and Specific Energy (SE) was not significantly different, only total energy input, energy outputs and yield are significant different among the different yield level groups. It could be conclude that the energy inputs used parameters are only statistically different in three municipality, not in among different yield levels groups. Total average energy output and input were calculated as 82622.50 MJ ha^{-1} and 14157.86 MJ ha^{-1} respectively.

Table5. Energy input, Energy Output and Energy use parameters in rice production of three different yield level groups and in three different Municipals, Laguna, Philippines.

	Pagsanjan	Sta. Cruz	Pila	LYG	AYG	HYG
TEI (MJ/ha)	15248.02[a]	13918.22[b]	13724.00[b]	9943.61[c]	14132.09[d]	17980.93[e]
EO (MJ/ha)	83489.13[a]	79285.36[b]	85093.02[a]	56461.67[c]	82651.48[d]	103783.36[e]
Yield (kg/ha)	4984.43[a]	4733.46[b]	5080.18[a]	3370.85[c]	4934.42[d]	6196.02[e]
EUE	5.67[a]	5.82[a]	6.38[b]	5.84[c]	6.06[c]	5.97[c]
EP (kg/MJ)	0.34 [a]	0.35[a]	0.38[b]	0.35[c]	0.36[c]	0.36[c]
SE (MJ/kg)	3.19[a]	2.93[b]	2.70 [b]	3.06[c]	2.87[c]	2.90 [c]

[a]Different letters show significant difference of means at 5% level. Mean comparisons are related to data in row of different between groups, and in different among locations.

Differences in rice yields were seen among the studied municipals and consequently in energy outputs. These differences were the results of variation in environmental conditions, agronomic managements, such as planting date and time of nutrient applications, and amount of energy input. Results show the higher energy output was associated with the rice production in Pila and Pagsanjan than Sta. Cruz(Table 5). However, the total energy input was 15248.02 MJha^{-1} in rice production of Pagsanjan, significantly higher than the other two municipals. Also there was no different total energy input between Sta. Cruz and Pila but energy out and yield were different. Thus the results revealed clearly that energy output of rice production was influenced by not only total energy inputs but also farm locations. The rice yields of different three level groups were significantly different each other and consequently in energy output. The highest energy output and total energy input were seen in the HYGwhile the lowest yield and energy output occurred in LYG because of the lowest total energy input compare to other groups (Table 5). As the result the study pointed out again that more energy inputs were required in order to increase yield level in rice production. On the other hand, not enough energy inputs will directly affect the rice yield and energy output of rice production.

Energy Use Efficiency (EUE), Energy Productivity (EP), and Specific Energy (SP) in the three different groups and three municipals of Laguna province, Philippines are shown in (Table 5). Regarding with the data analysis, the energy use efficiency varied from 5.67 for Pagsanjan to 6.38 for Pila, and from 5.84 for LYG to 6.06 for AYG. There was no difference recorded between Pagsanjan and Sta. Cruz municipals for this variable. Energy use in rice production of Sta.Cruz and Pagsanjan was lower efficient than the Pila because of thehigher total energy input in Pagsanjan and the lower energy output in Sta. Cruz. Also, no difference was recorded among three yield level groups for energy use efficiency. In this study, results reflected that energy use in rice production of HYG is not efficient and on the other hand the environment is polluted due to mainly excess input use. Therefore, reducing and optimizing inputs would be helpful to provide more efficient energy use in rice production. By maintaining the high yield of rice production with decreasing the energy inputs use will be efficient for HYG.

The specific energy and energy productivity of rice production was 3.06 MJ kg^{-1} and 0.35 kg MJ^{-1} in LYG, 2.87 MJ kg^{-1} and 0.36 kg MJ^{-1}in AYG and 2.90 MJ kg^{-1}and 0.36 kg MJ^{-1}in HYG, respectively (Table 5). The comparison of these values was not significantly different among each group but it was between municipals. According to different locations specific energy of rice production was 3.19 MJ kg^{-1}, 2.93 MJ kg^{-1} and 2.70 MJ kg^{-1} in Pagsanjan, Sta. Cruz and Pila, respectively. It was significantly higher in Pagsanjanthan the other two municipals. The energy productivity of rice production was 0.34 kg MJ^{-1}, 0.35kg MJ^{-1} and 0.38kg MJ^{-1} in Pagsanjan, Sta. Cruz and Pila, respectively. Energy productivity or rice production in Pila was significantly higher than inPagsanjan and Sta. Cruz municipals. The results of present study revealed that the rice production was more efficiency and productive in term of energy use in Pila than in Pagsanjan and Sta. Cruz. Specific energy, energy input requirements to produce one unit of rice in Pagsanjan was higher than in Pila and Sta. Cruz. In general, it is because environmental constraints such as combination of unsuitable land, weed and pest, unsufficien irrigation water, infertile soils significantly increase energy requirement and reduce its energy efficiency. By using high energy inputs to achieve high yield level will not be a good way to enhance the energy use efficiency and energy productivity of rice production according to the yield level group analysis, but also it will finally degrade the environmental resources.

Table 6 shows the total energy input as renewable, non-renewable, direct and indirect forms and its distribution of total energy input. Direct energy input ranged from 7.67% to of the total energy inputs in HYG to 12.46% in the rice production of LYG. On average 82.08% of total energy input used in rice production belonged to non-renewable, while the share of renewable energy was 17.92%. Also, the contributions of direct and indirect energy input were as 9.79% and 90.21%, respectively. Several researchers showed that the contribution of non-renewable energy is greater than that of renewable energy in crop productions (Shahanet al., 2005 and Yilmazet al., 2005). In this study, the energy inputs of rice productions derived mainly from these non-renewable and indirect sources.

Table6. Total energy input in the form of direct, indirect, renewable and non-renewable source of rice production and its share in different yield level groups and municipals

Forms ($MJ\ ha^{-1}$)	Pagsanjan	Sta.Cruz	Pila	LYG	AYG	HYG	Mean
Direct	1371.28	1208.43	1478.83	1239.30	1435.52	1379.76	1352.18
Indirect	13876.74	12709.79	12245.45	8704.32	12696.57	16601.18	12805.67
Renewable	2557.16	2336.84	2554.36	2314.02	2444.92	2659.90	2477.87
Non-renewable	12690.86	11581.38	11169.91	7629.59	11687.16	15321.03	11679.99
Direct (%)	8.99	8.68	10.78	12.46	10.16	7.67	9.79
Indirect (%)	91.01	91.32	89.22	87.54	89.84	92.33	90.21
Renewable (%)	16.77	16.79	18.61	23.27	17.30	14.79	17.92
Non-renewable (%)	83.23	83.21	81.39	76.73	82.70	85.21	82.08

As it can be seen in the (Table 7),the Pearson's correlation coefficient (*r*) between energy output and fertilizer, human labour, chemical and machinery were obtained 0.82, 0.32, 0.24 and 0.16, respectively. It depicted that there was strong correlation between energy output and fertilizer of rice production in this study. Energy output was moderate correlated with human labour input. And there was weak correlation between energy output and chemical and machinery but the correlation of them was significant. Baruah and Dutta (2007) reported that among the farm operations, tillage was the highest energy consuming operation followed by threshing, harvesting and transplanting for all four categories of farms. However, it was observed that rice yield was not positively correlatedwith tillage energy.

