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(Sustainable Management of Renewable Resources in Tropics)
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PREFACE

This proceeding consists of the papers presented in international seminar on cassava conducted by University of Lampung on November 23, 2017. As the university located in Lampung Province, University of Lampung realized that Lampung as the biggest producer of cassava in Indonesia has many problems concerning how to increase the poverty of farmers through cassava. There are two factors related to increasing poverty, namely upstream technology and downstream technology of cassava. Upstream technology is how to increase productivity per hectare and how to get the best quality of harvested tuber. While, downstream technology is the technology developed to fulfill people's need on cassava based products. Globally those products is demanded more as the increasing population. Therefore, Lampung needs many innovations about cassava since the development of cassava-based economics in Lampung is quite significant to influence the whole economics development. To get such important technologies, University of Lampung conducted an international seminar on cassava by inviting keynote speakers from the countries such as Thailand and Japan that have best experiences on upstream technology and downstream technology of cassava, beside some Indonesian scientists sharing their research.

After conducting such a seminar, hopefully this proceeding will be able to inspire all parties coming from government, scientists, industries, and practices. The proceeding of a seminar is very useful to bring the papers into the usage of technology. If the results actually need to be developed further, the scientists can carry out perfecting research in the next seminar. Therefore, the seminar on cassava nationally or internationally will strengthen the role of technology in fastening the growth of cassava-based economics.

University of Lampung would like to appreciate the dedication of the staffs in Research and Community Service Institution of University of Lampung working hard to finish the publication of this proceeding. We also would like to address our appreciation to Sungai Budi Group, the honorable Keynotes Speakers from Japan and Thailand for their support to the seminar.

Rector,

Prof. Dr. Ir. Hasriadi Mat Akin, M.P.

PREFACE

As the committee of The International Seminar on Cassava conducted in University of Lampung, we thanked you to all of the participants who has actively participated in that seminar. The participants consisted of researchers, students, staffs of cassava-based industries, and government officials of Lampung Province. The number of participants noted was 97 researchers and government officials and 33 students. The participants who submitted abstracts as the participants presenting their papers in the seminar were 35 people. After receiving the full papers, the committees reviewed all papers. As it was planned, if reviewers decided that the paper fulfilled the quality demanded by the journal, the paper would be forwarded to the international journal. Unfortunately, reviewers decided that there was no papers with proper in terms of subjects of research and grammar. Moreover, the committee faced the fact that not all participants sent their full papers, some of the participants chose to publish their papers in other journal. That was why this proceeding consisted of only 14 paper and took quite a long time to publish.

The committee would like to thank Rector of University of Lampung, the Head of Research and Community Service Institute of University of Lampung, Sungai Budi Group, and other institution that have support the publication of this proceeding.

Chairman,

Dr. Erwin Yuliadi, M.Sc.

PREFACE

University of Lampung is facing challenges to make cassava as potential commodity to increase the poverty of the people. As it is well known, cassava has beneficial use to fulfill daily needs of the people as food, feed, fiber, and pharmacy. The demand of cassava as raw material of those needs will increase as much as the increase of population. The problems appear related to productivity of cassava in Indonesia which is relatively low and low performance of downstream technology. As a research institution, LPPM (Institution of Research and Community Service) of the University of Lampung should do the action how to improve the upstream technology that can increase the productivity and quality of harvest of cassava and to improve and diversify downstream technology that can increase the demand of cassava as raw material of industry. Only then the income of farmers and cassava-based industry can be increased to improve the poverty.

One activity that can fasten to solve the problems is to conduct an international seminar on cassava. Hopefully through the seminar there will emerge some papers as results of researches on cassava that have great value to improve technologies on cassava. To make the seminar qualified, LPPM of University of Lampung invited keynote speakers from Thailand as greatest cassava exporter country in the world and from Japan as the country popularly with downstream technology.

After the seminar finished, the submitted papers were reviewed according to the quality demand of a paper that appropriate to be submitted to international journal. After working sometime, the papers finally can be arranged in form of proceeding. Beside the papers in this proceeding there are some papers that are not included because the authors chose to publish their papers in other journals.

LPPM of University of Lampung would like to thank to every party who had actively participated in the seminar and in the process of arranging this proceeding.

Chairman,

Warsono, Ph.D

CONTENTS

DIETARY FIBRE PRODUCTION AS CO-PRODUCT OF TAPIOCA INDUSTRY

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ABSTRACT

Cassava (*Manihot esculenta* Crantz) pulp, a solid by-product from starch processing can be converted to a range of value-added bio-products, including biofuels, biochemicals and biomaterials. Due, in part, to the processing practice in Indonesia, a large amount of starch remains in the pulp (up to 50±60%, dry basis) while the fiber's contains is about 20 – 30 %. Considering the low fat content of cassava root as raw material for producing tapioca starch, it leads to cassava pulp having a comparative competitiveness for dietary fiber resource. In order to provides the functional properties of the contained starch, physical or biological treatment on the material should be employed. The wet pulp was treated either by heating or shear stress that modify the contained starch granules and disrupt the complex polymer matrix surround, with the capacity of 600 to 730 kg per day. The physicochemical properties of the product percentage of Water, Total Dietary Fiber, Starch, Crude Protein, Fat, and Ash were 11-13, 26.6, 57.7, 1.3, 0.5, and 1.3 respectively. The functional properties of the dietary fiber showed that the water solubility, water holding capacity, digesting index, soluble dietary fiber were 3.07%, 685.5%, 2.89%, and 6% respectively.

Keywords: cassava pulp, dietary fiber, physical treatment.

INTRODUCTION

Dietary fiber (DF) is a nonstarch polysaccharide complex thatcomes from the edible parts of plants or analogous carbohydratesthat are resistant to digestion and absorption in the human smallintestine, but undergoes complete or partial fermentation in thelarge intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fibers promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation (AACC, 2001).

Dietary fiber can be classified into two major parts on the basis of solubility: soluble components, such aspectins, gums, and β-glucans; and insoluble components, whichinclude cellulose, lignin, and hemicelluloses. This final distinction governs their physicochemical properties and their nutritional effects (Thebaudin et al., 1997).Dietary fiber plays an important role in human health. Many studies have found that people on diets high in fibre have reduced risks of certain diseases such as cancers, coronary heart disease, obesity and possibly diabetes. Fibre is a collective term for a group of compounds, which differ in their chemical structure and physical properties and elicit a variety of physiological effects (Buttriss and Stokes, 2008). Nowadays, there commended DF intake is 25-30 g/day, with fiber addition to foods an alternative to compensate for deficiencies in the diet.

Apart from nutritional purposes, fiber can also be used fortechnological purposes such as a bulking agent or fat substitute. Fibre-rich ingredients can be used in foods only if the product has good sensory characteristics, regardless of the nutritional benefits of the fibres. The physiological actions of DF are likely based on its hydration properties that are described by four different and measurable parameters: water-holding capacity (WHC), water-binding capacity (WBC), swelling and solubility. Values for swelling, WHC and WBC are not relevant for soluble polysaccharides; rather, they are attributes of insoluble polysaccharides (Thebaudin *et al.*, 1997). Dietary fibers extracted from different materials or obtained using different methods differ in chemical composition, structure, and particle-size distribution, which obviously affect DF physicochemicalproperties, as a result of the influences on the physiologicalfunction and application of DF.

Indonesia is the third largest producer of cassava (*Manihot esculenta* Crantz) roots in the world, which is almost 20 million ton per year harvested from 0.93 million hectares. However, it's not enough to supply to the domestic market. Most of the cassava root is principally used in food and tapioca starch industry. Total capacity of the existing tapioca industries in Indonesia are not less than 2.0 million tonnes of starch per year, that are concentrated in Lampung Province (>80%). Based on their adopted equipment-processing system for the starch extraction stage, and drying system, those production facilities could be classified in three categories: (1) pre-traditional factory, (2) semi-traditional factory, and (3) modern factory. The first category of the tapioca production facilities are using either tabling or settling system for the starch extraction stage; and the product is dried by using sun drying. The second category facilities are using the same system for starch extraction stage, but in the final stage they are using flash drying system. The third category of the starch extraction facilities are using centrifugal-dewatering system and it is combined with the flash drying system.

In Lampung, cassava starch production is a large and growing industry with about 7 million tons of fresh cassava roots used for the production of starch, generating at least 0.7 million tons of pulp annually. Referring to Kosugi et al. (2009) the fibrous residual material, called cassava pulp accounts for approximately 10–30% by weight (wet) of the original tubers. Cassava pulp, a solid by-product from starch processing, is a promising and underused biomass that can be converted to a range of value-added bio-products, including biofuels, biochemicals and biomaterials. This material in particular contains a high level of starchy lignocellulosic biomass. At present condition, the main application for the large quantities of cassava pulp produced each year, after sun drying, is a low value animal feed, fertilizer as well as substrate for the fermentation industry. Due, in part, to the processing practice in Indonesia, a large amount of starch remains in the pulp (up to 50±60%, dry basis) while the fiber's contains is about 20 – 30 %.

The definition of what constitutes dietary fiber becomes important to the food industry if a claim is based on a minimum content of dietary fiber in the product. The inclusion of "associated plant substances" in the AACC definition can be interpreted as meaning that dietary fiber embraces such components as contained in the cassava pulp. This report describes the assessment of dietary fiber production using cassava pulp as raw material, that had been conducted in National Laboratory of Starch Technology, in order to develop the added value chain of the fiber-rich residue as co-product in the cassava starch production system.

MATERIALS AND METHODS

Sample Preparation

Cassava pulp was collected from the oult let of starch extraction apparatus as residues in the production line of several tapioca starch factories in Lampung Province. The collected samples were wrapped up by the plastic sheet and transported to B2TP pilot plant in Tulang Bawang, and proceeded to the trial production of DF (dietary fibre) as soon as possible.

Physical Treatment of Cassava Pulp

The method of DF production already patented in Indonesia with the certificate number IDP000042214. The wetpulp of cassava residues was collected from the extractor apparatus that operated in the commercial production line of tapioca starch factory. The moisture content of cassava pulp was reduced by means of screw press upto 40 – 60%, preferably 50%. The pressed pulp was fed to the drum drier for physical modification, specificallyheating or shear stressing that modify the contained starch granules and disrupt the complex polymer matrix surround. Dried cassava pulp as flakes form was ground into powder by an universal disc mill (FFC-45A, Shandong Jimo, China) continuously.The resulting powder was passed through a 80-mesh sieve (aperture ≈ 177 μm) and stored at the room temperature prior to analysis.

In order to reduce the starch contain of the final product, the ground flakes was fed to the cyclone classifier, and fine powder was separated on a horizontal-vibratingscreen, equipped with two sieves: 60-mesh (aperture ≈ 250 μm) on top and 80-mesh (aperture ≈ 177 μm)below, with ashaking frequency of 3.75 Hz. The portion of powder passing through the 60-mesh but held back by the 80-mesh sieve was the DF, which was collected and packed. Finally, the yield of DF was defined by the percentage of DF weight to wet cassava pulp sample weight.

Analytical Methods for Characterizing the Dietary Fiber

a) Fiber Content Determination

The assessment of dietary fiber characteristics was based on the definition proposed by the AACC Dietary Fiber Definition Committee in 2001: "Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances". The analytical method of dietary fiber was referring tothe methode of Van Soest (1989), by means of determining ADF (Acid Detergent Fiber), NDF (Neutral Detergent Fiber) and Lignin content.

b) Proximate Analyses

The ash, fat, protein, and starch contents were determined according to AOAC methods. Ash was produced by incinerating samples at 550 °C in a muffle furnace for 2 h (AOAC method923.03). Fat was determined using AOAC method 960.39. Proteins were analyzed as total nitrogen content by Kjeldahl procedure; a factor of 6.25 was used for conversion of nitrogen to crude protein (method 955.04). Starch was hydrolyzed into glucose using hydrochloric acid 25%; the glucose was then determined according to the modified Somogy methods, and starch content calculated as glucose x 0.9 (AOAC method 996.11).

C. The Functional Properties

The hydration properties of dietary fibres determine their optimal usage levels in foods because a desirable texture must be retained. The physiological actions of DF are likely based on its hydration properties that are described by four different and measurable parameters: water-holding capacity (WHC), water-binding capacity (WBC), swelling and solubility.

Referring the explaination of Thebaudin *et al.* (1997) the WHC is defined by the quantity of water that is bound to the fibres without the application of an external force (except for gravity and atmospheric pressure). The WHC is measured as the quantity of water absorbed into the pores of the sample by capillary action, under a defined vapour tension. The WBC can be defined as the quantity of water that remains bound to the hydrated fibres following the application of an external force (pressure or most commonly, centrifugation).

RESULT AND DISCUSSION

The physicochemical characteristics of thedietary fiber that produced from *cassava pulp*by means of the *drum drier* for physical treatment was described below:

a.	Starch content	: 50-60 % weight
b.	Moisture Content (maximum)	: 10 % weight
c.	Ash	: 1-1,5 % weight
d.	Crude Protein	: 1-2 % weight
e.	Fat (maximum)	: 0,5 % weight
f.	Particel size	: passed the sieve of 60-80 mesh
g.	Appearance	: brownish white
h.	pH	: 6-7

Specifically soluble dietary fiber content is about 5-8 percent weight and insoluble dietary fiber content is 20 to 25 % weight. The assessment result of the functional properties of the derived cassava dietary fiber showed that the water solubility index, water holding capacity, digesting index, soluble dietary fiber were 3.0 – 3.5%, 670 - 700%, 2.7 – 3.0%, and 6% respectively. Those characteristics of the product were better than commercial oat bran, rice bran, as well as wheat bran as shown in Tabel 1 and Tabel 2.

Table 1. The comparison of the functional properties of cassava pulp fiber to the oat bran as commercial product of dietary fiber.

Product Sample	Solubility (%)	WHC (%)	DigestibiltyIndex (%)	Crude Fiber (%)	Dietary Fiber (%)	Fat (%)
Oat Bran	2,53	224	126,83	2,003	13,08	6,93
Dietary Fiber of CP	3,07	685,33	2,89	13,28	18,21	0,3

Solubility and swelling properties are related to each other: the first step of the solubilization of polysaccharidesis swelling. The water moves into the solid structure and spreads the macromolecules (swelling) until they are completely dispersed. This phenomenon can lead to solubilization of the molecules. For some polysaccharides, such as cellulose, the final dispersion is not possible because of its conformation. It swells but solubilization does not occur.

The solubility depends on the nature of the glucidic components of the dietary fibres and on the structural characteristics of the dietary fibres. It is expressed as the percentage of solubilized fraction under defined conditions. Moreover Thebaudin et al. (1997) explained that the chemical regularity of a linear chain increases the strength of the links and stabilizes the ordered conformation. If a chemical irregularity or a branch is present on the linear framework, the links will be weaker, the ordered structure will be more easily dissociated, and the molecules will be more easily solubilized.

Another factor that influences the solubility of polysaccharidesis their electric charge. The presence ofcharged, dissociated uranic acid, sulphate or pyruvate groups, for example, tends to favour solubilization ofthe polymers. This effect will depend on the pH, temperature and concentration of other components in water, such as salts or sugars. The high WBC of cassava pulp fibres can have technological interest (e.g. increased technological yield of food), as well as nutritional interest. Increased water retention has been related to an increase in orocaecal transit time.

Tabel 2. The Comparison of the Cassava Pulp Fiber with the Other Various Commercial Products of Dietary Fiber

Items	Cassava PulpFiber	Oat Bran	Rice Bran	Wheat Bran
Total Dietary Fiber	30-35%	16-18%	25-35%	40-44%
Soluble Fiber	5-7%	6-8%	<2%	<1%
Color	off-white	Tan	Greenish brown	Brown
Flavor	Bland	Grainy	Sweet,grainy, fatty	Strong cereal
Odor	Bland	Grainy	Fatty	Cereal
Fat	0.4%	6-12%	18-22%	5%

Considering the low fat content of cassava root as raw material for producing tapioca starch, it leads to cassava pulp having a comparative competitiveness for dietary fiber resource. It would not face a rancidity problem while the product require to be stored for the distribution system. In order to provide the functional properties of the contained starch, physical or biological treatment on the material should be employed. The wet pulp was treated either by heating or shear stressing that modify the contained starch granules and disrupt the complex polymer matrix surround. Those disruption was expected to increase the effectiveness of the fiber dispersion while it is added to a formulation.

Table 3. The Yield of Dietary Fiber Production by using the Wet Cassava Pulp Collected from the Different Tapioca Factory in Lampung Province

Tapioca Factory Source of Cassava Pulp	Moisture Content of Wet Cassava Pulp (%)	Yield of Dietary Fiber (%)
Factory 1	±85	16
Factory 2	±90	10
Factory 3	±85	13.8
Small Scale Factory	±70	28

The integrated equipments that used for the trial production of the dietary fiber was limited by the drum drier performance with the capacity of 25 to 30 kg per hour. While the pilot plant facility was operated continuously, it can produce 600 to 730 kg dietary fiber per day. The various yield of the different source of cassava pulp that used as raw material in this assessment is shown in Table 3. The moisture content of the origin cassava pulp seem to influence the yield of dietary fiber production.

