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"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

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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

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Volume II

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Preface
COMMITTEE CHAIR

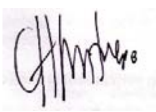
Recently, there are many discussions about food security as a complex issue of sustainable development. One of important topics is will the food needs in the future be met by the current production levels? In addition, the future production faces another sustainable development issues, one of which climate 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

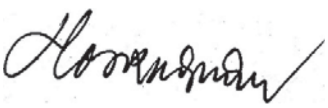
Many Asian countries face serious challenges on their food security due to changing consumption patterns including the demographics, declining of agriculture productivity, degradation of natural resources, rising input costs as well as cost for transportation of supplychains. All of these, need various 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

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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^{0}C 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.

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The University of Lampung, Lampung , Indonesia
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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]

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[3]Department of Silviculture Faculty of Forestry, Bogor Agricultural University, Kampus IPB Darmaga, Bogor, West Java, Indonesia.
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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

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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

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]

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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.

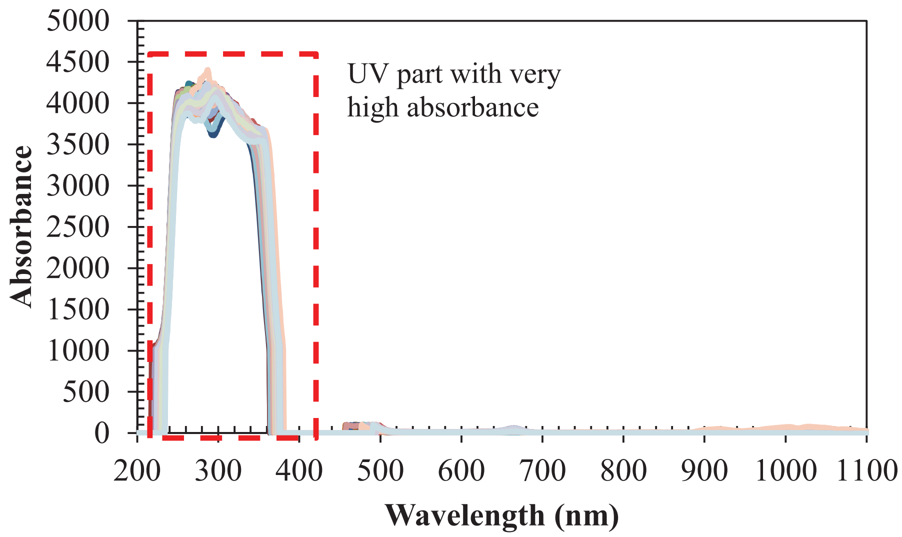

Figure 1. Absorbance spectra of extracted local oranges fruits in the range of 190-1100 nm acquired using UV-Vis spectrometer.

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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.