Table7. Results of Pearson's correlations analysis between energy output and varies energy inputs of rice production in the present study

Pearson Correlations									
	Seed	Labour	Animal	Manure	Fertilizer	Chemical	Fuel	Machinery	Output
Seed	1	.145	-.172*	.029	-.061	-.022	.183*	.136	.000
Labour	.145	1	.111	-.087	.289**	.245**	.321**	.299**	.322**
Animal	-.172*	.111	1	-.019	.223**	-.089	-.126	-.232**	.082
Manure	.029	-.087	-.019	1	-.051	-.041	.004	-.015	.024
Fertilizer	-.061	.289**	.223**	-.051	1	.164*	.104	.095	.816**
Chemical	-.022	.245**	-.089	-.041	.164*	1	.085	.060	.236**
Fuel	.183*	.321**	-.126	.004	.104	.085	1	.567**	.090
Machinery	.136	.299**	-.232**	-.015	.095	.060	.567**	1	.161*
Output	.000	.322**	.082	.024	.816**	.236**	.090	.161*	1
*. Correlation is significant at the 0.05 level (2-tailed).									
**. Correlation is significant at the 0.01 level (2-tailed).									

Pearson's correlation coefficient between indirect energy input and energy output, energy use efficiency and total energy input were obtained 0.75, -0.46 and 0.99, respectively(Table 8). It revealed that there was strong positively correlation between indirect energy input and energy output and total energy input. However energy use efficiency and indirect energy input was negatively correlated in the rice production of the present study. The results suggest that indirect energy inputs should be used properly to optimize the energy use efficiency of rice production in the study area. Furthermore, direct energy inputs should be reduced to enhance energy use efficiency of rice production because the result of Pearson's correlation was -0.32 between indirect energy input and energy use efficiency , it mean that it is negatively correlated.

Table8. Results of Pearson's correlation analysis between Total Energy Input (TEI), Energy Output and various parameters

	Output	TEI	EUE	Yield	EP	SP	Indirect	Direct
Output	1	.744**	.166*	1.000**	.166*	-.212**	.751**	.090
TEI	.744**	1	-.484**	.744**	-.484**	.448**	.993**	.256**
EUE	.166*	-.484**	1	.166*	.999**	-.937**	-.457**	-.324**
Yield	1.000**	.744**	.166*	1	.166*	-.212**	.751**	.090
EP	.166*	-.484**	.999**	.166*	1	-.938**	-.458**	-.322**
SP	-.212**	.448**	-.937**	-.212**	-.938**	1	.423**	.305**
Indirect	.751**	.993**	-.457**	.751**	-.458**	.423**	1	.144
Direct	.090	.256**	-.324**	.090	-.322**	.305**	.144	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Result of the multiple regressions with particular emphasis on the selected variable that affected yield, energy output of rice production is shown in Table 9. In the present study, three of the six variable tested significantly affected yield. These variables and their corresponding regression coefficient (β) are as follows: fertilizer (β=0.78), chemical (β=0.09), and machinery (β =0.11). The yield of rice production in this study was highly dependent on fertilizer, chemical and machinery. Increase in yield was influenced by fertilizer, chemical and machinery. The use of modern varieties which responded better to fertilizer application explains the effect of fertilizer. Inorganic fertilizer had a positive effect on yield because generally the soils had low fertility level.

Table9. Result of multiple liner regression analysis with particular emphasis on the selected variable that affected the energy output of rice production

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	28985.741	4564.040		6.351	.000
	Seed	2.133	2.250	.042	.948	.345
	Labour	5.304	4.104	.063	1.292	.198
	Fertilizer	4.742	.273	.784	17.366	.000
	Chemical	1.405	.664	.094	2.116	.036
	Fuel	-3.565	2.150	-.088	-1.658	.099
	Machinery	96.987	47.701	.107	2.033	.044

Dependent Variable: Yield (Energy Output) R Square = 0.69

Likewise chemical (herbicide and pesticide) had positive effect on yield. Most chemical energy inputs came from molluscicides and herbicides. In the study area golden snails and weeds were most encountered problem in the rice production. Golden snail attacks the young seedling stage after within three week of transplanting. Thus farmers relied on the chemical to maintain the high yield level. Herbicides were the first most option of rice farmers to control instead of using manual weeding because of labour scarcity, especially, during the growing period.Otherwise, the farmers applied machinery energy to prepare the land well to prevent the weed seed germination and weed propagation, and to maintain the irrigation water level.

As a result, machinery use also responded positively to yield because machinery using in the land preparation is more powerful than animal and well soil prepared in rice production enhances the rice yield. Another machinery use was thresher and blower after cutting to separate paddy from the straw. Using machinery in the threshing after harvesting is also done quickly which minimizes the yield losses and it save the time and reduces human labour requirements.Table 7 shows human labour input and energy output were significantly correlated but energy output of rice production was not affected by human labour inputs (Table 8).The result of regression analysis showed that energy output (rice yield) of rice production was significantly influenced by fertilizer, chemical and machinery inputs. It confirmed the important of fertilizer, chemical, and machinery inputs on total energy input in these municipals. And also these energy inputs contributed tremendous amount of total energy input consumption in rice production. Therefore, these energy inputs should be used carefully and properly. It seems to be possible to reduce energy input, especially fertilizer, chemical, seed and machinery by using better management and more efficient ways.

In Philippines, many studies have been conducted to determine the energy efficiency of rice production. However, there is no study as yet conducted regarding the comparison of energy use pattern and efficiency in different yield level groups. Analysis of energy inputs consumption for rice production in three yield level groups in three municipals of Laguna Province, Philippines, showed that energy use efficiency was not significantly different among three yield level groups and it this value was 5.84 for LYG, 6.06 for AYG and 5.97 for HYG. Also, no difference was recorded between Pagsanjan and Sta. Cruz Municipal for this variable. However, energy use efficiency in Pila was 6.38, and significantly higher than other municipals.It is possible to conclude that energy use efficiency can be increased by raising the crop yield with by decreasing or optimizing energy input consumption. The total energy input and total energy output in rice production were significantlydifferent among the groups. Highest its values were founded in HYG of rice production.Energy use in rice production in HYG is not efficient compared to AYG and LYG and detrimental to the environment due to mainly excess input use. The results of the research revealed that energy output and fertilizer, human labour, chemical and machinery were significantly correlated in the rice production. And also indirect energy input and energy output strongly correlation was observed but indirect energy input was negatively correlated with energy use efficiency. On average non-renewable energy inputs contributed as 82% of total energy input to rice production. The result of regression analysis showed that energy output (rice yield) of rice production was significantly influenced by fertilizer, chemical and machinery inputs. The results of the research confirmed the important of fertilizer, chemical, and machinery inputs on total energy input in these municipals. It seems to be possible to reduce energy input, especially fertilizer, chemical, and machinery by using better management and more efficient ways. Generally it concluded that the further researches need to consider energy use efficiency not only the yield level in the rice production to promote sustainable agricultural production.

ACKNOWLEDGEMENTS

I am grateful to SEARCA, SEARCA-IDRC Scholarship for financial supports for my study in Philippines, and Dr Teodoro C. Mendoza, Professor, Crop Science Cluster, College of Agriculture, University of the Philippines Los Banos for the precious guidance. And I also would like to thank Ms Jasmin C. Bondad, Municipal Agriculturist, Pila, Ms Roselyn V. Pagtananan, Agricultural Technician, Pagsanjan, and Ms Edith R. Tobias, Agricultural Technician, Sta. Cruzfor their assistance and facilitatingin field data collection in this study.