Unexpected performance was occured to the existing cyclone separation system that could not classify the starch-rich powder and fiber-rich one. The most probably causation is the disruption of starch granules while its heated and pressed in the combination of high temperature and moisture content conditions. Referring to the Anwar, Khotimah, and Yanuar (2006) report, the shape of untreated native cassava starch is compact sphere, while the pregelatinized cassava starch is broken debris. The treated starch debris seemly has a similar floating characteristic as fiber debris, so that why air classifier apparatus was not performed as expected.

CONCLUSION

The physical (heating and shear stressing) treatment of the cassava pulp by means of double drum dryer that pointed to modify the starch contained in the material is appropriate processing procedure for dietary fiber production. Eventhough the cassava dietary fiber having physicochemical characteristics that slightly better than the other commercial fibers, but it still contained high percentage of starch. It is a great challenge to develop the other physical treatment integrated with the air classifier system to separate the starch-rich powder and fiber-rich ones more efficient and effective.

Cassava pulp as a by-product of tapioca industry which is currently limited to be utilized as feed stuff seem to have a great potency to be converted as dietary fiber. Those functional food production that adhered to the starch production system would enhance both the added value chain and competitiveness of the tapioca industry.

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THE EFFECT OF *ZINCMICRO* NUTRIENT ON ROOT FUNGI DISEASE DEVELOPMENT OF CASSAVA (*Manihot esculenta* Crantz) IN SULUSUBAN, SUB-DISTRICT ANAK TUHA, LAMPUNG TENGAH

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ABSTRACT

The purpose of this study was to determine the effect of *Zincmicro* nutrient application on development of fungal disease in cassava root. The study was conducted in Sulusuban, Central Lampung Regency and in the Laboratory of Plant Pests and Diseases University of Lampung. The study consisted of 15 experimental plots with 3 treatments and 5 groups. Treatment was arranged in a randomized block design (RBD) with five groups based on the time of observation. Treatments consisted of control, fertilizer of 20 kg *Zincmicro*, and 40 kg *Zincmicro* per ha. The results showed that suspected pathogens fungal diseases that attack the roots of the cassava plant caused by the fungus *Neoscytalidium* sp. However, the nutrient application could increase plant height. Treatment of 40 kg *Zincmicro* per ha showed the highest occurrence of disease compared with controls and 20 kg *Zincmicro*/ha. Moreover, the effect of *Zincmicro* nutrient did not significantly affect the number of leaves and leaf greenness.
Key words: cassava, fertilizer *Neoscytalidium sp*, *Zincmicro.*

INTRODUCTION

Indonesia self-sufficient of rice had been already declining resulted in rice dependent reached an alarming level. Rice has become a major supplier of carbohydrates for the majority even almost all Indonesians. The public perception is when people do not consume rice yet, to be told not eat in that day even though the stomach was full. Such perceptions could be a deviant concept of thinking. The government along with the scientists is now working hard to find new sources of food for Indonesian people on a single source of carbohydrates perse (Hendy, 2007).

Cassava (*Manihot esculenta* Crantz) is an important food crop commodity as producer of food source of carbohydrate and raw material of food, chemical and animal feed. Indonesia has the potential of tubers as a source of carbohydrates as well as local flour raw materials that are not inferior to flour, namely ganyong, gembili, sweet potato, garut, cassava and others.

In Indonesia, cassava is used as staple food number three after rice and corn. The spread of cassava is widespread to all provinces in Indonesia. The cassava production centers that enter the top five provinces with the highest harvest in 2015 are Lampung Province (7,387,084 tons), Central Java (3,571,594 tons), East Java (3,161,573 tons), West Java (2,000,224 tons), and North Sumatra (1,619,495 tons). In Lampung Province, Central Lampung is the largest cassava production district with a total production of 2,523,230 tons (Center Bureau of Statistic, 2016).

Increasing the need for high utilization of processed cassava must be balanced with high production. There are many obstacles that cause the decrease of production that is the factor of seed and the area of cultivation land. In addition, there are also cultivation factors as well as attacks of pests and diseases (Adriani, 2016).

Based on data from the Central Bureau of Statistics (2016), a decline in cassava production in Lampung. In 2011 the production of cassava reached 9,193,676 tons, and decreased every year until the year 2015 reached 7,384,099 tons. One of the factors causing a decrease in production is suspected of a pathogen attack caused by root fungus.

One of the efforts in increasing the production of cassava is by fertilization. Nutritional needs of cassava plants are very high for the process of formation of tubers, stems, leaves, and resistance to pest and pathogen attacks. In the grouping, nutrient elements are divided into two, namely macro nutrients and micro nutrients. Micro nutrients that help in the process of plant metabolism element Fe, elements Zn, elements Mo, elements Cu, elements Mn, elements Boron (Mengel and Kirby, 1982).

MATERIALS AND METHODS

The research was conducted in Sulusuban, Kecamatan Anak Tuha, Central Lampung District and in Pest and Disease Plant and Plant Biotechnology 2 floor of Lampung University. This research was conducted for 5 months starting from October 2016 until March 2017.

Materials used included cassava stem, Zincmicro fertilizer with content of Mg, Zn, Mn, B, Cu, Ca, Co, Mo, S, PSA media, alcohol. While the tool used is meter, hand counter, green leaf gauge (SPAD), paper label, plastic bag, stationery, petri dish, *bor gabus*, ose needle, plastic wrap, hoe, and others.

The study consisted of 15 plots of experimental plots consisting of 3 treatments and 5 groups. Each plot measured 10 m x 10 m. The treatments were arranged in a randomized block design (RAK) consisting of five groups based on observation time. The treatments were P0 (control), P1 (Zincmicro 20 kg fertilizer), P2 (Zincmicro 40 kg fertilizer) repeated as many as five replications. In this research, cassava planting is done by other parties that have been planted in July 2016.

Observations were made at 5-month-old after planting of cassava. Sampling was determined by 5 samples per plot diagonally. The data obtained in each observation was analyzed the variation and separation of the mean value using 5% BNT test.

Land preparation

Before planting the land first done piracy twice and done renewal to smooth the chunks of soil.

Preparation of stem cuttings and planting

Varieties of cassava used in this study are cassava varieties of Thailand. Cuttings grown using stem cuttings that have grown with size 25 cm. Spacing used 80 cm x 60 cm.

Fertilization

The fertilizer used in this research is Urea 200 kg / ha, KCl 200 kg / ha, and SP-36 100 kg / ha. The application of Urea and KCl fertilizers was doubled with a dose of half the total fertilizer. While application of SP-36 fertilizer done at the same time at first fertilization. The first application of fertilizer was done when the plant was 1 BST and the second fertilization was done when the plant was 3 BST. Zincmicro application of fertilizer is given one time at the same time the first basic fertilizer by digging around the plant with a distance of 10 cm from the plant.

Variable Observations

Plant height was measured from the height of the plant using a scale meter from the base of the stem to the end of the leaf on each sample. The leaf number was counting including the petiole of cassava in each sample full openly leaf. Additionally, observation of green leaf is done by using green leaf gauge (SPAD) that is by reprimanding green leaves as much as three replications and then averaged. In measuring greenish leaf, the measured leaves are in the middle of the leaf and three leaf lobes at random. At the time of measurement (using the SPAD tool) the measuring position should be back to the sun, so that the measurement results obtained more accurate because it is not disturbed by sunlight.

Observation of the incidence of root fungus disease is done by counting the plants infected by root fungi on each plot measuring 10m x 10m by using hand counter tool.
To calculate the incidence of disease can be calculated by the formula:

$Kp = n / N \times 100\%$

Kp = Disease incidence
n = Number of illnesses
N = Number of population observed

Observations in the laboratory aim to ascertain the root cause of roots in cassava with the following methods:

Making PSA media.

To make a PSA media as much as 1 liter required 200 grams of potatoes, 20 grams of sugar, 20 grams for stems, and 1 liter of distilled water. How to manufacture is as follows: the potatoes are cut into small disc and then boiled for 45 minutes using aquades until the potatoes become soft and exit extract, then boiled potato water is inserted into the tube Erlenmeyer then put sugar and so that the stem has been cut into small pieces autoclave for 60 minutes at 1210C and 1 atm pressure. After sterilization of the media left to warm the nails then added lactic acid as much as 1.4 ml using a micro pipette then stirred and the media is poured into a petri dish.

Isolation of pathogens from plant tissues.

Part of cassava plant stems symptom of root fungus is isolated in the laboratory. Isolation is done by cutting the line between the sick and healthy sticks of ± 2 x 2 mm, then washed with aquades then 1% NaOCl solution and rinsed with different aquades. After that it is dried on tissue paper and then isolated on the PSA media. The root mushrooms that have grown are then purified. To get a pure culture that is done by taking hyphae by using needle end then grown on PSA media.

Inoculation of root fungus.

Pure root mushroom isolate was inoculated with cultivation of cassava crops by wounding and then attached to pure cultures isolated from sick plant tissue and then observed whether to cause symptoms such as plants that have been isolated previously.

RESULT AND DISCUSSION

Symptoms of root fungus disease began to be seen at the time of the five-month-old plant after planting (BST). Initial symptoms caused by root fungi are the occurrence of hyphae at the base of the stem of the cassava plant (Fig. 1A) and the leaves undergo chlorosis starting from the oldest leaves (Fig. 1B).

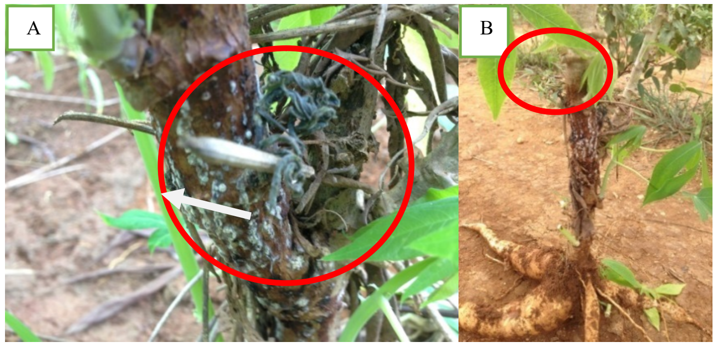

Figure 1. Symptoms of root fungus disease in cassava plants, there is hyphae at the base of the stem of cassava (A), and leaves have chlorosis starting from the oldest leaves (B).

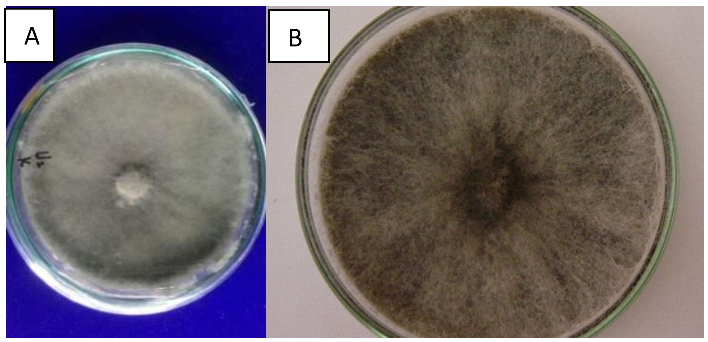

Figure 2. Pure culture of root fungus isolated at 7 days (A), culture of Neoscytalidium sp. according to Schechtman (2008) (B).

The base piece of the stem which is attacked by root fungi pathogens when grown on a PSA medium will result in a colony that is initially white and then slowly turns black (Fig. 2A). This is similar to the result of isolation obtained by (Schechtman, 2008) which has a *Neoscytalidium* sp. (Figure 2B).

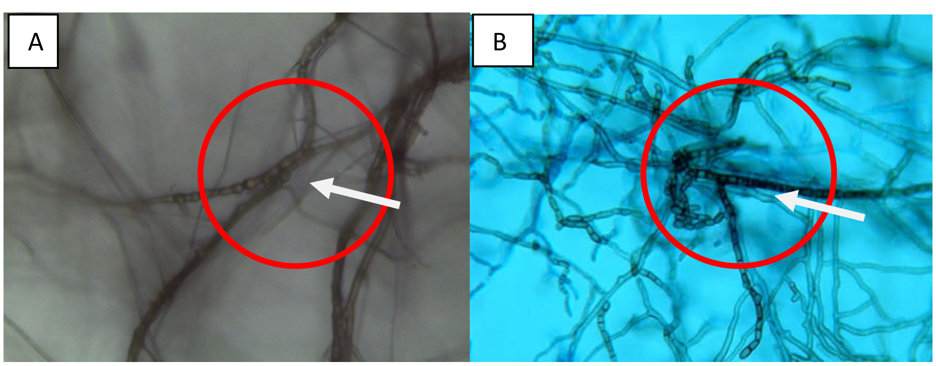

Figure 3. Arthrospora result of insulation of base of stem of cassava plant at magnification of 40x (A) Arthospora according to Tendolkar *et al*., (2015) (B).

Microscopic observations on pure cultures derived from the isolation of the base of the sick cassava stems indicate a special structure (Fig. 3A). The special structure obtained from the isolation of the base of the sick cassava stems is similar to the special structure possessed by the Neoscytalidium fungus which has arthospores (single-celled spores formed by discontinuation of hyphae cells) according to Ann *et al*. (2002).

Inoculation results have been done, plants that have been inoculated with a pure culture derived from the isolation of the base of the stem of sick cassava, showing the same symptoms with sick plants that are in the field. Early symptoms can be seen with yellowing of leaves starting from the oldest leaves, then at the base of the stem there are hyphae. Furthermore, the leaves begin to fall from the oldest leaves until eventually the plant becomes dead with the yams become rotten.

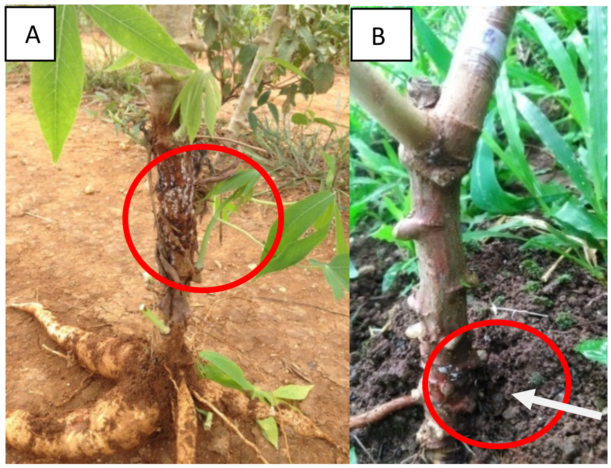

Figure 5. Symptoms present in the field (A), pathogenicity test results (B).

Based on similarities of data obtained from observation of symptoms in the field, macroscopic and microscopic observations, and pathogenesis tests have been done, suspected cause of root fungus disease that attacks cassava in Sulusuban, Sub-District Anak Tuha Central Lampung caused by fungus *Neoscytalidium* sp.

Field observation showed that the incidence of root fungus disease fluctuated in every observation. This is due to the humidity and temperature conditions that support the environment for the spread and development of root fungi. BNT test at 5% showed that the higher application of Zincmicro fertilizer given the higher the occurrence of cassava root fungus (Table 1). Treatment P1 showed that the level of fungus root fungus is lower than P2 treatment. However, treatment P1 showed no significant difference with P0 treatment.

Table 1. Effect of Zincmicro fertilizer on the incidence of root fungus cassava disease

Treatment	Information	The Occurrence of Cassava Root Fungus (%)
P0	Control	2,80 b
P1	Zincmicro fertilizer 20 kg / ha	1,80 b
P2	Zincmicro fertilizer 40 kg / ha	6,00 a
BNT 5%		3,20

Information: values in the same column followed by the same letter show no significant difference (BNT test 0.05).

The results showed that Zincmicro fertilizer has an effect on plant height, but it has no effect on leaf number and greenishness of leaves. Table 2 shows that the best dose of fertilizer that can increase the plant height is the Zincmicro 40 kg / ha fertilizer (P2) fertilizer.

Table 2. Effect of Zincmicro fertilizer on plant height

Treatment	Information	The Occurrence of Cassava Root Fungus (%)
P0	Control	106,72 b
P1	Zincmicro fertilizer 20 kg / ha	115,56 b
P2	Zincmicro fertilizer 40 kg / ha	162,60 a
BNT 5%		31,104

Information: values in the same column followed by the same letter show no significant difference (BNT test 0.05).