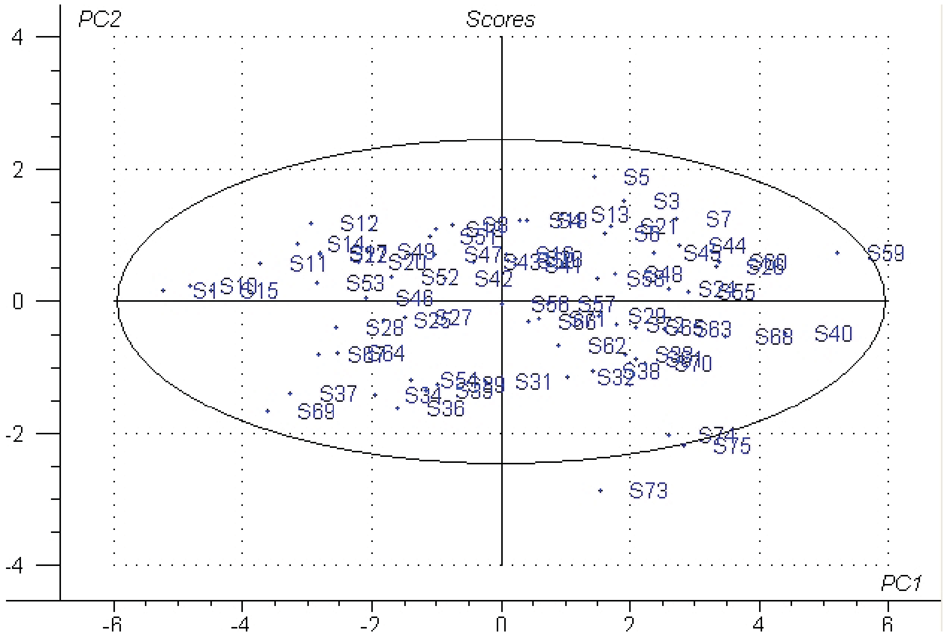

Figure 2. Scores scatter plot with Hotelling's T2 Ellipse for local oranges in the range 190-1100 nm.

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.

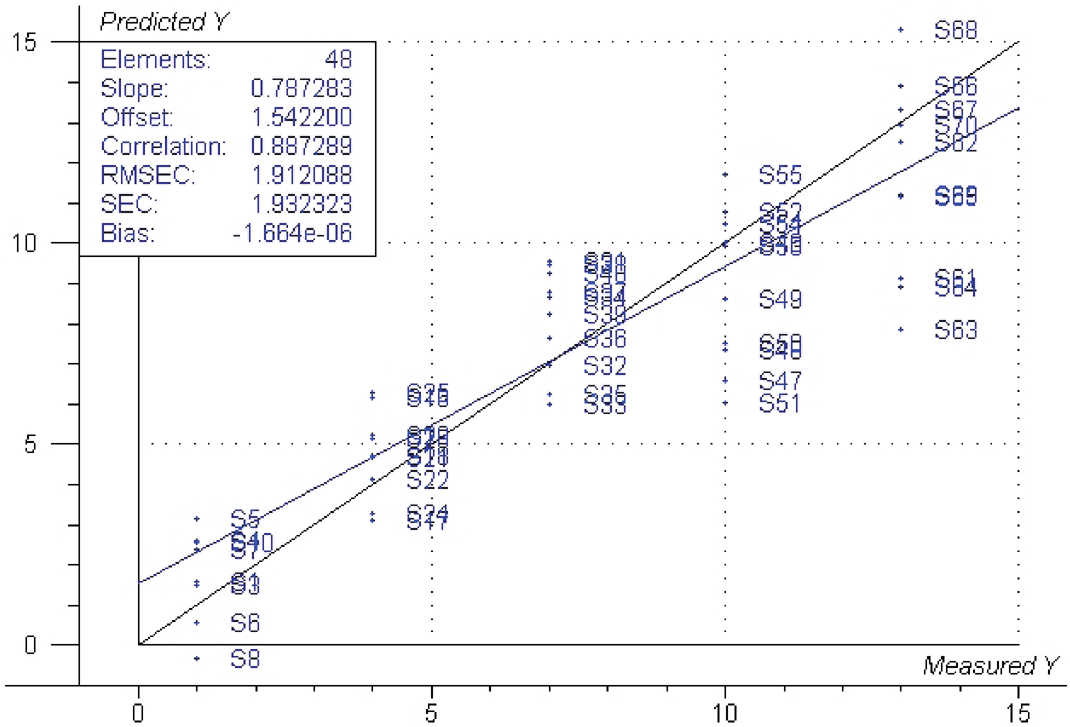

Figure 3. The calibration result for storage time determination using smoothing average spectra in the range of 190-1100 nm.