REFERENCES

Alipour, A., Veisi, H., Darijani, F., Mirbagheri, B. and Behbahani, A.G., 2012.Study and determination of energy consumption to produce conventional rice of the Guilan province.*Research in Agricultural Engineering*, *58*(3), pp.99-106.

Banaeian, N. and Zangeneh, M., 2011. Study on energy efficiency in corn production of Iran. *Energy*, *36*(8), pp.5394-5402.

Baruah, D.C. and Dutta, P.K., 2007.An investigation into the energy use in relation to yield of rice (Oryzasativa) in Assam, India.*Agriculture, ecosystems & environment*, *120*(2), pp.185-191.

Bautista, E.G. and Minowa, T., 2010.Analysis of the energy for different rice production systems in the Philippines.*Philippine Agricultural Scientist*, *93*(3), pp.346-357.

Beardsworth, E., 1975. *Perspective on energy accounting.[In conjunction with Public Law 935-77]* (No. BNL-20730; CONF-751107-15).Brookhaven National Lab., Upton, NY (USA).

Beckman, J., Borchers, A. and Jones, C.A., 2013.Agriculture's supply and demand for energy and energy products.*USDA-ERS Economic Information Bulletin*, *112*.

Bockari-Gevao, S.M., bin Wan Ismail, W.I., Yahya, A. and Wan, C.C., 2005. Analysis of energy consumption in lowland rice-based cropping system of Malaysia.*Energy*, *27*(4), p.820.

Cervinka, V., 1980.Fuel and energy efficiency.*Handbook of energy utilization in agriculture*, pp.15-21.

Chauhan, N.S., Mohapatra, P.K. and Pandey, K.P., 2006. Improving energy productivity in paddy production through benchmarking—an application of data envelopment analysis. *Energy Conversion and Management*, *47*(9), pp.1063-1085.

De Datta, S.K., 1975. *Major research in upland rice*.International rice research institute.

Doering, O.C., 1980. Accounting for energy in farm machinery and buildings.*Handbook of energy utilization in agriculture*, pp.9-14.

Esk, F., Bahrami, H. and Asakereh, A., 2011.Energy survey of mechanized and traditional rice production system in Mazandaran Province of Iran.*African Journal of Agricultural Research*, *6*(11), pp.2565-2570.

Fluck, R.C., 1992. Energy in world agriculture series, V. 6.*Energy Analysis for Agriculture Systems. Amsterdam: Elsevier, NL*, pp.45-51.

Fluck, R.C. and Baird, C.D., 1982. Agricultural energetics.University of Florida.*Agricultural Engineering Department, Gainesville, FL, USA*.

Gliessman, S.R., 2014. *Agroecology: the ecology of sustainable food systems*. CRC Press.

Heichel, G.H., 1980. Assessing the fossil energy costs of propagating agricultural crops.*Handbook of energy utilization in agriculture/David Pimentel, editor*.

Herdt, R.W. and Wickham, T., 1978.Exploring the gap between potential and actual rice yields: the Philippine case.*Economic Consequences of the New Rice Technology*, p.3.

Iqbal, M.T., 2007. Energy input and output for production of boro rice in Bangladesh. *EJEAFChe*, *6*(5), pp.2144-2149.

Kazemi, H., Kamkar, B., Lakzaei, S., Badsar, M. and Shahbyki, M., 2015.Energy flow analysis for rice production in different geographical regions of Iran.*Energy*, *84*, pp.390-396.

Kizilaslan, H., 2009. Input–output energy analysis of cherries production in Tokat Province of Turkey.*Applied Energy*, *86*(7), pp.1354-1358.

Kuswardhani, N., Soni, P. and Shivakoti, G.P., 2013. Comparative energy input–output and financial analyses of greenhouse and open field vegetables production in West Java, Indonesia.*Energy*, *53*, pp.83-92.

Lockeretz, W., 1980. Energy inputs for nitrogen, phosphorus, and potash fertilizers. *Handbook of Energy Utilization in Agriculture [David Pimentel, Editor]*, pp.23-24.

Mendoza, T.C., 2005. Energy-based analysis of organic low external input sustainable agriculture (LEISA) and conventional rice production in the Philippines.*Philippine Agricultural Scientist (Philippines)*.

Moreno, M.M., Lacasta, C., Meco, R. and Moreno, C., 2011. Rainfed crop energy balance of different farming systems and crop rotations in a semi-arid environment: results of a long-term trial. *Soil and Tillage Research*, *114*(1), pp.18-27.

Mudahar, M.S. and Hignett, T.P., 1987. Energy requirements, technology, and resources in the fertilizer sector.*Energy in world agriculture*.

Nabavi-Pelesaraei, A., Abdi, R., Rafiee, S. and Taromi, K., 2014. Applying data envelopment analysis approach to improve energy efficiency and reduce greenhouse gas emission of rice production. *Engineering in Agriculture, Environment and Food*, *7*(4), pp.155-162.

Nassiri, S.M. and Singh, S., 2009. Study on energy use efficiency for paddy crop using data envelopment analysis (DEA) technique. *Applied Energy*, *86*(7), pp.1320-1325.

Ortiz-Cañavate, J. and Hernanz, J.L., 1999.Energy for biological systems.*Energy and biomass engineering*, *5*, pp.13-24.

Ozkan, B., Akcaoz, H. and Fert, C., 2004. Energy input–output analysis in Turkish agriculture.*Renewable energy*, *29*(1), pp.39-51.

Pimentel, D., 1980. Handbook of energy utilization in agriculture.CRC Press, Boca Raton, Florida.

Pishgar-Komleh, S.H., Sefeedpari, P. and Rafiee, S., 2011.Energy and economic analysis of rice production under different farm levels in Guilan province of Iran.*Energy*, *36*(10), pp.5824-5831.

Ren, L.T., Liu, Z.X., Wei, T.Y. and Xie, G.H., 2012. Evaluation of energy input and output of sweet sorghum grown as a bioenergy crop on coastal saline-alkali land.*Energy*, *47*(1), pp.166-173.

Safa, M. and Samarasinghe, S., 2011. Determination and modelling of energy consumption in wheat production using neural networks:"A case study in Canterbury province, New Zealand". *Energy*, *36*(8), pp.5140-5147.

Safa, M., Samarasinghe, S. and Mohssen, M., 2011. A field study of energy consumption in wheat production in Canterbury, New Zealand. *Energy Conversion and Management*, *52*(7), pp.2526-2532.

Šarauskis, E., Buragienė, S., Masilionytė, L., Romaneckas, K., Avižienytė, D. and Sakalauskas, A., 2014.Energy balance, costs and CO 2 analysis of tillage technologies in maize cultivation.*Energy*, *69*, pp.227-235.

Schnepf, R.D., 2004, November. Energy use in agriculture: Background and issues. Congressional Information Service, Library of Congress.

Shahan, S., Jafari, A., Mobli, H., Rafiee, S. and Karimi, M., 2008. Energy use and economical analysis of wheat production in Iran: A case study from Ardabil province. *Journal of Agricultural Technology*, *4*(1), pp.77-88.

Singh, R.B., 2002. The state of food and agriculture in Asia and Pacific IFA and FAO.*Parries, France*, pp.1-21.

Sinha, S.K., 1986. Energy balance in agriculture: the developing world. *Natural resources and the environment series*.

Soriano, A. S., 1982. Energy-based analysis of alternative production system in irrigated lowland rice. M.S. Thesis. College Laguna, Philippines: University of the Philippines Los Banos.123p.