Microscopic observations on pure cultures derived from the isolation of the base of the stems of crops of sick cassava, indicate the existence of a special structure. The special structure obtained from isolation results is similar to that of the arthospores (one-celled spores formed by the breakdown of hypha cells). This is similar to Arthospora according to Tendolkar et al., (2015) obtained on the pure culture of Neoscytalidium sp fungi (Fig. 4B). Then inoculation of new plants. The inoculation results show the same symptoms as sick plants in the field. Early symptoms can be seen with yellowing of leaves starting from the oldest leaves, then at the base of the stem there are hyphae. Furthermore, the leaves begin to fall from the oldest leaves until eventually the plant becomes dead with the yams become rotten.

Results of field observations showed that Zincmicro fertilizer application did not affect the number of leaves and the greenishness of leaves. However, the application of such fertilizers can increase plant growth based on plant height. The results are in line with the results of research by Ershad (2017) which states that application of Bio-slurry fertilizer with micro nutrient content of Zn, Mn, Cu, Mo can stimulate the growth of plants. In Zincmicro fertilizer contain nutrients Mg, Zn, Mn, B, Cu, Ca, Co, Mo, S, One of the micro nutrients that serves to spur plant growth is Zn, which plays a role in enzyme activator, chlorophyll formation and help the process of photosynthesis .

Based on 5% BNT test showed that Zincmicro 40 kg / ha fertilizer dose was obtained by the highest disease incidence compared with control and 20 kg / ha. This means that the higher the dose of Zincmicro fertilizer applied, the more vulnerable plants to attack the root fungus of cassava. Therefore, plants need balanced nutrients to grow optimally. One of the micro nutrient content applied is the Mn element, which is a supporter of dehydrogenase enzyme activity, decarboxylation, kinase, oxidase, and peroxidase. Peroxidase enzyme activity can increase plant resistance to pathogen attack. This is in line with the research of Suswati et al. (2015) that peroxidase enzyme activity can increase banana fiber resilience against bacterial wilt disease caused by Blood Disease Bacterium (BDB) and Fusarium wilt by Fusarium oxysporum f.sp. cubense.

The disease caused by *Neoscytalidium* sp. tend to be found in tropical countries. This pathogen has the characteristics of a feathered colony or wool colony on day 2 to day 3, which gradually turns into gray colony on day 4, and dark gray to black pigmentation at day 7 (Rusmarini et al. 2017).

Root fungus disease can decrease the population because the wilted plant usually ends in death. When an attack on a plant has been berubi, many yams are rotten, easily loose and left in the soil when harvested so as to decrease the yield of sweet potato (Figure 6).

Figure 6. Tuber rot caused by root fungus attack

CONCLUSION

Zincmicro fertilizer application can not suppress the incidence of root fungus disease in cassava plants caused by *Neoscytalidium* sp. Zincmicro fertilizer application can increase the height of the plant, but it does not affect the number of leaves and the greenness of leaves.

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THE EFFECT OF ETHREL TREATMENT ON THE GROWTH AND PRODUCTION OF TWO VARIETIES OF CASSAVA PLANT *(Manihot esculenta* Crantz)

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ABSTRACT

Growth inhibition can be interpreted as a compound that affects the plant physiology process. Its influence can stimulate and inhibit the physiology of plants. One of the growth inhibitions that can be used to inhibit growth is ethrel with ethephon active ingredient. The application of ethepon results in the growth of plant obstacles. The purpose of this research was to study the effect of ethrel concentration which influenced on vegetative growth and production of two varieties of cassava plant. This research used the UJ 3 and Kasetsart varieties of cassava cuttings with 25 cm length and age of 8-12 months. The treatments were arranged factorially (8 x 2) in a randomized block design with 4 replications used as a block, each block consisted of 16 sub samples. The first factors were the treatment of eight different ethrel concentrations as 0; 0,5; 1; 1,5; 2; 2,5; 3; and 3,5 ml/l. The second factors were two types of cassava varieties haved UJ 3 and Kasetsart. Ethrel was applied through leaves when the plants were 60 days after planting with the volume of 50 ml per plant. Variables observed in this research were plant height; number of fresh leaves; wet weight of leaves, stems, and roots; and dry weight of leaves, stems, and roots. The result showed that ethrel treatment inhibited elongation of stem and decreased wet and dry weight of leaves, stem and roots of cassava plants in UJ 3 variety.
Key words: cassava, ethrel, varieties.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) was one of the food crops that can grow in the tropics including in Indonesia. Cassava can be used as a source of carbohyrates, food, feed and raw materials for various industrial products. According to Noerwijati *et al.* (2011), cassava plants could produce tubers well with a conducive growth at an altitude of 300 meters above sea level. Based on this, technology was needed to increase cassava production through an intensification program in the form of the use of growth inhibition.

Growth inhibitions were regulatory substances that affects the physiological processes of plants, both natural compounds and artificial chemical compounds whose effects can stimulate and inhibit the process of plant physiology (Nuryanah, 2004). Growth inhibitions in plants consist of five groups: auxin, gibberellin, cytokinins, ethylene and abscisic acid with distinctive features and different effects on physiological processes (Hendaryono dan Wijayani, 1994). This research used one of the plant growth regulator especially ethrel containing the active ingredient ethepon of some concentrations. Ethylene is one of the plant growth regulator which in the form of gas and is always formed in every network of plants that experience aging or stress. In plants, ethrel with the active ingredient ethepon releasing ethylene compounds and producing physiological effects similar to ethylene (Khrishnamoorthy, 1981).

Based on research of Siregar (1995), the ginger plant applied with ethrel with the highest concentration of 15000 ppm resulted a plant rhizome weight of 0,318 kg, increased compared to the control. According to Basra (2000), ethephon is used in the ornamental industry to delay flowering, selective flower abortion, leaf abscission as well as to reduce stem elongation and increase stem strength. Based on studies that have been carried out using ethrel, the effect of ethrel on cassava production has not been known yet and is expected to increase roots production. This was because the use of ethrel has never reported about its use in cassava plants. The purposes of the study were to study the effect of ethrel concentrations on vegetative growth of two cassava varieties and study the effect of ethrel concentrations on the production of two cassava varieties.

MATERIALS AND METHODS

This research was conducted in integrated field of University of Lampung from march 2017 until August 2017. Plot size was 16x10 m and cassava planted with distance 100x80 cm. The treatments were arranged factorially (8 x 2) in a randomized block design with 4 replications used as a block, each block consisted of 16 sub samples. The first factors were the treatment of eight different ethrel concentrations as 0; 0,5; 1; 1,5; 2; 2,5; 3; and 3,5 ml/l. The second factors were two clones of cassava called UJ 3 and Kasetsart.

Ethrel was applied through leaves when the plants are 60 days after planting with the volume of 50 ml per plant. The data in each treatment were calculated by its middle value and homogeneity was tested. Real data were analyzed by analyses of variance, followed by the least significant difference test with a level of 5%. The variables observed in 2 and 4 weeks after application were plant height and number of fresh leaves. The variables observed at harvest time of 5 months after planting were the wet and dry weight of leaves, stems and roots.

RESULTS AND DISCUSSION

Eight different ethrel concentrations (0; 0,5; 1; 1,5; 2; 2,5; 3; dan 3,5 ml/l) applied through leaves significantly affected plant height on 4 weeks after application, number of fresh leaves 2 and 4 weeks after application, wet and dry weight of roots. The use of 2 cassava varieties UJ 3 and Kasetsart significantly affected the number of fresh leaves on 2 and 4 weeks after application and the weight of wet and dry leaves, stems, and roots. The interaction between ethrel concentrations and 2 cassava plant varieties only had a significant effect on the number of fresh leaves on 2 weeks after application (Table 1).

Table 1. Recapitulation of variance analysis results based on the middle square for all observations of application treatment variables for eight different ethrel concentrations (0; 0,5; 1; 1,5; 2; 2,5; 3; dan 3,5 ml/L) to inhibit two cassava plant varieties.

Variables Observed	Ethrel (E)	Variety (V)	E x V
Plant Height 2 WAA	tn	tn	tn
Plant Height 4 WAA	973,02*	tn	tn
Number of fresh leaves 2 WAA	136,85*	526,13*	37,83*
Number of fresh leaves 4 WAA	5,70*	30,68*	tn
Wet Weight of Leaves	tn	222713,21*	tn
Dry Weight of Leaves	tn	23161,04*	tn
Wet Weight of Stems	tn	3783170,88*	tn
Dry Weight of Stems	tn	511117,76*	tn
Wet Weight of Roots	336972,81*	837591,04*	tn
Dry Weight of Roots	35603,76*	98000,30*	tn

* = significant difference at $\alpha = 5\%$;
tn = No significant difference at $\alpha = 5\%$

Plant Height

Observations on plant height on 4 weeks after application followed by LSD test analysis were presented in Table 2. Although the concentration of 2,5 ml/l was not significantly different from the concentration of 3 and 3,5 ml/l, but had a value with a low plant height. It indicated that concentration of 2,5 ml/l most inhibits plant height on 4 weeks after application (Figure 1). In the concentration treatment of 1 ml/l, the UJ 3 variety was higher than Kasetsart variety and then went down at a concentration of 1,5 to 3,5 ml/l. It was suspected that UJ 3 variety were more responsive to ethrel in inhibiting plant height at an increase of 1,5 to 2,5 ml/l.

Table 2. The effect of the application of ethrel concentration on the height of cassava plant at 4 weeks after application.

Ethrel concentrations	Plant Height **(cm)**
0,0ml/L	171,06 a
0,5 ml/L	164,44 ab
1,0ml/L	167,44 a
1,5 ml/L	150,38 cd
2,0 ml/L	158,06 bc
2,5 ml/L	141,06 e
3,0ml/L	145,50 de
3,5 ml/L	148,69 de
BNT 5 %	8,28

Information: The middle value followed by the same letter are not different according to the LSD test at α = 5%

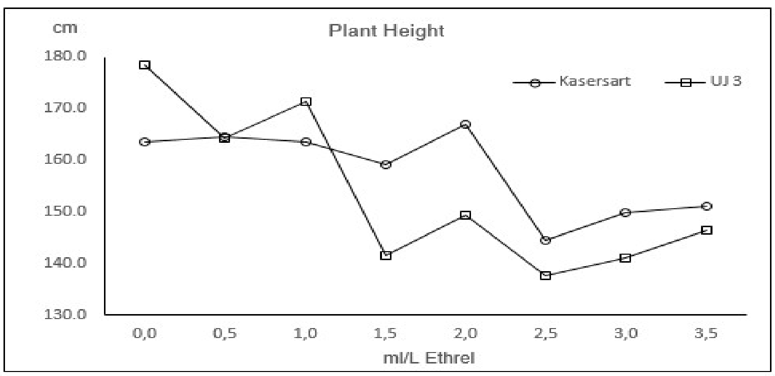

Figure 1. Graph of plant height for different ethrel concentrations in two cassava plant varieties observed on 4 weeks after application.

Number of fresh leaves

Application of some ethrel concentrations significantly affected the number of fresh leaves on plants on 2 weeks or 17 days after application, and also affected the use of two cassava plant varieties at 2 weeks after application. Combination of ehrel concentration and the use of two cassava plant varieties significantly affected the number of fresh leaves at 2 weeks after application (Table 3). The effect of concentration of 3,5 ml/l ethrel to UJ 3 variety inhibited the growth of leaf numbers with an average number of leaves lower than the other concentrations of 8,50 strands at the age of 11 weeks after plant or 2 weeks after application or 17 days after application. Based on the results the ethrel application concentration of 3,5 ml/l had an effect on inhibiting the growth of the number of leaves on UJ 3 variety. The number of fresh leaves of the plant on the age of 2 weeks after the application had a significant effect because the cassava plant had decreased the number of leaves. This was marked by the fallen leaves of plants especially in UJ 3 variety (Figure 2).

Table 3. The effect of the application of ethrel concentration on two cassava plant varieties to the number of fresh leaves of cassava plants at 2 weeks after application.

Ethrel concentrations	Number of fresh leaves **(Strand)**	
	UJ 3	Kasetsart
0,0 ml/L	25,13 a X	23,13 a X
0,5 ml/L	20,13 b X	22,50 a X
1,0 ml/L	21,38 a X	23,38 a X
1,5 ml/L	15,38 bc Y	23,00 a X
2,0 ml/L	12,25 cd Y	21,13 a X
2,5 ml/L	9,75 d Y	18,25 a X
3,0 ml/L	10,13 cd Y	18,50 a X
3,5 ml/L	8,50 d Y	18,63 a X
BNT 5%	5,47	

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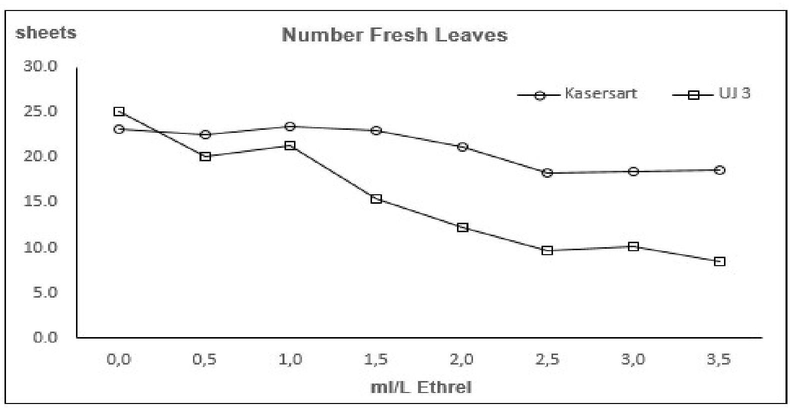

Figure 2. Number of fresh leaves for different ethrel concentrations in two cassava plant varieties observed on 2 weeks after application.

Cassava plants treated by some concentrations of ethrel on 4 weeks after the application haved a significant effect on the number of fresh leaves. In addition, the use of two cassava plant varieties also significantly affected the number of fresh leaves on 4 weeks after application (Table 4). The number of fresh leaves of UJ 3 variety was more than that of Kasetsart. This was due to an increase in the number of leaves in the plant which was characterized by the growth of leaves on the branch buds on the stem. Fallen leaves caused a decrease in the number of main stem leaves and UJ 3 variety lost more leaves on the main stem than Kasetsart. The place of the leaf stalk on the main stem whose leaves haved fallen would grow branch shoots with new leaves resulting in increasing the number of leaves and fresh weight of leaf of plants on 4 weeks after application. 0,5 ml/l ethrel treatment could inhibit the growth of fresh leaves on Kasetsart variety.

Table 4. The effect of the application of ethrel concentration and the use of 2 cassava varieties on the number of fresh leaves planted with cassava at 4 weeks after application.

Varieties	Number of fresh leaves **(Strand)**
UJ 3	61,25a
Kasetsart	39,97b
	BNT 5 % = 15,48
Ethrel concentrations	
0,0ml/L	32,75c
0,5 ml/L	32,13c
1,0ml/L	47,25b
1,5 ml/L	47,00b
2,0 ml/L	60,94a
2,5 ml/L	59,06a
3,0ml/L	60,19a
3,5 ml/L	65,56a
	BNT 5 % = 7,74

Information: The middle value followed by the same letter are not differ according to the LSD test at α = 5%

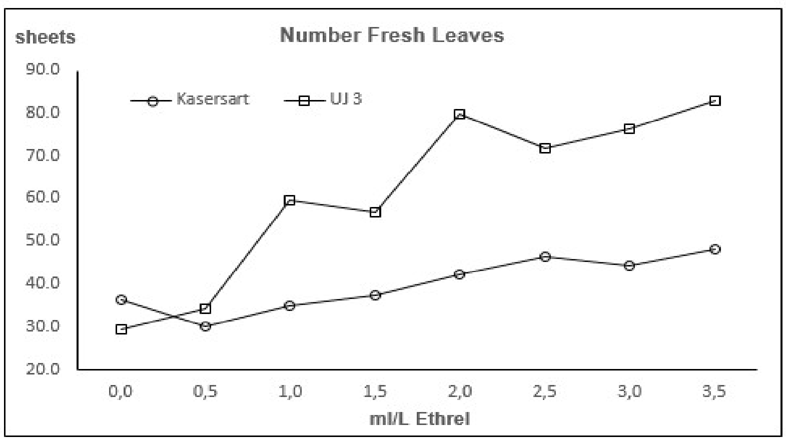

Figure 3. Number of fresh leaves in different ethrel concentrations in two cassava plant varieties observed at the 4 weeks after application.

Wet Weight of Leaves, Stems and Roots

The results showed that cassava plant varieties significantly affected the wet weight of leaves, stems and roots in plants at 5 months after planting (Table 5) and the application of ethrel significantly affected the wet weight of roots plant at 5 months after planting (Table 6.). Based on Graph 4, the wet weight of leaves on UJ 3 variety which showed the lowes weight was at 3 ml/l. In the Kasetsart variety the 2 ml/l ethrel application shows the lowest weight. The wet weight of leaves on UJ 3 variety showed lower yields than Kasetsart variety. This is because some leaves of UJ 3 variety leaves have fallen during harvesting.