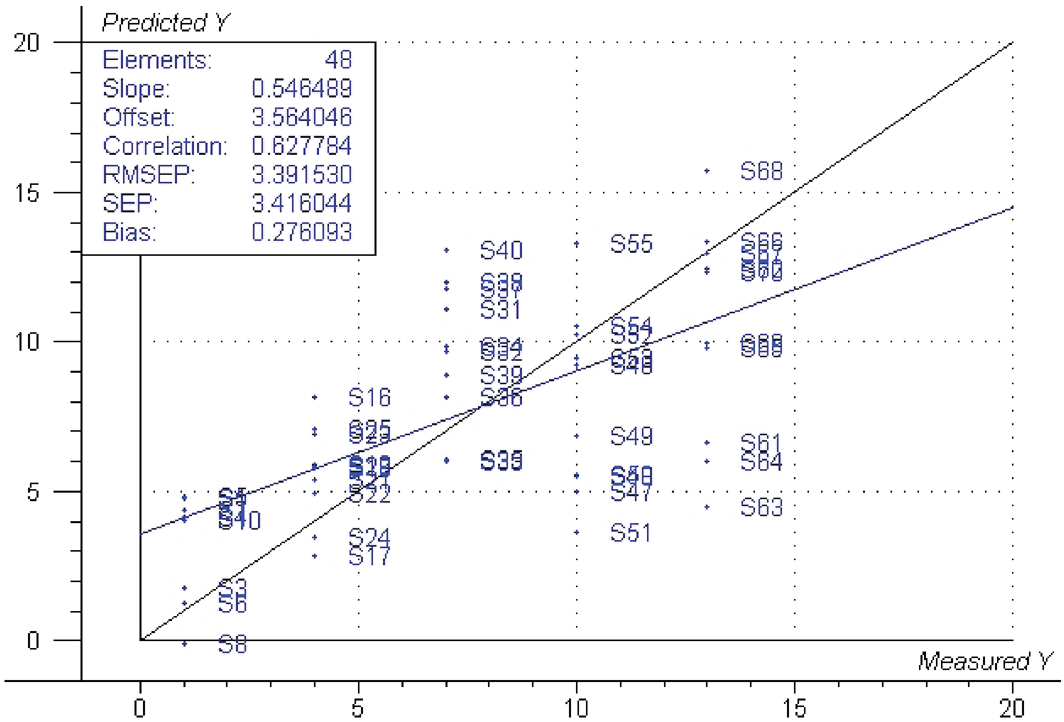

Figure 4. The validation result for storage time determination using smoothing average spectra in the range of 190-1100 nm.

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.

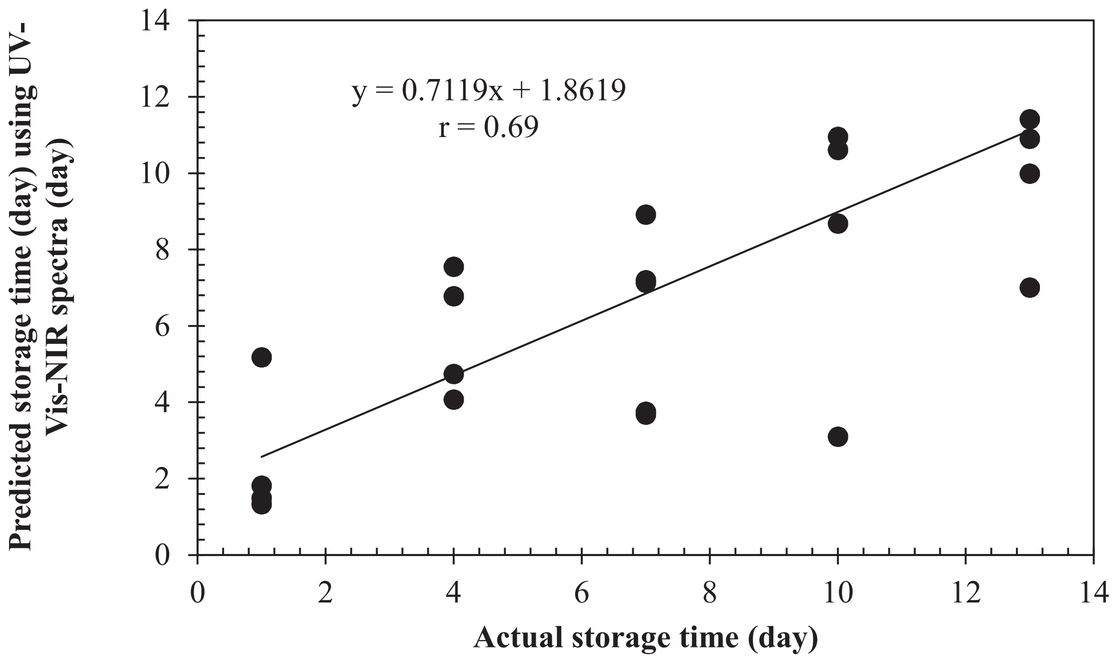

Figure 5. The scatter plot between actual and predicted storage time in the prediction step in the range of 190-1100 nm.

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.

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