Vaughan, D.H., Smith, E.S. and Hughes, H.A., 1977. Energy requirements of reduced tillage practices for corn and soybean production in Virginia.In *Agriculture and Energy. St. Louis, Mo.(USA). 17-19 Jun 1976.*.

Verma, A.K. and Dewangan, M.L., 2006. Efficiency and energy use in puddling of lowland rice grown on Vertisols in Central India.*Soil and Tillage Research*, *90*(1), pp.100-107.

Yilmaz, I., Akcaoz, H. and Ozkan, B., 2005. An analysis of energy use and input costs for cotton production in Turkey.*Renewable Energy*, *30*(2), pp.145-155.

NUMBER OF ARBUSCULAR MYCORRHIZA FUNGI SPORE FROM TRAP CULTURE AFFECTED BY TYPE OF MEDIA USED

MARIA VIVA RINI

Department of Agrotechnology, Faculty of Agriculture, TheUniversity of Lampung
Email: vatrin66@yahoo.com

ABSTRACT

Trap culture is commonly technique used to develop fresh and viable spore of arbuscularmycorrhiza fungi (AMF) from field soil sample. In this study, soil sample for trap culture were collected from rhizosphere of 3 years old *Albizia* (Sengon) plantation. Two media were tested consisted of mixture of river sand and zeolite and mixture of malang sand and zeolite. Maize as the host plant was used in these media. The pot cultures were maintained for 3 months and let to dry for another 2 weeks. At the end of study, spore number were determine using wet sieving method and the result showed that media of mixture of river sand and zeolite had higher number of spore (91.0 spore/10 g media) compared to mixture of malang sand and zeolite which only had 41.0 spore per 10 g media. The AMF root infection in maize was also determinedby using tryphan blue dye. The result obtained showed that there was no different rate of AMF infection between two tested media.

Key words: Arbuscularmycorrhiza fungi, trap culture, spore, root infection

INTRODUCTION

Arbuscularmycorrhizal fungi (AMF) are fungi that belong to the Phylum Glomeromycota that form symbiosis with the roots of most plant. The AMF are believed to support plant growth by increasing the supply of immobile nutrient and water and improving plant tolerance to soil pathogen as well as a-biotic stresses (Babaj*et al*., 2014; Faceli*et al*., 2009; Siddiqui and Pichtel, 2008).It is generally accepted that AMFare non-specific in their selection of host, since in nature they have been found to infect plant species belonging to different genera, family, or class (Smith and Read, 2008; Hijri, 2006). Because of the AMF advantage, most of bio-fertilizer based on AMF sporeis now commercially available.

Naturally, AMF present in the soil from savanna to forest ecosystem in form of spore, external hyphae, or infected root. However, the population and their diversity is vary depend on host type, soil fertility, humidity, soil chemistry, and climate (Smith and Read, 2008; Jie*et al*., 2013). However, not all AMF spores present in the soil sample were in good condition physically nor high germination rate. Some spores were broken or parasitized by other soil microorganisms. To develop AMF inoculum as bio-fertilizer, trap culture of field rhizosphere soilcan be used to develop AMF starter inoculum (Douds*et al*, 2000; Sieverding, 1991). Soilless media which have lower bulk density, providing better aeration and allowing to control over the substrate chemical composition have successfully been used for mycorrhizal propagation such as sand, perlite, expanded clay, peat and vermiculite (Sharma *et al*., 2000; Corkidi, 2008). The majority of researchers used sterilized sand augmented with a nutrient solution as a growth media for propagation of AMF (Ridgway *et al*., 2006), however this media is too coarse with very low water holding capacity which effect the growth of the host plant. Therefore, in this study two type of sand (river sand and malang sand) were mixed with zeolite which have high water holding capacity and cation exchange capacity were usedto elaboratetheir effect on AMF spore production.

MATERIAL AND METHOD

Study sites

Soil sample was collected from area with 3 years old *Albiziafalcataria*(Sengon)plantation at Jember - East Java -Indonesia(8° 10' S, 113° 42' E and 133 m abl). The*Albizia*were planted at rectangle 2 x 1 m planting distance and the space between *Albizia* stand were covered by *Puerariajavanica* and some grass species. No fertilizer was applied for the last two years.

Sampling Procedure

Soil samples were collected on 8th August 2011. TwentyAlbiziatrees were randomly sampled. Soils were taken from 8 points at a circle with radius of1 m from the tree and using soil core to 20-25 cm depth. The soils plus roots were uniformly bulked to form a composite sample and 3 kg of it then was taken and stored in sealed plastic bags for further study. About 250 kg of soil from each soil sample were air dried for chemical and physical analysis.The soil chemical and physical characteristics were presented at Table 1.

ISBN 978-602-0860-10-7

Table 1. Soil chemical and physical characteristics at sampling sites

Soil Characteristic	Unit	Value
Chemical properties		
pH H_2O (1:1)		5.2
C-org (Walkey& Black)	%	1.60
N-Total (Kjeldal)	%	0.17
P-HCl 25%	ppm	155.3
P- Bray	ppm	16.0
K – Bray	ppm	46.3
Physical Properties		
Sand	%	7.83
Clay	%	57.79
Silt	%	34.4

Trap Culture

Trap culture of soil sample is usually used to enrich the AMF propagule including spore from the soil sample. In this study, trap culturewas doneby using two different media (1) mixture of river sand: zeolite (V:V=1:1) and (2) mixture of malang sand and zeolite (V:V=1:1). Maize as a trap plantswere used with10 replications.Clean pots (1 L volume) were filled with 400 g sterilized river sand and zeolite or river sand and malang sand, according to treatment at the bottom and about 300 g soil sample from rhizosphere of *Albizia* was placed on top of sterilized media. Seedsofmaize were surface sterilized with 30% clorox for 15 minutes and washed several times. Four seeds were planted and the pots were kept in the glass house for 3 months. The trap pot cultures were watered daily and fertilized with 20 ml red hyponex (2 g/L) per pot every two days for two months. Three months after planting, no water was added for another two weeks in order to stimulate the trap plants to dry and the AMF produce spores. Two weeks after drying periods, the media from pot cultures were taken out and sterilized media at the bottom of pot media and the roots of the trap plant were separated and mixed thoroughly. Fifty gram of sterilized media was then sieved (using 45 and 500 μm sieves) by wet sieving method (Brundrett*et al.*, 1996) to isolate AMF spores. Spore counting was done manually under stereo microscope.The roots of host plants were randomly sampled about 2 gram and stain with tryphan blue according to the method of Brundrett*et al.*,

1996) and AMF root infection were determined.Data obtained were subjected to t-test analysis

RESULTS AND DISCUSSION

The results from the trap culture experiment for rhizosphere soil of *Albizia* showed thatthe number of spore harvested were significantly higher in mixture of river sand with zeolite as the growing media when compared to mixture of malang sand with zeolite (Figure 1). Mixture of river sand with zeolite gave spore number of 91.1 per 10 g media while the mixture of Malang sand and zeolite only gave 14.0 spores per 10 g media.