UJ 3 and Kasetsart varieties, in the node section, plants grew buds or branches. The shoots or branches eventually grew and elongated. This caused the wet weight of the stem to be treated differently. Wet weight of stem of UJ 3 variety showed the lowest weight found at concentrations of 2,5 ml/l. In the application of 1,5 ml/l ethrel, Kasetsart variety showed the lowest weight. Based on the varieties, UJ 3 variety had a lower weight.

Table 5. The effect of the use of two cassava plant varieties on the wet weight of leaves, stems and roots in plants 5 months after planting.

Varieties	Wet Weight of Leaves **(g/plant)**	Wet Weight of Stems **(g/plant)**	Wet Weight of Roots **(g/plant)**
UJ 3	89,65 b	998,99 b	247,91 b
Kasetsart	207,63 a	1485,25 a	476,71 a
BNT 5 %	74,79	369,45	206,44

Information: The middle value followed by the same letter are not differ according to the LSD test at α = 5%

Table 6. The effect of the application of ethrel concentration on wet and dry weight of roots of cassava plant at 5 months after planting.

Ethrel concentrations	Wet Weight of Roots **(g/plant)**	Dry Weight of Roots **(g/plant)**
0 ml/L	702,08 a	219,01 a
0,5 ml/L	568,65 b	182,36 b
1 ml/L	499,23 b	156,90 b
1,5 ml/L	322,26 c	101,88 c
2 ml/L	297,30 c	92,54 c
2,5 ml/L	151,94 d	44,20 d
3 ml/L	193,50 d	50,93 d
3,5 ml/L	163,55 d	49,34 d
BNT 5 %	103,22	35,85

Information: The middle value followed by the same letter are not differ according to the LSD test at α = 5%

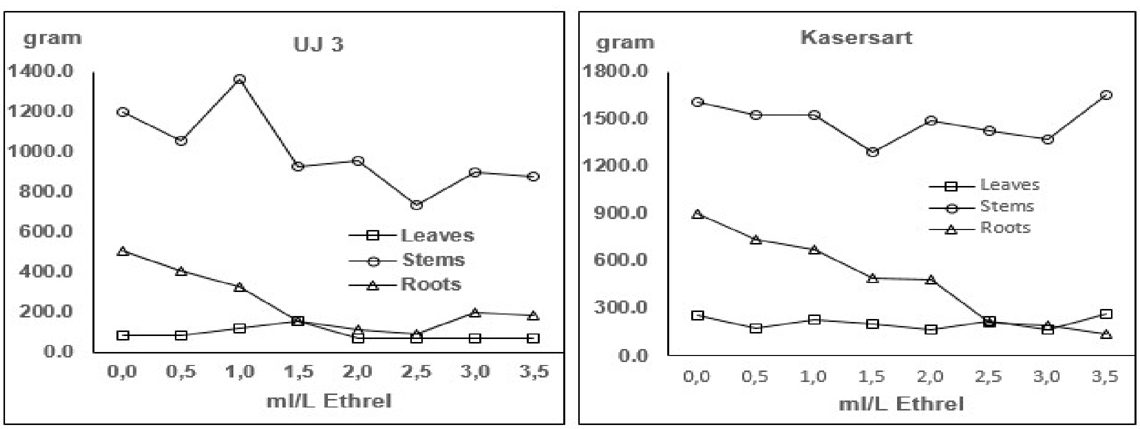

Figure 4. Fresh weight of leaves, stems and roots for different ethrel concentrations in two cassava plant varieties observed on the 5 months after planting.

The application of different ethrel concentrations caused the root wet weight to be lower than without ethrel or control. This proved that ethrel affected the wet weight of roots. Wet weight of roots in UJ 3 variety showed the lowest weight found at concentrations of 2,5 ml/l, in the Kasetsart the application of 3,5 ml/l showed the lowest weight compared to other concentrations.

Dry Weight of Leaves, Stems and Roots

The results showed that the used of two cassava plant varieties significantly affected the dry weight of leaves, stems, and roots on plants aged 5 months after planting (Table 7). In addition, the application of several ethrel concentrations significantly affected the dry weight of roots on plants at 5 months after planting (Table 6). Dry weight of roots of UJ 3 showing the lowest weight was found at concentrations of 2,5 ml/l compared to other concentrations. The 3,5 ml/l of ethrel application in Kasetsart variety showed the lowest weight compared to other concentrations.

The dry weight of leaves of UJ 3 variety showed the lowest weight compared to Kasetart variety, especially at concentration of 2,5 ml/l compared to other concentrations (Table 7). In the Kasetsart variety application of 3 ml/l ethrel showed the lowest weight compared to other concentrations (Figure 5). This was the same as the wet weight of leaf because the number of leaves of UJ 3 variety was less because at the time of harvest many leaves of the cassava plant have fallen.

Table 7. The effect of the use of two cassava plant varieties on the dry weight of leaves, stems and roots in plants 5 months after planting.

Varieties	Dry Weight of Leaves (g/plant)	Dry Weight of Stems (g/plant)	Dry Weight of Roots (g/plant)
UJ 3	25,90 b	228,90 b	73,01 b
Kasetsart	63,95 a	407,63 a	151,28 a
BNT 5 %	22,14	114,23	71,71

Information: The middle value followed by the same letter are not differ according to the LSD test at α = 5%

The dry weight of stems in UJ 3 variety showed the lowest weight found at a concentration of 2,5 ml/l compared to other concentrations. In the Kasetsart variety application of 1,5 ml/l ethrel showed the lowest weight compared to other concentrations (Figure 5). The dry weight of the stems at each concentration of both UJ 3 and Kasetsart varieties varied. This was due to the number of buds or branches that grew in the plant node or the place where the leaf stalks were different. In addition to plant height also affected the weight of the stem both wet and dry.

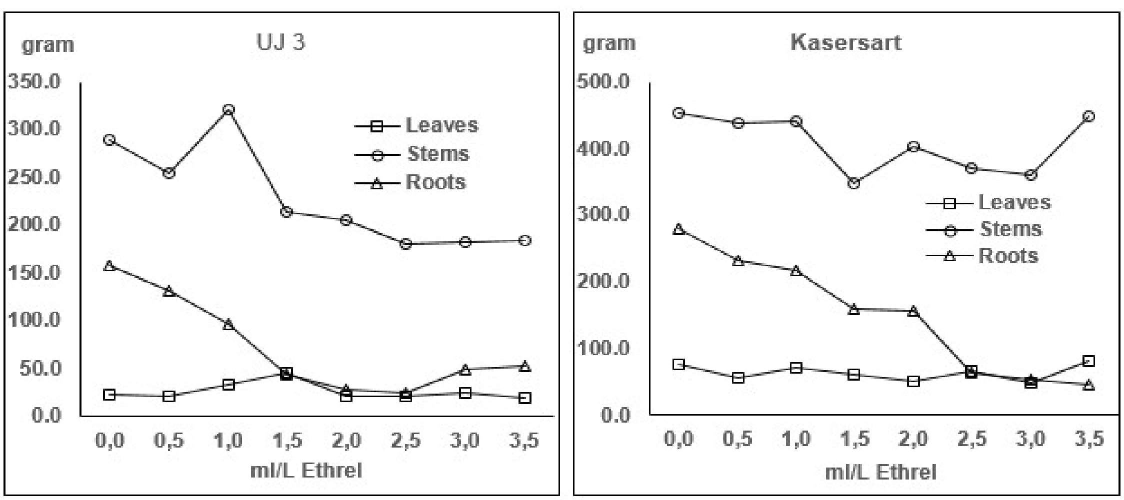

Figure 5. Graph of dry weight of leaves, stems and roots for different ethrel concentrations in two cassava plant varieties observed on the 5 months after planting.

Plant growth was inhibited after ethrel application, the higher the ethrel concentration, the more inhibition of the extension of the plant stem. The inhibition occured was marked by shortening the segment on the stem. Ethrel application was in suppressing plant growth also occured in chili plants in which ethrel inhibited the growth of plant height and leaf size compared with no treatment. In soybean Tondang (2015), appling ethrel with concentrations of 0, 100, 200 and 300 ppm gave the result that the higher the concentration resulted in lower plant height.

Cassava plants applied by some ethrel concentrations had a smaller wet and dry weight of roots compared to controls or without ethrel. These results were similar to other study with ethrel treatment in *Curcuma alismatifolia* Gagnep. In this study plant height was inhibited and the weight rhizome per clump reducted, but did not affect the size and number of rhizomes. Application of 500 ppm ethrel reduced the accumulation of nutrients in the upper part of the soil (N, P, and K) and the organs in the soil (Khuankaew, 2009). Some what different from the results of this study, the ethrel application with gibberellic acid in sugarcane plants increased the dry weight of the plant and sucrose content.

The influence of ethrel or ethepon was thought to caused cassava plants to aging on the leaves. According to Saparwadi (2014), hormones that played a role in leaf abortion were auxin and ethylene. When the leaves were old the amount of auxin would decrease as a result of the cells in the abscess layer which are more sensitive to ethylene. So ethylene affect the formation of an enzymes dissolved the middle lamella and the wall in the abscess cells. As a result the abscess cells will be weak and be unable to support the leaves finally the leaves will fall. Experiments on water culture in the *Ipomea cairica* plant showed that ethepon released ethylene directly on the leaves and caused an increase in electrolyte leakage, aminocyclopropane-1-carboxylic acid (ACC), abscisic acid, and H_2O_2 and decreased chlorophyll content and photosynthetic activity (Sun, *et al*., 2015).

CONCLUSSION

Ethrel treatment of cassava plants in UJ 3 variety was more effective in inhibiting the growth of plant height, the number of fresh leaves and reducing the weight of wet and dry leaves, stems and roots.

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IDENTIFYING CHEMICAL COMPOUND IN CEARA RUBBER SKIN WHICH IS POTENTIAL TO BE NATURAL ANTI-MICROBE BY USING GAS CHROMATOGRAPHY-MASS SPECTROMETRY (GC-MS)

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ABSTRACT

The ceara rubber skin is one of wastes seldom to use, even though ceara rubber contains saponin active compound which is potential to be natural anti-microbe. The objective of this research was to find out the content of ceara rubber skin extract. This research was conducted in 2 stages. The first stage was extracting ceara rubber skin with ethanol dissolvent. The extraction contained of maceration and evaporation conducted in Chemistry Laboratory of Faculty of Science in Lampung University. The second stage was testing the ceara rubber skin content by using GC-MS. This research was conducted in Integrated Laboratory of Lampung University. The results showed that ceara rubber skin contained of chemical compounds including Ethanedioic acid, dibutyl ester., Octanoic acid, methyl ester., 2,4-dihydroxy-2,5-dimethyl-3(2H)-furan-3-one., Estra-1,3,5 (10-trien-17-one, 2[(trimethylsilyl) amino] -3-[trimethylsilyl) oxy]., Nonanal dimethyl acetal., 2-Furancarboxaldehyde, 5-(hydroxymethyl)., 1-pentanol, 2-ethyl-4-methyl., Decanoic acid, methyl ester., Benzaldehyde, 3-hydroxy-4-methoxy., Sucrose., Dodecanoic acid, methyl ester., 1-carbethoxy-3,4-dicarbomethoxy-gamma-carboline., Tridecanoic acid, 12-methyl, methyl ester., Pentadecanoic acid, 14-methyl ester., Methyl.beta-d-galactopyranoside., 9-Octadecenoic acid (Z), methyl ester., 8-Octadecenoic acid (Z), and methyl ester. Most of these chemical compounds are antioxidant, such as Octadecenoic Acid, which inhibit microbe growth.

Key words: chemical compounds, ceara rubber skin, GC-MS

INTRODUCTION

Indonesia is a country with rich natural resources, including cassava, a popular plant in Indonesia. Cassava has some varieties, and one of cassava varieties growing widely in Indonesian regions is ceara rubber cassava. Ceara rubber is one of unused cassava varieties by people, because it contains cyanide acid toxic compound, including its skin. However, according to Hilda (2011), ceara rubber contains saponin bioactive compound. Saponin compound has anti-microbe property by reducing surface tension of bacteria cell wall so that it inhibits bacteria enzyme activity (Zahro, 2013). Cassava skin is a side product of peeling in cassava-based food product processing. Cassava skin constitutes 16% of total of cassava tuber weight (Hidayat, 2009). The objective of this research was to find out the chemical components contained in ceara rubber cassava skin by using GC-MS method, because cassava skin is merged with the tuber, the skin is expected to have the same compound with the tuber and have a potential to be a natural anti-microbe, and this will improve the use of ceara rubber cassava skin which has been being treated as waste so far.

MATERIAL AND METHOD

Material and equipment

Materials used in this research were ceara rubber cassava skin collected from Mr. Rohman's cassava plantation in Metro of Lampung province, ethanol 70%, polar dissolvent, aqua distillate, and alcohol 70%. Equipments used included knife, basin, blender, filter paper, macerator, beaker tube, Erlenmeyer tube, vacuum rotary evaporator, scale tube, stirrer, Gas Chromatography-Mass Spectrometry (GC-MS).

Research Method

This research was conducted in two stages. The first stage was ceara rubber cassava skin sample preparation and extraction of the skin in the Laboratory of Chemsitry in Faculty of Sciences in Lampung University. The second stage was the research included testing of chemical compounds contained in the ceara rubber cassava skin by using Gas Chromatography-Mass Spectrometry (GC-MS) which was conducted in Integrated Laboratory of Lampung University.

RESULT AND DISCUSSION

Ceara Rubber Skin Extraction

Ceara rubber cassava skin was taken in the morning, washed and dried to remove dirt on the material. It was shredded into smaller sizes. Grated skin was then dried to remove water content to make extraction process easier. After grated skin was dried up, 500 gram of dry weight was taken to make extraction by using ethanol 70% solvent.

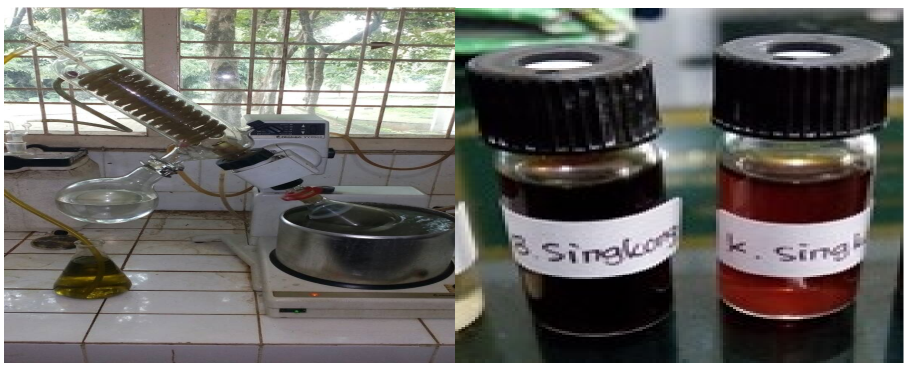

Figure 1. Extraction of ceara rubber cassava skin and leaf

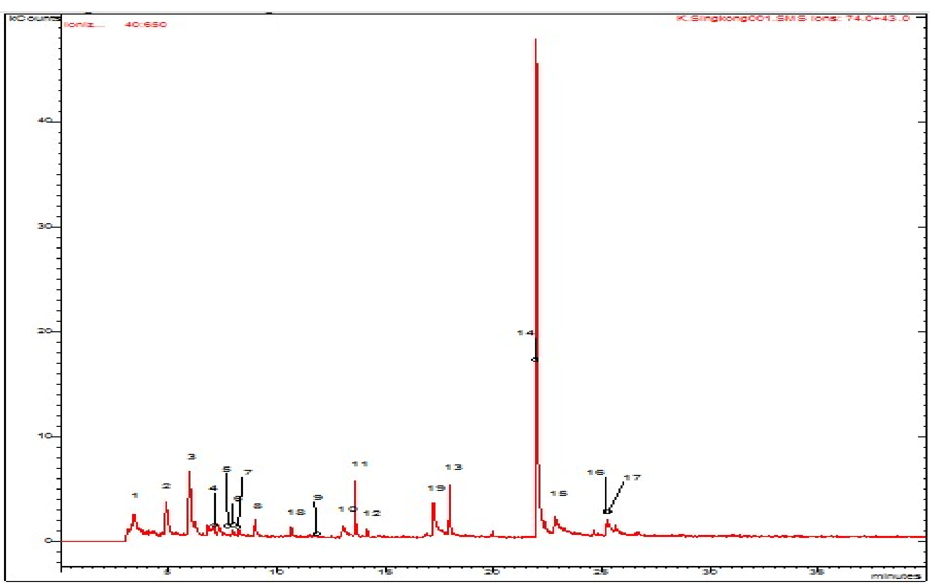

Figure 2. Chromatograph graphic of ceara rubber cassava skin extract

Testing Chemical Compounds in the Ceara Rubber Cassava Skin

Three µl of sample (ceara rubber cassava skin extract) which had been washed with ethanol solvent was taken by using gas chromatograph inlet. The sample was then injected into gas chromatograph by the following conditions: Gas Chromatograph with Auto Sampler (Agilent Technologies 5973 N) and Mass Selective Detector 5873 I; Capillary Column (Innowax) with dimension of 60 m length, 0.2mm wide, 0.25 mm film thickness; 290^{o}C injector temperature; 290^{o}C temperature detector; temperature program of 90^{o}C(150 minutes) - 290^{o}C (20 minutes); carriage gas – Helium 1 ml/min with constant flow; 1uL Split (ratio 50:1) injection volume; ethanol solvent. The analysis of chemical compounds contained in ceara rubber cassava skin was conducted by using Gas Chromatography-Mass Spectrometry (GC-MS). Chromatograph results are presented in Figure 2.

The result of chromatograph graphic reading in Figure 2 derived the following compounds found in the ceara rubber cassava skin extract.

Table 1. Chemical compounds found in the ceara rubber cassava skin extract

No	Retention Time (minute)	Name of compound	% Prob	Area	% Area
1	3,357	Ethanedioic acid, dibutyl ester	56,23	1974	0,48
2	4,857	Octanoic acid, methyl ester	63,23	26481	6,45
3	5,994	2,4-dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	74,66	46502	11,32
4	7,079	Estra-1,3,5(10-trien-17-one,2-[(trimethylsilyl)amino]-3-[trimethylsilyl)oxy]	45,23	2811	0,68
5	7,755	Nonanal dimethyl acetal	63,52	5829	1,42
6	7,936	2-Furancarboxaldehyde, 5-(hydroxymethyl)-	85,19	2949	0,72
7	8,241	1-pentanol,2-ethyl-4-methyl	45,61	1545	0,38
8	8,978	Decanoic acid, methyl ester	53,25	7762	1,89
9	11,837	Benzaldehyde, 3-hydroxy-4-methoxy	57,92	1090	0,27
10	13,081	Sucrose	69,94	9218	2,24
11	13,599	Dodecanoic acid, methyl ester	68,1	17459	4,25
12	14,156	1-carbethoxy-3,4-dicarbomethoxy-,gamma-carboline	35,99	2715	0,66
13	17,986	Tridecanoic acid, 12-methyl-, methyl ester	68,72	17656	4,30
14	21,997	Pentadecanoic acid, 14-methyl ester	62,99	223950	54,53
15	22,854	Methyl,beta,-d-galactopyranoside	56,64	7047	1,72
16	25,241	9-Octadecanoic acid (Z), methyl ester	23,67	5017	1,22
17	25,346	8-Octadecanoic acid (Z), methyl ester	21,51	7435	1,81
18	10,672	-		3806	0,93
19	17,234	-		19435	4,73
		Total		410681	100

Table 1 shows that the ceara rubber cassava skin extract contained phenol and fatty acid compounds which haved anti-bacteria property. According to Gurning (2015), Octadecenoic acid methyl ester has anti-oxidant and anti-microbeactivities, and it also has activities as hypocholesterolemic, nematicide, anti-arthritic, hepato-protective, anti-androgenic, hypocholesterolemic 5-alpha reductase-inhibitor, anti-histaminic, anti-coronary, insectifuge, anti-eczemic, anti-acne. Pentadecanoic acid, tridecanoic acid, dodecanoic acid, decanoic acid, octanoic acid and ethanedioic acid compoundsare fatty acids with anti-bacteria properties which impair cell membrane and wall structures with synergic mechanism of varying active compounds so that they will improve anti-bacteria activities (Padmini, *etal*.; 2010). 9-octadecenoic acid methyl ester (methyl elaidate), 9-octadecenoic acid(oleic acid), andoctadecanoic acid (stearic acid) are able to inhibit microbe growth (Noviyanti, 2010; Asghar, *et al*., 2011).

Benzaldehyde compound content has a benefit to be preservative, because it can inhibit damage caused by microbe contamination and it can be used to make perfume because it produces fragrance aroma. Benzaldehyde is also widely used in making almond flavor in food and beverage. It can also be used as pesticide and intermediary to synthesize other organic compounds. Benzaldehyde is transformed into benzoate to make it into preservative, but it is more often to be used as material to make perfume (Gita, 2014).

CONCLUSION

The results of the research indicated that the ceara rubber skin has an opportunity to be material for making natural anti-microbe, because it contains chemical compunds which are able to inhibit microbe growth such as pentadecanoic acid, tridecanoic acid, dodecanoic acid, decanoic acid, octanoic acid and ethanedioic acid.

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CORRELATION OF WHITENESS AND PROTEIN CONTENT OF MODIFIED CASSAVA FLOUR (MOCAF) MADE FROM DIFFERENT VARIETIES OF CASSAVA

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ABSTRACT

Modified cassava flour (mocaf) is a local flour alternative which is expected to be a substitute for wheat flour. The objective of this study was to examine the effect of cassava varieties on the whiteness and protein content of mocaf. The cassava varieties used in this study were Manggu, UJ-5, Mentega and Perelek. The whiteness of four mocaf samples was measured by using colorimeter. Data of mocaf whiteness was analyzed by ANOVA (analysis of variance) at a significance level of 5% and Duncan Multiple Range Test (DMRT) if significantly different. There were significant differences (α <0,05) on whiteness of four varieties of mocaf sample. There was no significant different of the whiteness level between UJ-5's mocaf flour (92,78%) and Mentega's mocaf flour (92,67%). The highest level of flour whiteness was UJ-5, while the lowest protein whiteness was Perelek variety (91,61%). The highest protein content was found in the flour of Mentega variety (3,4%), while the lowest content was found in Perelek flour (1,25%). Other than variety, the whiteness of the flour was also influenced by protein and water content.

Key words: whiteness, mocaf, protein, variety

INTRODUCTION

Cassava (*Manihot esculenta Crantz*) is one of Indonesian local commodity which can be utilized to meet local needs of foods as alternative source of calories in certain communities other than rice and maize. According to Loebis *et al*. (2012), one of cassava derived product is Edible Modified Cassava Flour (EMCF) or called as mocaf. It has been reported that beneficial characteristics of mocaf are typical flavor and taste, whiter and higher of dissolved fiber content than *gaplek* flour and higher mineral than wheat and rice. It has swelling ability equal to medium protein flour (Subagio, 2009).

One of modification method for producing cassava flour is by fermentation (Subagio, 2009). The fermentation is performed before drying stage of fresh cassava flakes in order to improve physicochemical characteristic of mocaf. Improvement of the modification result is caused by starch liberation and hydrolysis (Hidayat *et al*. 2009). Hartati *et al*. (2003) have stated that high quality of mocaf has an equal whiteness to wheat flour. For selected food product, the quality of mocaf determines the final product of food. Other study has found the highest level of whiteness was produced by 0,5% salt using and soaking for three days i.e. 94,37% (Wanita and Wisnu, 2013).

Efendi (2010) has reported that mocaf characteristics are influenced by variety of cassava and length of fermentation time. The study aimed to investigate the correlation of whiteness to protein content of selected cassava variety.

MATERIALS AND METHODS

Time and Place of Study

The study was performed on August 2016 in Postharvest Laboratory of Balai Pengkajian Teknologi Pertanian (BPTP), Banten. The current study of advanced research has been reported by Lestari (2017).

Materials

Materials used in the experiment were four varieties of cassava: Manggu, Mentega, Perelek and UJ-5. Equipments used were knife, peeler, grater, spinner, soaking tub, cabinet dryer, pressing tools, grinding machine and sieve.

Preparation of Mocaf

Process of mocaf production was performed the following procedures presented in Figure 1.

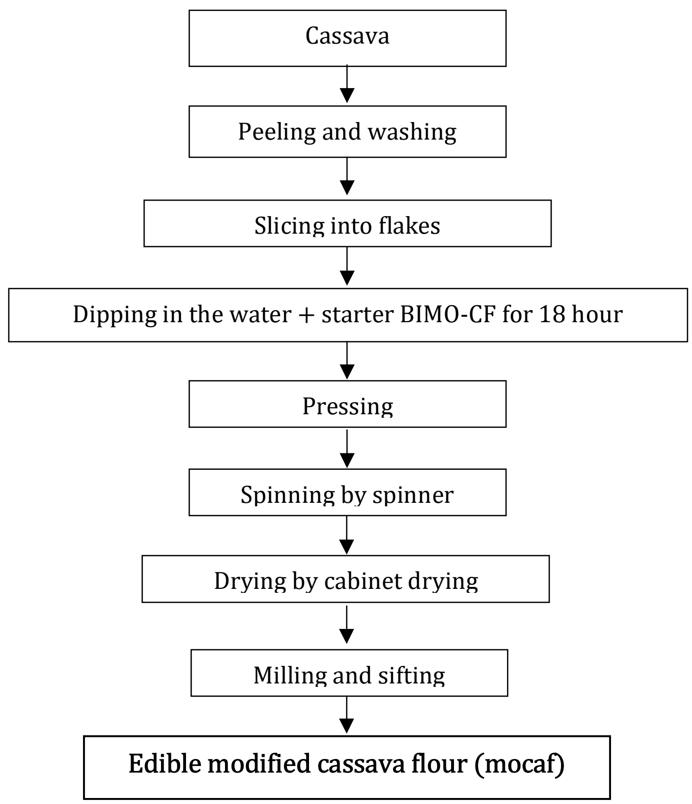

Figure 1. Flowchart of mocaf production

Whiteness, Protein and Water Content Analysis

The value of protein and water content used found in previous study by Lestari (2017). The mocaf was packed with clear plastic. The whiteness of mocaf was measured by colorimeter which was attached to the packed mocaf. The measurement was carried out in triplicate on three spot of each sample. Data of whiteness was analyzed statistically by using analysis of variance 5%. Subsequently, the analysis was followed by Duncan Multiple Range Test (DMRT) if significantly different (Steel *et al.*, 1993).

RESULT AND DISCUSSION

Whitenes Analysis

Colour is an important atribute which determine product performance as it affects to the consumer preferences. The whiteness is often used to present the flour quality during storage (Uchechukwu-Agua *et al*., 2015). The current study compared the whiteness value of four varieties of cassava i.e. Manggu, Mentega, Perelek and UJ-5 which is presented in Table 1.

Table 1. Whiteness, protein and water content of mocaf

Variety	Whiteness	Protein (%)	Water Content (%)
Manggu	91,91[a]	1,88	6,72
Mentega	92,67[b]	3,40	8,40
Perelek	91,61[a]	1,25	8,43
UJ-5	92,78[b]	1,52	4,67

*Different letters in the same column indicate significant differences ($p < 0.05$) between variety at 5% level

According to Subagio (2008) in Hidayat *et al*. (2009), production of mocaf by chipping or grating cassava into flakes form resulted in whiteness value approximatelly 88-91%. As shown in Table 1, the highest degree of white colour was found in UJ-5 flour (92.78%), on the other hand the lowest whiteness was found in Perelek flour (91,61%). The whiteness of Manggu and Perelek showed the significant differences to the Mentega and Uj-5 which was indicated by p value < 0.05. The value indicates that there was correlation between variety of cassava and the whiteness of the flour.

General acceptable criteria of mocaf was arranged by Indonesian National Standard. In accordance with the standard of mocaf No. 7622:2011 Table 2 showed that minimum quality requirement of whiteness is 87 (BSN, 2011). Therefore, the flour made from these varieties was in accordance with the required standard in terms of whiteness. Requirement of whiteness and water content of mocaf is presented in Table 2.

Table 2. Quality requirement of mocaf (BSN, 2011)

Criteria	Requirement	Unit
Whiteness	Min 87	-
Water content	Max 13	%

According to Muchtadi and Sugiyono (1992), the whiteness of mocaf depends on tuber colour of cassava used. Yellow tuber of cassava contained of caroten as the source of vitamin A resulted in the low degree of whiteness when processed into the flour. Visually, Manggu, Perelek and UJ-5 had white colour of tuber while Mentega had yellow tuber. Other study reported that whiteness measurement of white tuber of cassava Malang 1 with fermentation length of 0, 24, 48 and 72 hour were about 68,48 to 76,40. While, the whiteness measurement of yellow tuber of cassava Mentega with fermentation length of 0, 24, 48 and 72 hour were about 68,24 to 70,30 (Efendi, 2010).

Based on data shown in Table 1, whiteness of Mentega was higher than Manggu and Perelek even though it had yellow tuber of cassava. This is probably caused by browning reaction at the time of drying which resulted in the appearance of brown colour. Rahmiati *et al*. (2016) stated that not only tuber colour of cassava which affects to the whiteness, temperature and humidity during drying could also do. Uneven heating temperature will affect on the brightness of the cassava flakes.

Protein Content

Wahjuningsih (2011) has reported that protein content of the material has a strong influence to the whiteness of the flour. The higher of protein content in cassava, the lower of the whiteness of the mocaf produced. Other study stated that yellow colour of cassava Mentega produced mocaf with the highest content of protein (3,40%) compared to Manggu (1,88%), Perelek (1,25%) and UJ-5 (1,52%) (Lestari, 2017).

The data in Table 1 showed different circumstances where mocaf produced from Perelek had the lower whiteness than Mentega. As stated before that temperature during production had also affect to the flour colour (Rahmiati *et al*., 2016). Kusnandar (2010) has reported that browning reaction occurs to the high carbohydrat food material if heated. In the current study, drying stage of mocaf was carried out by using oven drying (40-60^{o}C) without flipping the position of the flour that cause heat in the oven was not evenly distributed. As a result, the mocaf resulted had a different water content as presented in Table 1.

The highest water content in the flour was found in cassava Perelek (8,43%). This is probably affected on the whiteness degree. As shown in Table 1 where the lowest whiteness value is cassava Perelek (91,61%). On the oher hand, UJ-5 flour had the highest whiteness value (92,78%). This value was inversely proportional to its content of water which was the lowest value (1,25%).

Protein content of mocaf is relatively lower than wheat flour which is resulted from wheat milling extraction. The wheat flour has approximately 10-14% protein (Riganakos *et al*., 1995). Therefore, many studies of food processing use mocaf as an alternative to wheat flour subtitute. Yulifianti *et al*. (2012) have reported that the proportion of mocaf as wheat flour subtitute varies between 30-40% in bakery, pastry and noodles. While in cakes, cookies and fried food the substitution reaches 50-100%.

CONCLUSION

The highest whiteness of mocaf was found in cassava UJ-5, while the lowest was cassava Perelek. The whiteness was affected by some factors: cassava variety, protein content and water content of the mocaf.

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FARMERS CASSAVA MOTIVATION TO CHANGE PARTNERSHIP (CASE OF FARMERS SUGARCANE AND CASSAVA PARTNERSHIP)

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ABSTRACT

Partnerships in farming between companies and farmers are common. The purpose of this research to know 1) farmer income of Cassava and Sugarcane, 2) comparison income of farmer cassava and sugarcane, and 3) factors related to the change partnership of farmers. The location of the research was selected in Lampung Tengah District by purposive. The number of respondents was 47 people, and data collection was done through interview technique. Data analysis was done by using Binary Regression Logistic. The study was conducted from December 2015 to May 2016. The results showed: 1) farmer income of cassava farming is Rp.13.282.985,00 / ha / season, and farmer income of sugarcane farming is Rp. 11.403.828,00 / ha / season, 2) R/C cassava farming partnership is 2,15 and R/C sugarcane farming is 2,13, and 3)factors related to change from sugarcane partnership to cassava partnership were capital aid in partnership, partnership requirements, farming income share system, farm income, and production materials.

Key word: cassava, farmer motivation, partnership

INTRODUCTION

The role of agricultural sector in Indonesia's development is very important also for Lampung Province. Contribution of agriculture sector in LampungProvince economy is 31,86% (Bappeda Lampung Province, 2016). The influence of this sector can be seen from various subsector, namely food crops, plantation crops, livestock, forestry, and fisheries. One of the food commodities and plantation commodities are cassava and sugarcane crops.

PT.Gunung Madu Plantations is one of Indonesian industry in sugar cane plantation with an area of 4000 hectares of land. The company is partnering with sugar cane farmers to produce sugar. In 2013, the number of farmers who partnered with PT.Gunung Madu Plantation reached 309 people, and in 2014 increased to 589 people, but in 2015 the number of farmers who partnered decreased to 491 people, while Bumi Waras Company to partnerships with farmers cassava to producing tapioca. In the relation to this partnership, there were many sugarcane farmers moving to partnership to farming of cassava. By 2015, the number of sugarcane farmers who changed partnerships to cassava farmers was 143 people. Therefore, knowing the factors that causethe motivation of farmers to switch in partnership is very interesting to be studied.The purpose of this research was to know: 1) farming income of Cassava and Sugarcane, 2) comparison of farming income of cassava and sugarcane, and 3) factors related topartnership change fromsugarcane farmers to be cassava partnership in Lampung Province.