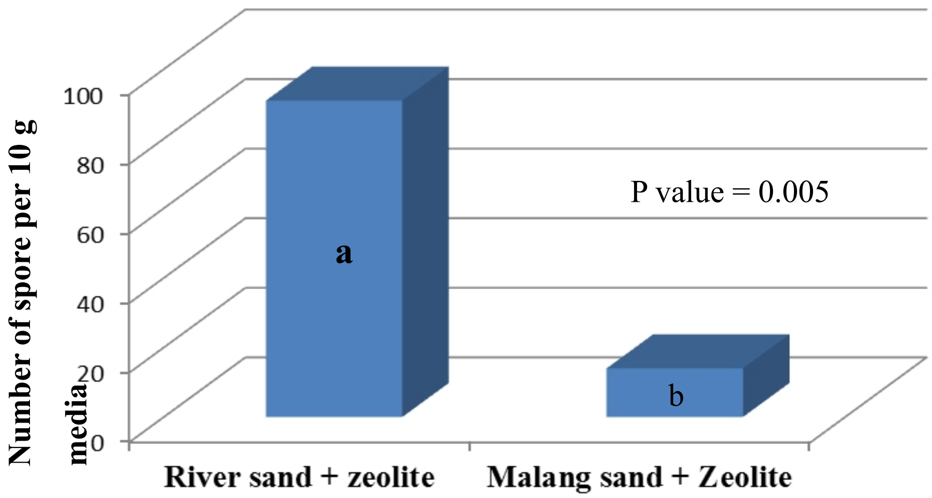


Figure 1. Spore number of AMF from trap culture using two different media.

Based on the result obtained, mixture of zeolite with the river sand was a better growing media to propagate AMF spore in trap culture. The river sand size is smaller than zeolite, so the sand particle covered the macro pores formed between particles of zeolite which have bigger size. This combination can hold more water for the plant andgive good condition for the root of host plants to grow as well as the external hyphae of the AMF, hence the production of AMF spore in the pot culture was better than the other media. In addition, zeolite also has higher CEC (BalaiPenelitian Tanah, 2010) which can retain the nutrient added into the media and available for the host plant root. The better host plant growth support AMF growth and development because they provide organic carbon to the fungi (Treseder, 2013; Giovannetti*et al*, 2010).The malang sand size is higher than river sand and almost the same with zeolite. This combination of growing media had a lot of macro pores which make the media very porous with low water holding capacity. Therefore, the host plant could not grow well consequently affected the development of AMF hyphae and AMF spore production.

In contrast to number of spore, no significant difference was obtained in root infection between the two media tested (Table 2).This result indicated that the host plant used was suitable for the AMF present in the soil. The AMF infect the root and develop along the root system massively as the rate of root infection was above 90%. Although the root infection was very high (>90%), it can be assumed that the hyphae of AMF growth outside of the rootare affected by the growing media used (Figure 1). This result also in agreement with other result that the rate of root infection is not always has correlated with the external hyphae growth in the growing media (Rini, 2001)

Table 2. Maize root infection by AMF from trap culture of Albiziarhizosphere soil

Media	Root Infection (%)
River sand:zeolite	96.0
Malang sand:zeolite	94.0
P value	Not significant

From the results of this study, it can be concluded that the mixture of river sand and zeolite is a suitable media for the trap culture of AMF as this media produced significantly higher AMF spore when compared to the mixture of malang sand and zeolite.

REFERENCES

Babaj, I., G. Sallaku and A. Balliu. 2014. The effect of endogenous mycorrhiza (*Glomus spp.*) on plant growth and yield of grafted cucumber (*Cucumissativus*) under common commercial greenhouse conditions.*Albanian J. Agric. Sci*. 13 (2): 24—28.

Balai Penelitian Tanah. 2010.Pembenah tanah Zeo KkapKan meningkatkan efisiensi serapan $NH4^{+}$pupuk Urea dan produksi pada tanah sawah Grumusol di Ngawi Jawa Timur. Laporan Penelitian.

Brundrett, M., N.Bougher, B.Dell, T.Grove, and , N. Malajczuk. 1996.*Working with Mycorrhizas in Forestry and Agriculture*, Australia Centre for International Agricultural Research (ACIAR), Canberra.

Corkidi, L., M. Evans and J. Bohn. 2008. An introduction to propagation of arbus cular mycorrhizal fungi: in pot cultures for inoculation of native plant nursery stock. *Native Plant Spring*. 9 (1): 29—38.

Douds, D.D. Jr, V. Gadkar, and A. Adholeya. 2000. Mass production of VAM fungus biofertilizer.In *Mycorrhizal Biology*. Edited by K.G. Mukerji, B.P. Chamola, and J. Singh, pp.197—215. Kluwer Academic/Plenum Publisher. New York.

Faceli, E., S.E. Smith, and A. Smith. 2009. Mycorrhizal symbiosis – overview and new insight into roles of arbuscularmycorrhizas in agro- and natural ecosystem. *Asutralian Plant Pathology Soc*. 38: 338—344.

Giovannetti, M., L. Avio and C. Sbrana. 2010. Fungal spore germination and pre-symbiotic mycelial growth – physiological and genetic aspects. In *Arbuscular Mycorrhizas: Physiology and Function.* Edited by H. Koltai and Y. Kapulnik, pp. 3—32. Springer Science + Business Media B.V. London.

Hijri, I., Z. Sykorova, F. Oehl, K. Ineichen, and P. Mader. 2006. Communities of arbuscularmycorrhizal fungi in arable soils are not necessarily low in diversity. *Molecular Ecology*, 15: 2277—2289.

Jie, W., X. Liu and B. Cai. 2013. Diversity of rhizosphere soil arbuscularmycorrhizal fungi in various soybean cultivars under different continuous cropping regimes. *Plos one*. 8 (8): 1—9. www.plosone.org.

Ridgway, H.J., J. Kandula and A. Stewart. 2006. Optimising the medium for producing arbuscularmycorrhizal spores and the effect of inoculation on grapevine growth. *New Zealand Plant Protection*.59: 338—342.

Rini, M.V. 2001. Effect of arbuscularmycorrhiza on oil palm seedling growth and development of basal stem rot diseasecaused by *Ganodermaboninense*. Desertation. Universiti Putra Malaysia.

Sharma, A.K., C. Singh and P. Akhauri. 2000. Mass culture of arbuscularmycorrhizal fungi and their role in biotechnology. In Proceeding of Indian Natn. Sci. Acad (PINSA) pp 223—238.

Siddiqui, Z.A. and J. Pichtel. 2008. Mycorrhiza: an overview. *In Mycorhizae: Sustainable Agriculture and Forestry*. Edited by Z.A. Siddiqui, M.S. Akhtar, and K. Futai, pp. 1—35.Springer Science + Business Media B.V. No Place.

Sieverding, E.(1991) *Vesicular Arbuscular Mycorrhizae Managementin Tropical Agroecosystem*, Deutsche Gesellschaftfur Technische Zusammenarbeit (GTZ) Gmbh, Eschborn.

Smith, S.E. and D.J Read, 2008. *Mycorrhizal Symbiosis*, 3rd edition, Elsevier, NewYork.

Treseder, K.K. 2013. The extent of mycorrhizal colonization of roots and its influence on plant growth and phosphorous content. *Plant and Soil*.371: 1—13.