MATERIALS AND METHODS

Research was conducted in the Lampung Tengah subdistrict, Lampung Province from December 2015 until May 2016. Respondent were selected from sugarcane and cassava farmersand determined purposively because in the districts many farmers were switching from sugarcane partnership to cassava partnership. Data were collected through interview technique and in-depth interview and FGD. Data analysis was done by using parametric statistic of binary logistic regression.

RESULTS AND DISCUSSION

Partnership in farming of sugarcane and cassava are business strategy to mutual profits for agricultural company and farmers (Hafsah, 2002). Because of partnership is business strategy, partnership successfully is determined of farmers and agricultural company. For example, discipline to obedient partnership procedure from farmers and company is most important. Agribusiness system in Indonesia, partnership shape are 1) nucleus - plasma , 2) subcontract, 3) trade shape, 4) agency shape, and 5) operational partnership (Soemardjo, 2004). The result of this research, partnership shape between PT. GunungMadu Plantation and PabrikBumiWaras with sugarcane and cassava farmers is nucleus-plasma partnership. In the form of partnership the company provides capital aid and materials of production to sugarcane and cassava farmers. The company also provides assistance to farmers in technical cultivation, maintenance, harvesting, and marketing of production. Table 1 showed the company partnership performance with sugarcane and cassava farmers.

Table 1. Partnership pattern performance by sugarcane and cassava farmers

No	Aspect	Performance	
		Sugarcane partnership	Cassava partnership
1.	Cultivation techniques	More difficult, and got guidance from the company about cultivation techniques	Easier, and no guidance from company about cultivation techniques
2.	Productions of materials	The company provided production of materials	The company no provided production of materials
3.	Capital aid	Only for sugarcane farming	For cassava of farming and other nescessities of life.
4.	Processing of product	Companies that process production of sugarcane	Companies that process production of cassava
5.	Marketing of production	The company receives the production of sugarcane farmers	The company receives the production of cassava farmers
6.	Profit-sharing system	Farm income is paid in stages (80% paid when harvesting and 20 % paid later)	Farm income is paid when harvesting (100%)
7.	Partnership requirement	More difficult	Easier
8.	Farm income	High enough (Rp.11.403.828,00/ha/season), but paid in stage	High enough (Rp.13.282.985,00/ha/season)and paid when harvesting
9.	Land area	Requires a large area (15 hectare each smallgroup farmers)	No requires a large area each smallgroup farmers)

Table 1 showed that partnership in cassava farming is more convenience compared to partnership in sugarcane farming. In addition, the farm income factor obtained from cassava farming is higher than sugarcane farm income and the presence of capital loan to cassava farmers for other purposes causes farmers who previously partnered in sugarcane farming to switch to cassava partnership. Furthermore, the capital aid received by cassava farmer for livinglostalso influenced the moving of sugar cane farmers into cassava partnerships. This fact showed that the relative advantages and farming income received and the other factors have effected the movement in partnership. Thus, if these two forms of partnership are to be maintained must be considered the other factors. The results of this study also supported the results of research conducted byHasanuddin (2013), Mardikanto (1998), Scott (1983),and Wolf (1981) that farm income and relative advantage influence to farmers' decision making to adopt of inovation such as moving commodities in farming. Table 2 showed that several factors affecting the movement of sugarcane farmers to cassava partnership.

Table 2. Several factors that affected the movement of sugarcane farmers to cassava partnership.

Variable	Variable	α	Significancy
Capital aid			0,000
Farming income share system	Changes to partnership in farming by farmers	0,05	0,132
Partnership requirement			0,005
Large of area			0,000
Farming income			0,001
Production of materials			0,000

Table 2 showed that farming income share system had no relation to change in partnership of farmers, but capital aid, partnership requirement, large of area, farming income, and production of materials affected to change partnership. If it is related to the needs of the farmers life, the farming income sharing system needs to be considered.

CONCLUSION

The results of research showed that 1) farming income of Cassava (Rp.13.282.985,00/ha/season) more than farming income of Sugarcane (Rp.11.403.828,00/ha/season), 2) Revenue and cost ratio of cassava farming partnership (2,15) was more than revenue and cost ratio of sugarcane farming partnership (2,13), and 3) factors related to the change partnership of farmers in Lampung Province were capital aid, partnership requirement, large of area, farming income, and production of materials.

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GROWTH AND YIELD OF CASSAVA *(Manihot esculenta* Crantz*)* UNDER INTERCROPPING WITH SEVERAL GENOTYPES OF SORGHUM (*Sorghum bicolor* [L.] Moench)

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ABSTRAK

The purpose of this experiment is to evaluate the growth and yield of cassava under intercropping with several genotypes of sorghum. This research was conducted in Sukanegara Village, Tanjung Bintang, South Lampung district in March 2017–March 2018, dry matter analysis conducted in the laboratory of Agronomy, Faculty of Agriculture, University of Lampung, Bandar Lampung. The experiment was set in RCBD (Randomized Completely Block Design) with three replications. Its homogeneity of variance was tested with Bartlett test and data's additivity of will be tested with Tukey's test. If these two assumptions are fulfilled then continued with analysis of variance (anova). Since factors in anova are significant then the comparison of treatment means were analyzed by LSD's test (Least Significant Difference) at the 5% level. The results showed that cassava under intercropping with sorghum genotypes of P/F-5-193-C and GH 5 tend to show a slower growth than the cassava planted in intercropping with other sorghum genotypes in this research. While, on the results of the component, the cassava plant in intercropping with P/F-5-193-C and GH 5 produce number of tuber fewer than when in the intercropping with other sorghum genotypes. Instead, the resulting starch content higher.
Keywords: cassava, intercropping, and sorghum

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is one of a tubers plant which have many uses, from tuber, stem, and the leaves can be utilized. Its tuber can be used as ingredients of food and industrial raw material such as tapioca, sugar, liquid cosmetics, toothpaste, paper, envelopes, etc. Cassava stems are usually used as a seed for cuttings, while the leaves are used as livestock feed.

The province of Lampung province is one of the major producers of cassava in Indonesia, in addition to plant palm plantations, rubber, and sugarcane. Cassava has been cultivated due to its important economic value. It is also supported by existing of tapioca industry in Lampung. In 2016, there are 295,550 hectares of harvest area for cassava producing a total of 7.74 million tons of tuber, so it makes the Lampung province the first rank in contributing cassava in Indonesia (BPS, 2017).

The use of cassava monoculture planting systems causes open space between plants that can be used when cassava plants are still in the vegetative phase, where the canopy between plants has not covered each other. Therefore, this condition can be used for intercropping. Sorghum (*Sorghum bicolor* [L.] Moench) is a crop that produces within three months, where in the three or four months at the beginning of the growth of cassava, the plant canopy still provides open space for soil under the plants so that it is suitable for intercropping with cassava.

As stated by Cong et al. (2014), intercropping, the simultaneous cultivation of multiple crop species in a single field, increases aboveground productivity due to species complementarity. Intercropping can allow the main crop, such as cassava, to be disturbed, due to competition to obtain nutrients, water, sunlight, and cause micro-climate changes under the canopy. This cropping system is believed to be most likely to affect the growth and yield of the main crop. Planting some different sorghum genotypes as intercropping with cassava will affect cassava on its growth and yield due to genetic of sorghum plants. Therefore, this study aims to evaluate the growth and yield of cassava plants grown intercropping with several sorghum genotypes.

METHODS

The experiment was conducted in March 2017 - March 2018 in Sukanegara Village, Tanjung Bintang District, South Lampung Regency, dry matter analysis was conducted at the Agronomy Laboratory, Faculty of Agriculture, University of Lampung, Bandar Lampung. Equipment used in the field experiment are tractor, oven, starch content measuring instrument (Thai Sang Metric Co. Ltd.), and SPAD-500. Cassava clone of UJ5 was intercropped with eight sorghum genotypes (GH 3, GH 4, GH 5, GH 7, Mandau, P/F-5-193-C, Super 1, and Talaga Bodas), denoted as UB 1 (cassava + GH 3), UB 2 (cassava + GH 4), UB 3 (cassava + GH 5), UB 4 (cassava + GH 7), UB 5 (cassava + Mandau), UB 6 (cassava + P/F-5-193-C), UB 7 (cassava + Super 1), and UB 8 (cassava + Talaga Bodas). The experiment was set in RCBD (Randomized Completely Block Design) with three replications. Its homogeneity of variance was tested by using Bartlett's Test, and additivity by Tukey's Test. Analysis of variance continued with LSD's test (Least Significant Difference) at the 5% level, and all data were analyzed by Minitab (Version 17).

RESULTS AND DISCUSSION

The results showed that at the age of 6-21 WAP there was no difference in the height of cassava plants intercropped with sorghum genotype, but there was a tendency for plants to be shorter when intercropped with P/F-5-193-C. Plant height differences among intercropped genotypes are consistently seen at 26-51 WAP. The results showed that cassava under intercropping with P/F-5-193-C consistently tended to be shorter than other genotypes. Meanwhile, if cassava is grown in intercropping with the Talaga Bodas tended to increase (Figure 1).

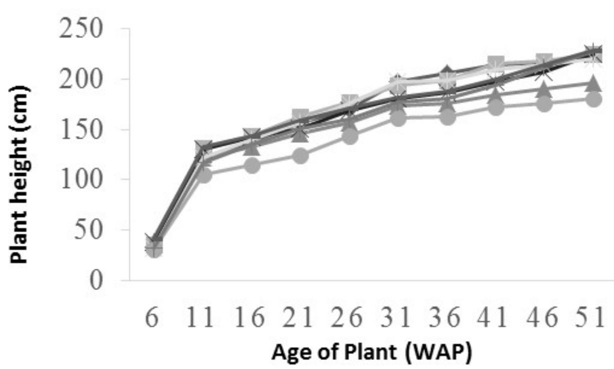

Figure 1. Plant height of cassava under intercropping with several genotypes of sorghum.

Description:

UB 1 UB 2 UB 3 UB 4
UB 5 UB 6 UB 7 UB 8

WAP: Weeks after planting

Cassava competition with sorghum plants occurred at the initial growth of sorghum. The results showed that in the range of 8-18 WAP, cassava had a disturbance due to light competition with sorghum plants which were higher than cassava resulting the depressed growth of cassava. Cassava recovery due to this competition was happened after harvesting sorghum (18 WAP). Cassava growth and yield under intercropping with sorghum P/F-5-193-C consistently tend to be inhibited (Figure 2). This is presumably due to the high and the large number of leaves of the sorghum genotype, causing cassava to be shaded by a sorghum canopy. This experiment is supported by Herdiana *et al.* (2008), where shade density results in poor plant growth. Shade that is too tight causes disruption to growth. In addition, photosynthetic factors can affect the growth and yield of plants as Komariah (2017) stated that photosynthesis is the process of changing certain organic materials into food organic matter, where sunlight is an energy source for food crops. Sunlight is a source of energy for photosynthesis, so it can affect vegetative and generative growth.

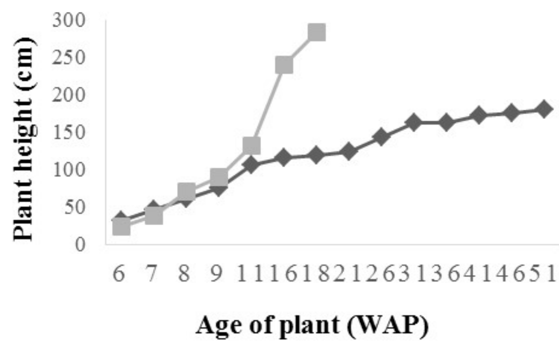

Figure 2. Comparison of plant height of cassava and sorghum genotypes P/F-5-193-C

Description:

The number of cassava leaves showed a fluctuative increase every week (Figure 3). It is understandable because in August 2017 the rainfall was 38.6 mm, then increase to be 77.5 mm in the following month. Although cassava plants are classified as drought-resistant plants, it does not mean that cassava does not need water for its growth as stated by Craft et al., (1949) and Kramer (1969) that lack of water will disrupt the chemical balance in plants which results in reduced photosynthesis or all physiological processes run abnormally. Howeler (2014) states that during drought, cassava roots will grow deeper to absorb water and at the same time the stomata will be closed to reduce transpiration and stop producing new leaves and old leaves fall. However, after a period of drought ends cassava can return to its normal state in which new leaf buds appear.

Leaves greenness is only used to indicate the presence of chlorophyll content, but not real chlorophyll content. As Parry (2014) said that if chlorophyll is uniformly distributed, the SPAD value will be linearly related to the leaf chlorophyll concentration and the CCI (Chlorophyll Content Index) values will be related to chlorophyll concentration as a logarithmic function. However, chlorophyll is not evenly distributed in thez leaves and this causes the estimated concentration based on the transmission measurements to be deviant. The wood which is intercropped with sorghum genotype produces different leaf greenness. The results showed that when 51 WAP there was a tendency for leaf greenness to decrease in some intercropped genotypes.

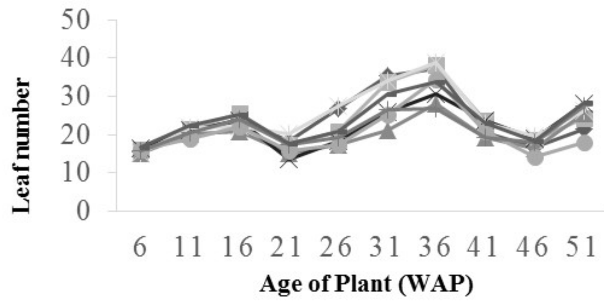

Figure 3. Leaf number of cassava under intercropping with several sorghum genotypes

Description:

UB 1 UB 2 UB 3 UB 4

UB 5 UB 6 UB 7 UB 8

WAP: Weeks after planting

Cassava intercropped with P/F-5-193-C has the lowest leaf greenness compared to cassava intercropped with other sorghum genotypes (Figure 4).

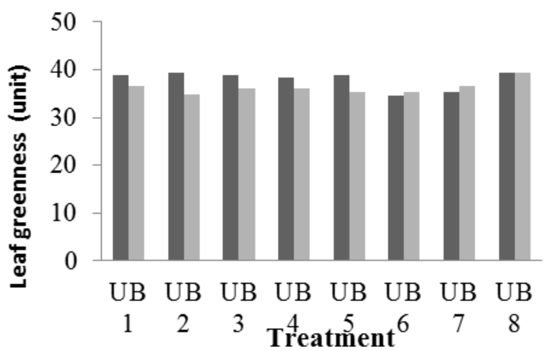

Figure 4. Leaf greenness of cassava under intercropping with several sorghum genotypes

26 WAP 51 WAP

WAP: Weeks after planting

The results of the experiment (Table 1) showed that cassava plants intercropped with P/F-5-193-C or GH 5 caused lesser number of tubers. Conversely, if it is intercropped with Talaga Bodas or Super 1 there is an indication that it can increase production because the number of tubers produced is more than the others. Although the weight is small but this can be improved by means of fertilization and a good environment. In tuber formation, cassava plants need sufficient P and K nutrients (Howeler, 2014). Although potassium is not a basic component of protein, carbohydrates, or fat, it plays an important role in their metabolism. Potassium stimulates clean photosynthetic activity from the given leaf area and increases photosynthetic translocation to tuberous roots. This results in low carbohydrates in the leaves, thus increasing photosynthetic activity (Kasele, 1980). Blin (1905), Obigbesan (1973), and Howeler (1998) reported that the application of K not only increases the weight of tubers but also the starch content. Obigbesan (1973) and Kabeerathumma et al. (1990) reported that K application also decreases HCN content from roots.

Table 1. Tuber number under intercropping with several sorghum genotypes

Treatment	Tuber number
UB 1	4,33 bc
UB 2	5,22 abc
UB 3	4,00 c
UB 4	4,67 abc
UB 5	5,22 abc
UB 6	3,56 c
UB 7	6,22 ab
UB 8	6,44 a
BNT 5%	1,92

Description: The number followed a similar letter on the same column shows no different of LSD's test at 5% level.

The diameter of the tuber is closely related to the number and length of tuber. The size of the tuber that extends is usually not followed by a large diameter. This is in accordance with Widodo (1990) which states those long tubers are generally not large in diameter while tuber with large diameter do not elongate. The results showed that cassava under intercropping with Talaga Bodas and Super 1 genotypes tended to produce more fresh weight per tuber (Figure 5) and lower tuber length (Figure 6), while the diameter of the tubers was medium (Figure 7). On the other hand, cassava intercropped with P/F-5-193-C produces fewer tubers and their weight.

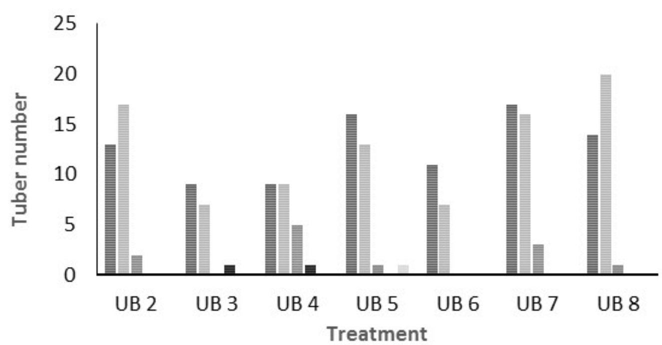

Figure 5. Category fresh weight per tuber of cassava under intercropping with several sorghum genotypes

Description:

Very Low(0-100 g) Low (100-300 g) Medium (300-500 g)

High (500-700 g) Very High (700-900 g)

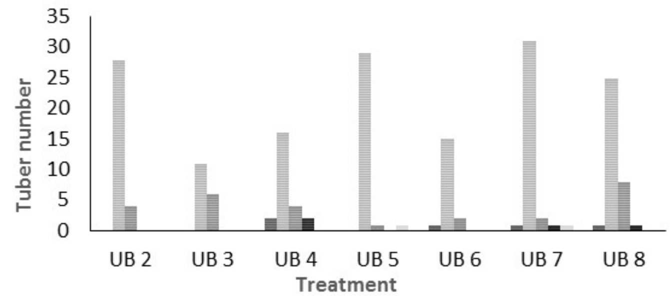

Figure 6. Category tuber length of cassava under intercropping with several sorghum genotypes

Description:
Very Low (0-10 cm) Low (10-20 cm) Medium (20-30 cm)
High (30-40 cm) Very High (40-50 cm)

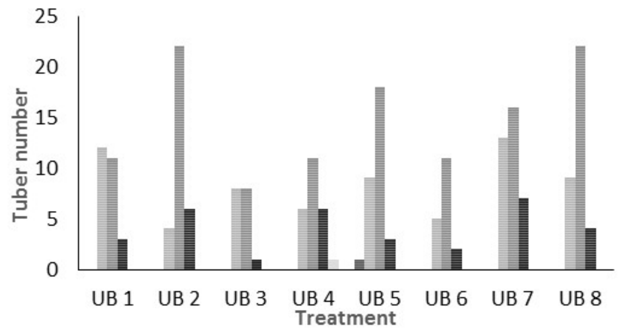

Figure 7. Category tuber diameter of cassava under intercropping with several sorghum genotypes

Description:
Very Low (0-20 mm) Low (20-35 mm) Medium (35-50 mm)
High (50-65 mm) Very High (65-80 mm)

Although the fresh weight of the tuber produced is not different when planted in intercropping with any sorghum genotype (Figure 8), the starch content is different (Figures 9 and 10). Based on the experiment it was found that cassava planted in intercropping with GH 3, P/F-5-193-C and Super 1 genotypes produced more starch than others. If viewed from the aspect of starch content processing efficiency, it turns out that tubers with low weight and high starch content can reduce the cost of production when processing tubers into starch.

The longer the cassava harvest (to a certain extent) the higher the cassava starch content produced, up to 51 WAP still shows an increase in starch content. In cassava aged 36 MST, the highest starch content was 25.5%, while at the age of 51 WAP it reached 29.17%. Susilawati *et al.* (2008) stated that the longer cassava harvest, the more starch granules formed in the tuber. This is in accordance with the report of Abbot and Harker (2001) which states that with increasing age in the tubers the texture will be harder due to the increasing starch content but if the fiber is too old the fiber content increases while the starch content decreases.

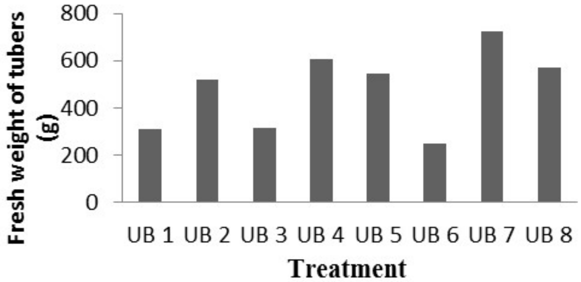

Figure 8. Fresh weight of cassava tubers under intercropping with several sorghum genotypes

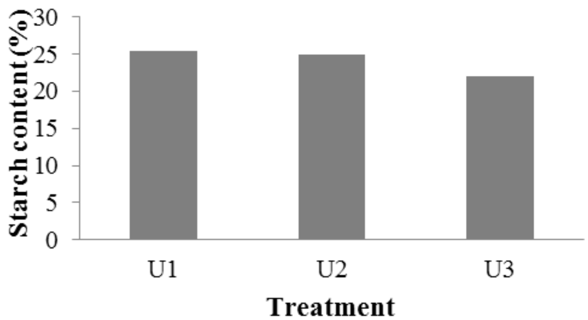

Figure 9. Starch content of cassava under intercropping with several sorghum genotypes at the time aged 36 WAP

Description: U1: Replication 1, U2: Replication 2, U3: Replication 3

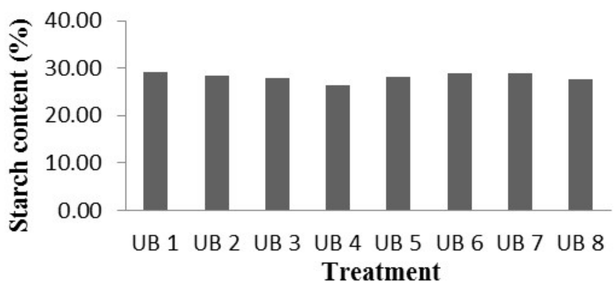

Figure 10. Starch content of cassava under intercropping with several sorghum genotypes at 51 WAP

CONCLUSION

This experiment showed cassava under intercropping with sorghum genotypes of P/F-5-193-C and GH 5 tended to show slower growth and produced lesser tuber number compared to intercropping with other sorghum genotypes in this experiment. Conversely, the starch content produced was higher.

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ATTACK INTENSITY AND ITS POPULATION OF MAJOR PESTS IN CASSAVA (*Manihot esculenta* Crantz) BY APPLICATION OF "ZINCMICRO" FERTILIZER

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ABSTRACT

The major pests that attack the cassava plant are mealybug and mite. Mealybug (*Phenacoccus*) can reduce production by 30-80%, while mite (*Tetranychus*) can reduce production by more than 50% in cassava plantation. This study aims to (1) investigate the intensity of mealybug infestation and mite on cassava with application of "Zincmicro" fertilizer; (2) investigate the population of mealybug and mite on cassava with application of "Zincmicro" fertilizer. This research was conducted in Sulusuban, Seputih Agung, Lampung Tengah, starting from august 2016 until march 2017. This research use direct observation method by scoring the level of pest attack on cassava plantation. The experiment showed that: 1) Application of 20 kg ha^{-1} "Zincmicro" was significantly lower than without application "Zincmicro". Increasing the dosage of "Zincmicro" until 40 kg ha^{-1} did not differ significantly; 2) Although there was no significant different between with and without application "Zincmicro", application "Zincmicro" tended to be lower in mite attack intensity than without application "Zincmicro"; 3) The population of mealybug was more abundant in the upper leaves; meanwhile, the mite population was more abundant in the lower leaves. Application of "Zincmicro" tended to deacrease the population of mealybug and mite compared to without application "Zincmicro".
Keywords: cassava, mealybug, mites, "zincmicro" fertilizer

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a useful plant. Cassava crop is widely cultivated because it can adapt in areas where water is limited. Lampung is the largest cassava production center in Indonesia. Production of cassava in Lampung Province in 2015 was reportedly reached 7,387,084 tons (Badan Pusat Statistik, 2016). Currently cassava has been developed as an agro-industry commodity, such as tapioca flour products, fermentation industry, and various food industries. Increasing demand for cassava as raw material of industry, should be fulfilled by increasing production (Wardani, 2015).

Fertilization is used to supply nutrients lost due to harvesting. Fertilizer needs must be in accordance with the amount of nutrients lost during harvest. The nutrient needs equal to the amount of nutrients lost when harvested while farmers only fertilize macro nutrients while the micro nutrients are relatively never used. The fulfillment of nutrient needs can support the health of cassava plant so that it can produce optimal and resistant to pest and disease attack. Pest and disease can decrease prodution until crop failure. Mealybug is one of the major pests of cassava. In 2009 to 2010 Thailand experienced crop failure due to mealybug attack. In Lampung, attack of mealybug could potentially cause crop failure (Rojanaridpiched, 2017). This study aims to investigate the intensity and the population of mealybug and mite on cassava with application of "Zincmicro" fertilizer.

MATERIALS AND METHODS

The research was conducted in Sulusuban, Seputih Agung, Lampung Tengah. Observations on population of mite and mealybug were done at Plant Pest Laboratory, Faculty of Agriculture, University of Lampung. This research was conducted for 8 months starting from August 2016 until March 2017. The materials used were cassava (clone UJ-3), "Zincmicro" fertilizer with Zn, Mn, B, Cu, Co, Mo, macro nutrients in the form of urea , SP-36, KCl, herbicides, 1 kg-plastic bags, 70% alcohol, aquades, glycerine, elastic bands and labels. While the tool used is hoe, sprayer, brush, vial bottle, binocular stereo microscope, binocular compound microscope, camera, and stationery. This research used direct observation method that is by scoring the level of pest attack on cassava cultivation. Population observation and identification were performed in the laboratory. The experiment was conducted by giving "Zincmicro" fertilizer to 12 experimental units consisting of "Zincmicro" fertilizer 0 kg ha^{-1}, 20 kg ha^{-1} and 40 kg ha^{-1} with 4 replications. The experimental unit is a plot of 23 m x 30 m.

69 m

120 m

P1U1	P2U1	P3U1
P1U2	P2U2	P3U2
P1U3	P2U3	P3U3
P1U4	P2U4	P3U4

Figure 1. Experimental Layout

Information :
P1 = Treatment 1 ("Zincmicro" fertilizer 0 kg ha^{-1})
P2 = Treatment 2 ("Zincmicro" fertilizer 20 kg ha^{-1})
P3 = Treatment 3 ("Zincmicro" fertilizer 40 kg ha^{-1})
U1 = Repeat 1
U2 = Repeat 2
U3 = Repeat 3
U4 = Repeat 4

Cassava variety grown was UJ-3 clones. The soil was done by plowing twice with the time interval between the first plow and the second was 14 days. Cassava was planted with a spacing of 80 cm x 60 cm and length of cuttings of 25 cm. Fertilization was applied on 4 Week After Planting (WAP) with macro fertilizer in the form of urea 100 kg ha^{-1}, SP-36 100 kg ha^{-1}, and KCl 100 kg ha^{-1}, and "Zincmicro" fertilizer 0 kg ha^{-1}, 20 kg ha^{-1}, and 40 kg ha^{-1}. The second fertilization was conducted on 12 WAP with macro fertilizer in the form of urea 100 kg ha^{-1}, and KCl 100 kg ha^{-1}. Fertilization was done by means in addition to plants with a depth of 10 cm. Herbicide spraying was performed with systemic herbicides at 12 WAP and 24 WAP. Harvesting was done at 28 WAP. Observations were made when cassava aged 18 WAP to 26 WAP. The observation time interval was 14 days. Sampling was done by determining 10 rows of plants as subsample according to the diagonal direction on each plot. Each subsample consists of 10 samples. Determination of subsample was done randomly systematically. The first row determination was done randomly, the next row would be adjusted to the spacing and area of the experimental plot.

Observation of mite and mealybug population was conducted on one sample plant selected from subsampel line, after which the top, middle, and bottom leaves were taken with each 3 leaves. Three top, middle, and lower cassava leaves were put into plastic bags and tied with rubber bands and labeled. Leaf samples were taken to the laboratory and counted the number of individual mites and mealybug using a setereo microscope at magnification 2.5 times - 4 times.

Observation of the intensity of the attack was done visually based on the symptoms of mite and mealybug attack. Observation of the intensity of mite and mealybug attack was performed on each sample that was in the subsample. On observation of the intensity of plant damage caused by the mites was given a score of 0-5 as in Table 1. While in mealybug was scored 0-2 as in Table 2. The damage intensity was calculated by using the formula:

$$I = \Sigma ni \times vi/(N \times V) \times 100\%$$

I = Intensity of attack
ni =Number of leaves in each score category
vi = Score category (0 to 5)
N = Number of leaves in one plant
V = Value of the highest score (in this case 5)

Table 1. Scoring intensity of crop damage due to mite attack based on Indiati (2012).

Score	The magnitude of damage (%)	Information
0	0	Healthy leaves (no spotting)
1	$0 < x \leq 10$	There are early yellowish spots (about 10%) on some lower leaves and or middle leaves.
2	$10 < x \leq 20$	Yellowish spots rather (11-20%) in the lower and middle leaves.
3	$20 < x \leq 50$	Clear damage, many yellow spots (21-50%), few areas that do not experience necrotic (<20%), especially the lower and middle leaves rather shrink, a number of leaves turn yellow and fall off.
4	$50 < x \leq 75$	Severe damage (51-75%) in the lower and middle leaves, population of mites abundant and found white threads like cobwebs.
5	$x > 75$	Total leaf loss, shoots of smaller plants, more white threads, and death of plants.

RESULTS AND DISCUSSION

Intensity of Mealybug Attack (*Phenacoccus*). The intensity of severe mealybug attack is seen in cassava plants that were dwarfed and the leaves were curly and there was a collection of mealybugs that cover the lower surface of leaves and stems in the upper leaves of the cassava plant. The highest intensity of mealybug attack was found in plots without application of “Zincmicro” fertilizer. The intensity of attack on the plot with the application of “Zincmicro” fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the intensity of the attack on the plot without “Zincmicro” fertilizer. The intensity of the attack on plots given “Zincmicro” fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was not different (Figure 2).

The intensity of attack on plant age of 18 WAP to 26 WAP did not appear to be different. In plots without application of “Zincmicro” fertilizer (P1), the intensity of the mealybug attack was 68.5% to 77.6%. In plots with application of “Zincmicro” fertilizer 20 kg ha^{-1} (P2), the intensity of mealybug attack was 31.9% to 43.1%. In plots with application of “Zincmicro” fertilizer 40 kg ha^{-1} (P3), the intensity of mealybug attack was 26.9% to 38.9%. The addition of “Zincmicro” fertilizer can affect the intensity of the attack of mealybug so that it is suspected to affect the cassava plant resistance.

Table 2. Scoring intensity of crop damage caused by pest infestation of mealybug

Score	Information	Picture
0	Healthy plants, There are no symptoms of white flea pest attack on the upper leaves.	
1	Symptoms of mild attacks. There are some parts of the leaves on the plant slightly curling.	
2	Symptoms of severe attacks. At the top of the plant to be dwarfed or "bunchy top", the upper leaves will curl and stem distortion	

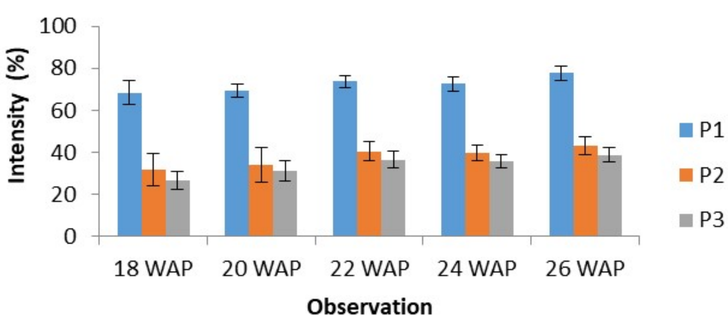

Figure 2. Bar chart of the intensity of a mealybug attack

According to Catalayud *et al*. (1994) in Wardani (2015), cassava resistance is caused by differences in content of secondary compounds in cassava plants. Cyanide acid compounds are secondary compounds contained in cassava plant floem. Floem is a tissue where mealybug sucks fluid to be consumed as a nutrient. The higher of cyanide acid content in cassava, the more susceptible the variety is to the attack of mealybug (Wardani, 2015).

Population of Mealybug (*Phenacoccus*) in Lower Leaf Zone. Populations of mealybug are mostly found in the upper leaf zone. However, in severe attacks, mealybug populations could be found in the lower leaf zone. The mealybug population in the plots with aplication of "Zincmicro" 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the mealybug population in plots without "Zincmicro" fertilizer. The mealybug population in plots with application of "Zincmicro" without "Zincmicro" fertilizers did not differ (Figure 3).