DYNAMICS OF CLIMATICAL CHANGES AND RICE PRODUCTION IN SOUTH SUMATRA, INDONESIA

Supli Effendi Rahim[1)], Nurhayati Damiri[2)] and Indra Purna[3)]
[1)] Agricultural Faculty, University of Palembang,Palembang, South Sumatra, Indonesia. Email: sup_effendi@yahoo.co.id
[2)] Agricultural Faculty, University of Sriwijaya, Indralaya Ogan Ilir, South Sumatra, Indonesia. Email: nurhayatidamiri@yahoo.co.id
[3)] Meteorology, Climatology and Geophysics Agency, Kenten, Palembang, South Sumatra, Indonesia. Email: bmkg.indra@gmail.com

ABSTRACT

Climate change causes an interruption in the production of rice plants that affect food security conditions in South Sumatra. This paper aimed to describe the dynamics of climatical changes and the rice production and needs in South Sumatra Province in the years of 2006-2025. The research used an approach that integrates numerical and spatial models. Numerical model simulations rice crops explain the relationship between the physical environmental conditions with the physiological condition of the plant in the form of mathematical equations. Input model consists of weather elements. Data gathered in this study were from the Agency of Agricultural food Affairs of South Sumatra province and from the Meteorology, Climatology and Geophysics Agency (MCGA), Kenten, Palembang South Sumatra. The gathered data were analyzed and discussed. Results of this study showed that: 1) Changes in annual rainfall showed similar trends with the rice productions in South Sumatra. In the years before 2010, a steady increase of annual rainfall was followed by a steady decrease of rice productions in the province. Similar trends were also obvious by the years after 2010. The falling amount of annual rainfall were in agreement with the decrease in the harvested area of paddy rice and hence the rice productions, and 2) The availability of rice would not be in deficit for a long time. In 2025 there was a surplus of rice by nearly three million tonnes. A total surplus of nearly one million ton has been started since 2006 and in 2014, and 3) Necessary strategic steps are suggested to maintain food security as the efforts to cope with the future impacts of climate change.

Keywords: climate change, production, rice plant, environmental condition, soil

INTRODUCTION

The phenomenon of climate change has been happening and is expectedly to occur in the years to come. In principle, climate change happens when some elements of climate intensity deviate from certain direction. Various scientific studies have reported that carbon dioxide (CO_2) in the atmosphere layer that results from the combustion of coal, forest fires, oil and gas, has increased by almost 20 % since the beginning of the industrial revolution. Mudiarso (2003) explains that the industrial estates produce waste "greenhouse gases" (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), which can lead to "blanket effect". This results in a rise in temperature of the earth's surface including rice fields.

Climate change is characterized by among others, higher average air temperature and diminishing and erratic rainfall. Since the industrial revolution, global temperature started to increase at the end of the 18th century and to date has increased about 1 ^oC. A climatology prediction suggests that the rise in temperature 1^oC until 1,5 ^oC has been happening. Rice Research Institute in the Philippines (IRRI) reported that an increase in air temperature of 1^oC causes 10% decrease of rice production and threatens security of the world population. Without any action, temperature can increase even further. However, global climate change has not had a significant impact on food production in South Sumatra, especially rice. This is indicated by an increase in rice production in this area from year to year (IRRI, 2004).

Global climate change is believed to have impact on the effort of strengthening food security nationally and regionally, especially in South Sumatra. Anticipatory measures are needed to fullfil rice consumption and its availability. These measures should be taken based on an understanding of the capabilities and dynamics of agricultural production as affected by climate change and anomalies. A simulation model could be used to estimate the impact of climate change on rice production. The simulation model could be used to explain the process in a cropping system at various levels of complexity and is flexible in the synthesis of information because it can explain the system output for the feedback system consisting of a number of environmental factors and the application of cultivation techniques.

Some researchers have discovered and predicted that the northern part of the islands of Sumatra and Borneo shows a rainfall pattern in which rainfall intensity tends to decrease and take a longer period. By contrast , in other regions in Indonesia the rainfall tends to increase with shorter period (Naylor, 2007). According to Boer *et al*. (2009) spatial changes occurs nationally, where rainfall in the rainy season is more diverse than that the dry season. In the southern part of Sumatra, climate change has resulted in longer dry season.

A simulation model of plants could be used to (1) get more understanding of the interaction effects of their physiological and environmental conditions and (2) obtain information on management practices that can be done by farmers and to provide information to decision makers to make predictions Using the simulation model, the response of crops, soil, weather and management to climate change could be predicted (Djufry, 2005). One advantage of the application of simulation model is that it could predict using a quantitative approach that can be applied on a wider scale. Food security is a system that consists of three sub-systems i.e sub-system of food availability, food distribution, and food consumption. All of the sub-systems have supporting aspects. Food production and reserves support food avalilability. Food accessability and price support food distribution. Food diversification supports food consumption. Food production that support food availability is influenced by several factors such as climate, availability of land and water, and physical and chemical properties of soil.

Rahim (2016) reported that there existed variations of climatic elements that seemed to have impacts on the planting indexes both positively and negatively. High measurements of annual rainfall can increase planting index for some districts in one side, on the other side they decrease the planting index for other districts. Furthermore, variations in annual rainfall increased the paddy land productivities in some years but decrease them in other years. How the dynamics of climate changes affect the productions and needs for future matters remain unanswered.

This study aimed to describe the dynamics of climate changes and the rice production and needs in South Sumatra Province in the years of 2006-2025. Results of this research could be used as guidelines for rice program facing the climate changes in the next decades in South Sumatra.

RESEARCH METHODS

This research was conducted as a quantitative descriptive research. of the secondary and primary data for the areas of the scope analysis of region of South Sumatra, including data from the Agency of Agriculture Food Affairs in the province of South Sumatra and from Meteorology, Climatology and Geophysics Agency (MCGA), Kenten, Palembang. Climate data were the results of measurement from 2006 to 2015. Materials and tools used are: Administrative map of South Sumatra Province; GPS (Geoposition System); The city and districts which were included in the study were Palembang, Banyuasin, Ogan Komering Ilir (OKI), Ogan Ilir (OI), Ogan Komering Ulu (OKU), South Ogan Komering Ulu, East Ogan Komering Ulu, Musi Rawas, Muara Enim and Lahat. Rice crop simulation models of Shierary Rice developed by Handoko (1994). This model was used to predict rice production. The elements used in this model were the average air temperature, precipitation, rain days and rice production for city and districts that were selected purposively. Data of air temperature, precipation, raindays and production were gathered and analyzed in accordance with the requirements of simulation model of Shierary Rice for rice production and productivity. Results of the analysis will show the dynamics of climatic and rice production changes in South Sumatra in the period of 2006 – 2025.

RESULTS AND DISCUSSION

Dynamics of Rainfall in South Sumatra

The climate in South Sumatra is included in a tropical climate which is influenced by Munson wind. In October to March the wind blows from the northern hemisphere that bring moist air mass so that the rainy season is identical in these months, while in April to September the wind blowing from the southern hemisphere causes a dry season. Climate data for the last 10 years showed a prolonged rainy season that caused an unobvious dry season. Data of rainfall and rainy days between 2006-2015 showed that rainfall was not evenly distributed among the districts/cities in the province. Annual rainfall ranges between 1168-4200 mm, with a monthly average of between 110-374 mm, while the number of rainy days between 97-297 days (MCGA Kenten Palembang, 2015).

Annual rainfall in South Sumatra in 2014 when compared with 2006 rainfall has decreased in six districts/cities but increased in five districts/cities. Areas experiencing the highest degradation over a period of 8 years were the Muara Enim regency as much as 47 percent, followed Banyuasin 32 percent, Ogan Ilir 22 percent, Palembang 20 percent, Ogan Komering Ulu 14 percent and Ogan Ilir 10.38 percent. On the other hand, there are some areas that showed an increase in annual precipitation namely Pagar Alam 97 percent, followed by Musi Rawas 96 percent, Banyuasin 62 percent, East OKU 28 percent and South OKU 7 percent (Rahim, 2016). Changes in rainfall patterns as a whole tend to decline when compared with the overall figures. The decline in rainfall was followed by an increase in average annual air temperatures. Results of the rainfall data measurements of the MCGA Kenten Palembang were in line with the broader rainfall changes in the near future period (see the map in Figure 1).

Changes in precipitation that has a close link with the rice production in South Sumatra somewhat delayed the dry season in the months of April, May and June with a marked presence of precipitation is about 200 mm per month. Delays in the water in the marsh subsidence caused delays in planting season for rice planted in both rice swamps and tidal marsh lowland rice. In terms of typology of wetlands occupy an area of the most widespread rice field in South Sumatra. On the other hand, prolonged drought could be disastrous for the people of South Sumatra due to the massive fires that are hard to put down.

Dynamics of Air Temperature

From the simulation results of air temperatures, it is understood that rice production decrease if the air temperature increases an average of 0.5 ° C every five years. Figure 2 showed the map of annual air temperature changes for the near future period in Indonesia including South Sumatra. The increase of air temperature has become obvious in many areas of rice production. This is due to the effect of increased rainfall and air temperature on rice production. The decline in rice production is caused by the disruption of physiological processes (photosynthesis and respiration) in the rice plant. Temperature effects on growth, especially respiration. In the process of respiration, photosynthesis results will be converted into CO_2 and H_2O, so the greater the respiration rate the less the rice yield, and therefore an increase in air temperature should be controlled (Handoko, 1994).

Dynamics of Rainfall, Temperature and Rice Production in 2015-2025 for South Sumatra

Based on observations and calculations of data obtained during the research, it was found that rice productivity experienced a relatively similar dynamic changes between regions and between time. Changes in rice productivity is influenced by many factors, among others, annual rainfall but slightly due to changes in monthly and annual air temperature. Reports by Rahim (2016) stated that there are a number of rice-growing districts/cities whose productivity is relatively unchanged from year to year as Ogan Komering Ulu, Ogan Komering Ilir, Muara Enim, Lahat, Banyuasin, Banyuasin, Ogan Ilir and Palembang.

However, in regions such as East OKU, Musi Rawas and Pagar Alam, the rice productivity relatively high and sustainable. Effect of climate change such as rainfall was strongly felt in areas that are not irrigated as in regions of Banyuasin, Ogan Komering Ilir, Ogan Ilir and Palembang. However climate changes are not so obvious in areas that have adequate irrigation namely East OKU, Musi Rawas and Pagar Alam.

Table 1 showed that changes in annual rainfall showed similar trends with the rice productions in South Sumatra. In the years before 2010 a steady increase of annual rainfall was followed by a steady decrease of rice productions in the province. Similar trends were also obvious by the years after 2010. The falling amount of annual rainfall were in agreement with the decrease in the harvested area of paddy. This is particularly true for Handoko et al. (2008) stated that the increase in air temperature on paddy rice through three factors, namely through the decrease of harvest are as a result of water shortage for the increase of evapotranspiration, the decline of productivity and the increase of plant respirations.

Table 2 shows that the availability of rice would not be in deficit until a long time. In 2025 there was a surplus of rice by nearly three million tonnes. A total surplus of nearly one million ton has been started since 2006 and in 2014 up to 2025. Analysis of the availability of rice until 2025 carried out using several assumptions such as that land area experienced an increase of around 3 percent per year. Another assumptions included the increase in agricultural mechanization of using of tools and agricultural machinery, and the increase of harvested area as a result of planting 2 to 3 times per year on some kind of typology rice field irrigation.

Noting the conditions of supply of rice until 2025 it is necessary to take strategic steps in anticipation of food security, among others, extensification and intensification, diversification of food consumption based on local food, increase the productivity of rice plants through the use of superior seeds that are resistant to high temperature conditions, and minimize land use to perform spatial policy agricultural area.

Food Security Strategy in the Climate Change Impact on the food security system is mainly on sub-system availability of adequate food production. In order to maintain food security in the face of climate change impacts in the region of South Sumatra, it is necessary to take strategic steps, namely: 1) Agriculture industry development policy; 2) Land and infrastructure development policy; 3) Institutional development of farmers; 4) Development of regions; 5) Development of food technology; and 6) Food consumption diversification.

Based on the results of this study it can be concluded that: 1) Changes in annual rainfall showed similar trends with the rice productions in South Sumatra. In the years before 2010 a steady increase of annual rainfall was followed by a steady decrease of rice productions in the province. Similar trends were also obvious by the years after 2010. The falling amount of annual rainfall were in agreement with the decrease in the harvested area of paddy rice, and 2) the availability of rice would not be in deficit until a long time. In 2025 there was a surplus of rice by nearly three million tonnes. A total surplus of nearly one million ton has been started since 2006 and in 2014, and 3) Necessary strategic steps are suggested to maintain food security as the efforts to cope with the impacts of climate change.

Recommendation

The need for further research on climate change as a whole in the region of South Sumatra: 1) the need for biotechnology development of quality seeds that are resistant to disruption of climate change, 2) Anticipating climate change on food production, it is necessary to take measures on security policy, namely: (a) Policy development in agricultural industry (Agro industry), (b) Policy on land and infrastructure development, (c) Institutional development of farmers, particularly institutional food reserve communities, (d) Development of regional (spatial arrangement), (e) the development of food technology and (f) the diversification of food consumption.

REFERENCES

Boer, R. and A.R. Subbiah. 2005. Agriculture drought in Indonesia. p. 330-344. *In* V. S. Boken, A.P. Cracknell, and R.L. Heathcote (Eds.). Monitoring and Predicting Agricultural Drought: A global study. Oxford Univ. Press.

Boer, R., A. Buono, Sumaryanto, E. Surmaini, A. Rakhman, W. Estiningtyas, K. Kartikasari, and Fitriyani. 2009. Agriculture Sector. Technical Report on Vulnerability and Adaptation Assessment to Climate Change for Indonesia's Second National Communication. Ministry of Environment and United Nations Development Programme, Jakarta.

Djufri, F., A. Yanto, Handoko and Kusmaryono. 2005. Estimation of Water Deficit Jatropha (*Ricinus communis* L). Journal Agromet Indonesia. Vol. XIX: 2, December 2005.

Handoko, I., Y. Sugiarto, and Y. Syaukat. 2008. The linkage of climate change and strategic food production. Studies on independent policy review in trade and development. SEAMEO Biotrop. Bogor. Indonesia.

International Rice Research Institute. 2004. *IRRI's Environmental Agenda: An Approach Foward Sustainable Development*. IRRI, Los Banos, Philippines, 35p.

Las, I., A. Pramudia, E. Runtunuwu, and P. Setyanto. 2011. Anticipating climate change in securing national rice production. Journal of Innovation Development Agriculture 4 (1): 76-86.

Meteorology, Climatology and Geophysics Agency (MCGA), Kenten Palembang. 2016. Analysis of climate changes of South Sumatra. Unpublished.

Mudiarso, D. 2003. Ten years traveling the climate change convention negotiations. Book Publishers Kompas, Jakarta, 2003, p. 11.

Rahim, SE. 2016. Seasonal and Spatial Variations of Rainfall and Rice Production in South Sumatra. Report to Agency of Agriculture Food Affairs, South Sumatra.

Suryana, A. 2005. The national food security policy. National Symposium Papers Resilience and Food Security in the Era of Autonomy and Globalization, Faculty of Agriculture, IPB, Bogor, November 22, 2005.

World Bank. 2011. Adaptation to Climate Change . Policy Brief World Bank .

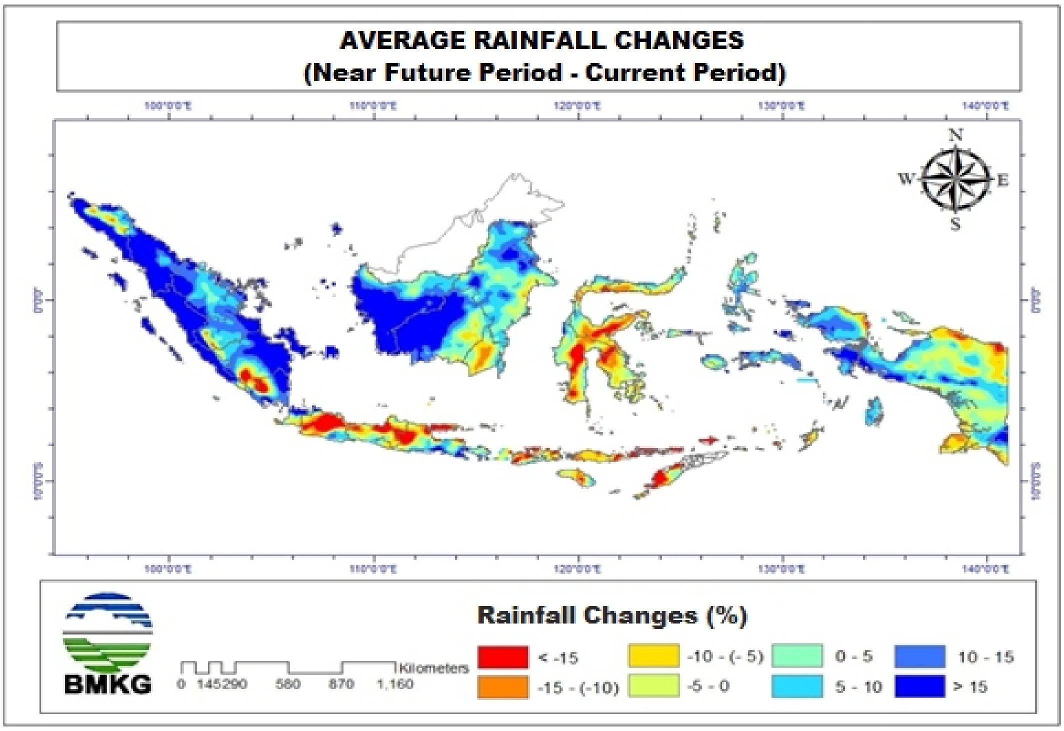


Figure 1. Map of Rainfall Changes in near future – current periods

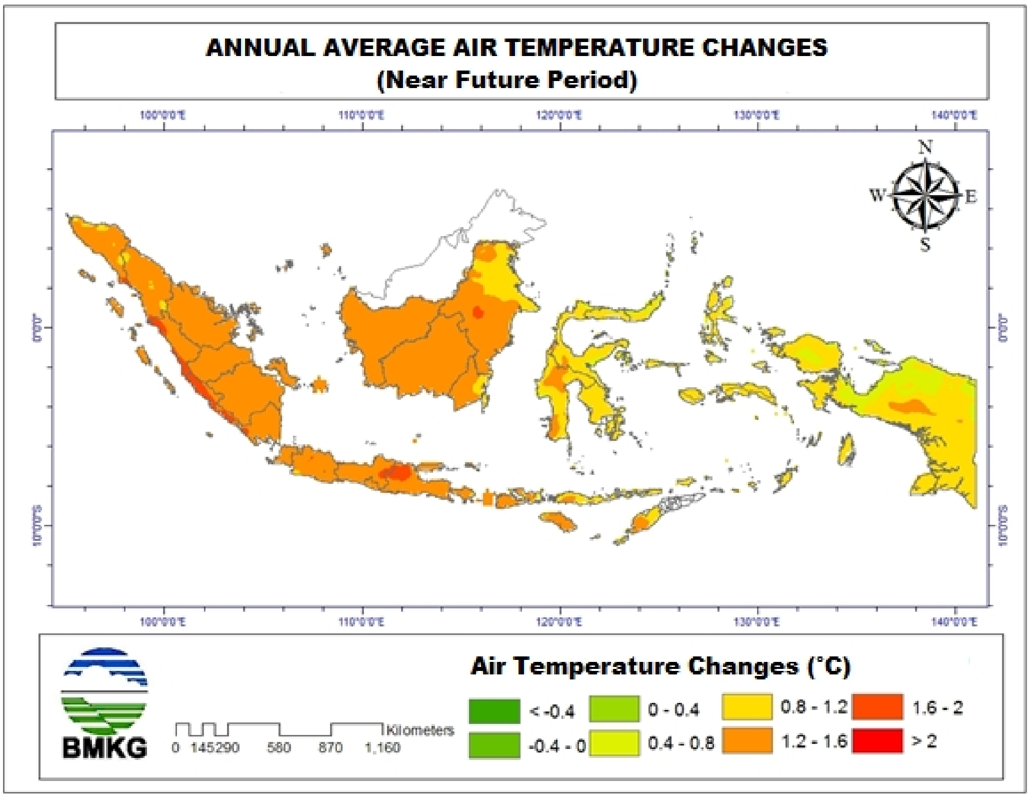


Figure 2. Map of Annual air temperature changes (near future period)

Table 1. Dynamics of Climatic changes and Rice Production in South Sumatra betweeen 2006-2015

	Years of measurements									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Rainfall (mm)	1953	2159	2145	2288	3286	2521	2498	3552	2496	3104
Changes		+206	-14	+143	+998	-765	-23	+1054	-1056	+608
Air Temperature (ºC)	27.3	27.2	26.9	27.4	27.4	27.3	27.3	27.3	27.5	27.7
Changes		-0.1	-0.3	+0.5	0	-0.1	0	0	+0.2	+0.2
Harvested area (ha)	646.927	691.467	718.797	746.465	769.478	784.820	769.725	800.036	810.900	872.737
Changes (%)		0.69	3.9	3.8	3.1	1.9	-1.9	3.9	1.35	7.6
Production (ton)	2,456.251	2.753.644	2.971.296	3.325.237	3.372.452	3.384.669	3.295.246	3.676.728	3.670.434	4.247.922
Changes (%)		12.1	7.9	5.2	4.7	3.4	-2.6	11.6	0.02	15.7
Productivity (ton/ha)	3.63	3.78	3.93	3.97	4.01	4.03	4.01	4.36	4.25	4.39
Changes		0.15	0.15	0.04	0.04	0.02	-0.02	0.35	-0.11	0.14

Table 2. Calculation and prediction of the conditions of rice productions and consumption in 2006-2025

	2006	2014	2025
Rice Production (ton)	1,535,156.88	2,796,671.88	3,773,127
Planting area (ha)	646,927	810,900	1,093,660
Consumption (kg/capita/yr)	124	114	105
Population (people)	6,899,892	7,941,495	9,260,407
Rice Needs (ton)	855,586.61	905,330.43	972,342.74
Deficit/surplus (+/- ton)	+ 679,570.27	+1,891,341.45	+ 2,800,784.26