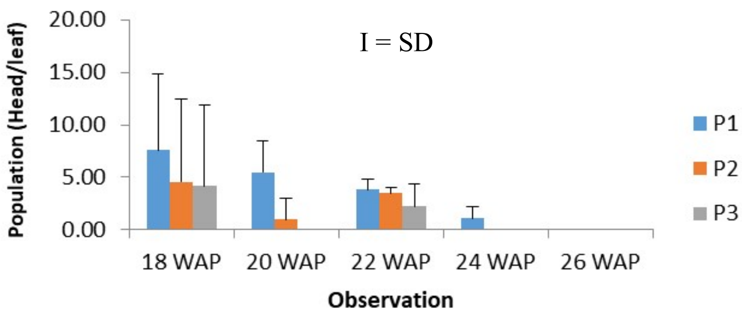

Figure 3. Diagram of the mealybug population stem in the lower leaf zone

The mealybug population at plant age of 18 WAP to 26 WAP did not appear to be differ. In plots without the application of "Zincmicro" fertilizer (P1), the population of mealybug 0 to 8 head per-leaf bottom. In the plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} (P2), the population mealybug 0 to 5 head per leaf bottom. In the plot with the application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the population mealybug 0 to 4 head per leaf bottom. Rainfall is a determinant factor in the dynamics of the mealybug population. Rain can cause mealybug to drift mechanically. Changes in mealybug population can also occur due to stress on plants caused by drought or lack of water. Drought will increase secondary compounds in cassava plants. This compound serves as phagostimulan for mealybug, so it can increase the population in plants (Nurhayati, 2012).

Population of Mealybug (*Phenacoccus*) in Middle Leaves Zone. The mealybug population was found in the central leaf zone more than the mealybug population in the lower leaf zone. This showed that the mealybug population strikes at the top of the leaf towards the lower leaf. The population in the plots with application of "Zincmicro" fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the mealybug population in plots without "Zincmicro" fertilizer. The mealybug population in plots with application of "Zincmicro" fertilizer without "Zincmicro" fertilizers did not differ (Figure 4). The mealybug population at plant age of 18 WAP to 26 WAP did not appear to be differ. In plots without application of "Zincmicro" fertilizer (P1), the population mealybug 1 to 12 head of per-leaf. In plots with application of "Zincmicro" fertilizer 20 kg ha^{-1} (P2), the population mealybug 0 to 4 head per-leaf. In plots with application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the population mealybug 0 to 9 head per-leaf.

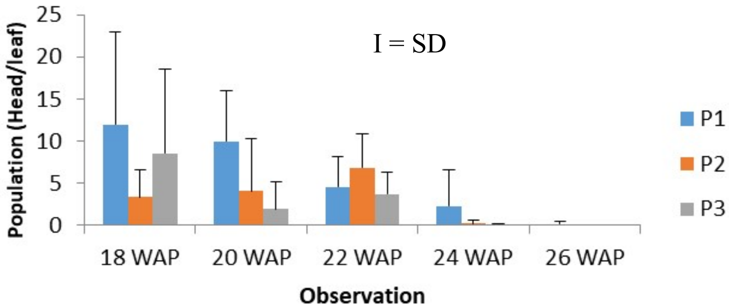

Figure 4. Diagram of the mealybug population stem in the central leaf zone

Population of Mealybug (*Phenacoccus*) in Upper Leaves Zone. When compared with the population in the middle and lower leaf zones, mealybug populations were found in the upper leaf zone. The population in the plots with application of "Zincmicro" fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the mealybug population in plots without "Zincmicro" fertilizer. The mealybug population in plots with application of "Zincmicro" fertilizer without "Zincmicro" fertilizers did not differ (Figure 5). The mealybug population at plant age of 18 WAP to 26 WAP did not appear to be differ. In plots without the application of "Zincmicro" fertilizer (P1), the population mealybug 1 to 20 heads per leaf top. In a plot with a "Zincmicro" fertilizer application of 20 kg ha^{-1} (P2), the mealybug population was 4 to 12 heads per leaf. In the plot with the application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the population mealybug 1 to 10 heads per leaf top.

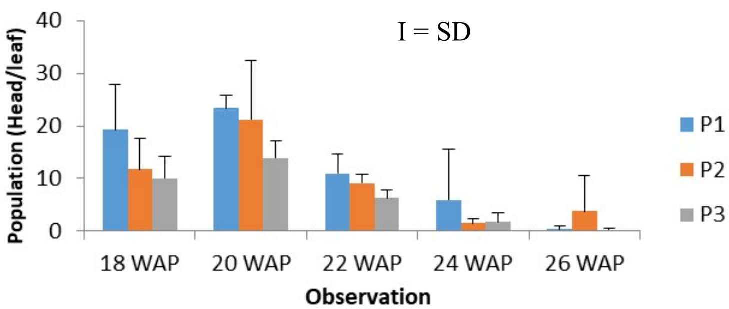

Figure 5. Diagram of the mealybug population stem in the upper leaf zone

Intensity of Mite Attack (*Tetranychus*). The intensity of severe mite attack was seen in the leaves of the yellow crop plants and red rust around the leaf bone. In severe attacks could cause the leaves to fall. High intensity of mite attack was found in plots without application of "Zincmicro" fertilizer. The intensity of attack on the plot with application of "Zincmicro" fertilizer of 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the intensity of attack on the plot without "Zincmicro" fertilizer. The intensity of attack on plots with "Zincmicro" fertilizer and without "Zincmicro" fertilizer did not differ (Figure 6).

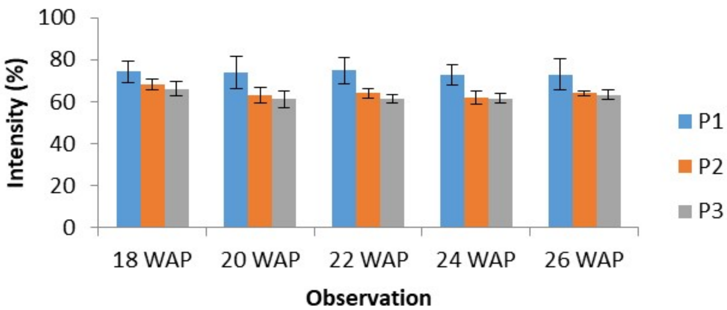

Figure 6. Bar chart of mite intensity intensity

The intensity of attack on plant age of 18 WAP to 26 WAP did not look differently. In plots without application of "Zincmicro" fertilizer (P1), the intensity of the mite attack was 72.87% to 74.25%. In plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} (P2), the intensity of mite attack was 61,98% to 66,2%. In plots with application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the intensity of mite attack was 61.16% to 66.2%. "Zincmicro" fertilizer did not affect the intensity of mite attack. Dry climate is a factor that supports the proliferation of mites. Mites can fall mechanically due to rain (Rismunandar, 1981).

Population of Mites (*Tetranychus*) in Lower Leaf Zone. Mites were found in the lower leaf zone. In severe attacks, mite populations can be found up to the upper leaf zone. The population of mites on plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the mite population in the plot without "Zincmicro" fertilizer. The population of mites on plots with application of "Zincmicro" fertilizer without "Zincmicro" fertilizers did not differ (Figure 7). The population of mites at plant age of 18 WAP up to 26 WAP did not look differently. In plots without the application of "Zincmicro" fertilizer (P1), the population of mites 7 to 74 heads per leaf. In the plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} (P2), population of mites was 7 to 64 heads per leaf bottom. In a plot with application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the mite population was 10 to 61 heads per leaf. Weather can affect mite populations. Mites populations decline at the start of the wet season and remain at a low level in winter. Maximum and minimum temperatures have a positive correlation with mite attacks (Sadeghi et al., 2016).

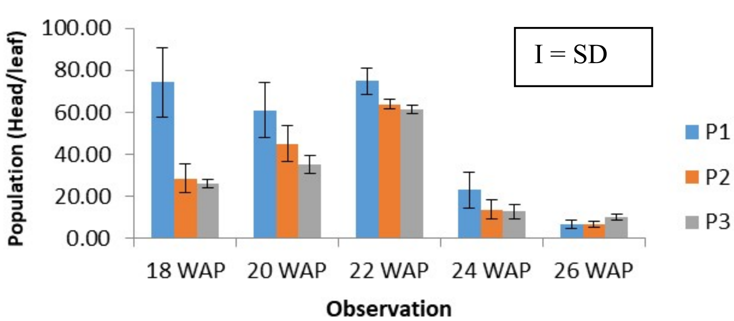

Figure 7. Diagram of the mites population stem in the lower leaf zone

Population of Mites (*Tetranychus*) in Middle Zone Leaves. The population of mites found in the middle leaf zone indicated that the mite populations were mostly found in the lower leaf zone, so the development of the mites populations spreaded to the upper leaf zone through the central leaf zone. The population of mites on plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the mite population in the plot without "Zincmicro" fertilizer. The population of mites in plots given "Zincmicro" fertilizer without "Zincmicro" fertilizer did not differ (Figure 8). The population of mites at plant age of 18 WAP up to 26 WAP did not look different. In plots without application of "Zincmicro" fertilizer (P1), the population of mites was 11 to 36 heads per middle leaf. In a plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} (P2), the population of mites 4 to 27 heads per-leaf the middle. In the plot with the application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the population of mites 4 to 18 heads per-leaf the middle. Fertilization will affect the durability of the impulse.

This resistance characteristic rised and was driven by the existence of certain environmental conditions so that the plant was able to survive against pest attacks. Resistance of this impulse occured, among others, due to the fertilization and irrigation and other cultivation techniques. The life and development of insects was strongly influenced by the state of nutrition availability in plants, whereas the nutrient conditions of plants were affected by fertilization and irrigation. The availability and proportion of nutrients greatly affected pest life. For example Aphis louse is very sensitive to N content in plants and has a negative response to the content of K (Untung, 1993).

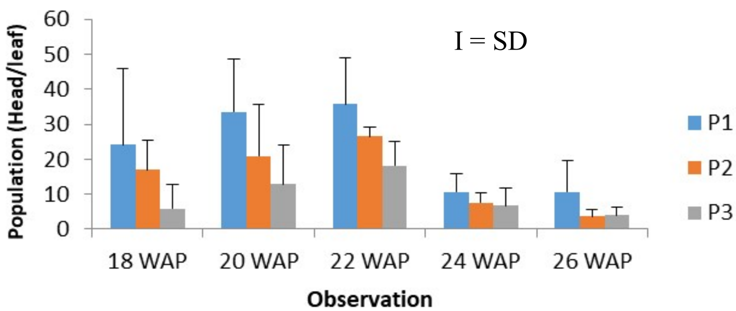

Figure 8. Diagram of the mites population stem in the central leaf zone

Population of Mites (*Tetranychus*) in Upper Leaf Zone. The population of mites found in the upper leaf zone indicates that the mite populations were mostly found in the lower leaf zone so that the mites extended their attacks towards the upper leaf zone. The population of mites in the upper leaf zone was less than the population of the lower leaf zone. This was because the mites first attacked the lower leaves. The population of mites on plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} and 40 kg ha^{-1} was lower than the mite population in the plot without "Zincmicro" fertilizer. The population of mites in plots given "Zincmicro" fertilizer and without "Zincmicro" fertilizer did not differ (Figure 9).

The population of mites at plant age of 18 WAP up to 26 WAP did not look different. In plots without the application of "Zincmicro" fertilizer (P1), the population of mites 0 to 19 heads per-leaf top. In the plot with application of "Zincmicro" fertilizer 20 kg ha^{-1} (P2), population of mites 0 to 8 heads per leaf top. In plots with application of "Zincmicro" fertilizer 40 kg ha^{-1} (P3), the population of mites was 0 to 5 heads per leaf.

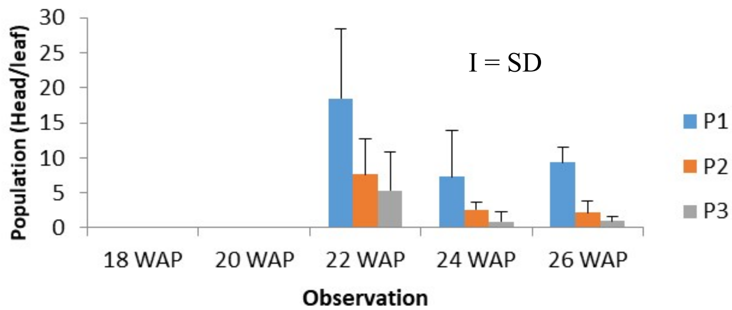

Figure 9. Diagram of the mite population stem in the upper leaf zone

CONCLUSION

Based on this research it can be concluded that application of 20 kg ha^{-1} "Zincmicro" was significantly lower than without application "Zincmicro". Increasing the dosage of "Zincmicro" until 40 kg ha^{-1} did not differ significantly; although there was no significant different between with and without application "Zincmicro", application of "Zincmicro" tended to reduce mite attack intensity than without application "Zincmicro"; and the population of mealybug was more abundant in the upper leaves; meanwhile, the mite population was more abundant in the lower leaves. Application of "Zincmicro" tended to decrease the population of mealybug and mite compared to without application of "Zincmicro".

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USING CEARA RUBBER AS NATURAL ANTI-MICROBE IN REDUCING CONTAMINATION OF *Staphylococcus aureus, Salmonella sp, Vibrio sp* AND *Escherichia coli* IN MACKEREL TUNA FISH (*Euthynnus affinis)*

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ABSTRACT

Mackerel tuna fish is one of fishing results that be like by people because it have thick meat and contain high protein that be source omega 3 fatty acid. However, mackerel tuna fish is easy to be contaminated by microbes, so that causes in reducing quality. Microbe contamination can be reduced by using ceara rubber as an alternative a natural anti-microbe. Ceara rubber contains antimicrobial such as saponin active compound which reduces bacterial cell wall surface tension and inhibits enzyme activity. The objective of this research was to find out the inhibition ability and reduced amount of *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli* bacterias in mackerel tuna fish. This research was conducted in two stages. The first stage was preparing ceara rubber extract samples, bacteria isolation and mackerel tuna fish. The second stage was the research conduct including colony count test, inhibiting zone test and test of reduced counts of *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli,* with 25%. 50%, 75% and 100% ceara rubber extract concentrations. The results showed that ceara rubber extract produced the highest inhibition zone of 13.06 mm at *Escherichia coli* bacteria, and the followed by 12.78 mm at *Salmonella sap*, 11.07 mm at *Vibrio sap*, and the smallest was 10.69 mm at *Staphylococcus aureus*. The reduced bacteria count results by 10^4 dilution and ceara rubber extract were 1.68 x 10^6 cfu/ml to *Vibrio sp*, 1.41 x 10^6 cfu/ml to *Salmonella sap*, 1.3 x 10^6 cfu/ml to *Staphylococcus aureus*, and 1.01 x 10^6 cfu/ml to *Escherichia coli*.

Keywords: Mackerel tuna fish, ceara rubber, anti-microbe, inhibiting zone

INTRODUCTION

Indonesia is a maritime country and rich of ocean and fishery outcomes. Indonesia fishery production in 2015 reached 14.79 million tons. One of fish catching outcomes having production increase 5.65% compared to previous year was mackerel tuna fish which reached 241 thousand tons. The most significant growths for mackerel fish types are *kenyar, lisong,* and *komo* (Sulistyo *et al.,* 2015). People love mackerel fish to consume because its thick flesh with bigger bone sizes to make the flesh easier to be separated. The mackerel fish also contains many protein (26.2 mg/100 g) and omega-3 fatty acid which are beneficial for children intelligence. However, the mackerel fish is easy damaged by microbe contamination (Sanger, 2010). The use of natural anti-microbe becomes one of alternatives to reduce microbe contamination. Ceara rubber tree is one of materials to use as an anti-microbe. The ceara rubber is a poisonous cassava unused in daily life, but it contains saponin, a compound which is capable to inhibit the microbe growth (Hilda, 2011). According to SNI 7388-2009, microbes which should not exist in the fish and fishery products are *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli.* The objective of this research was to find out the formed inhibition zone by the ceara rubber extract administration and the influence of microbe reduced counts of *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli* in mackerel tuna fish.

MATERIAL AND METHOD

Material and equipment

Materials used in this research were mackerel fish acquired from Gudang Lelang market in Teluk Betung; ceara rubber tree acquired from Mr. Rohman's plantation in Metro; ethanol 70%; *Buffered Peptone Water (BPW)*; *Mac Conkey Agar (MCA)* medium; selective medium for *Staphylococcus, Salmonella* and *Vibrio*; aqua distillate, alcohol 70 %, aluminum foil, cotton and disc paper. Equipment to use in this research were knife, basin, blender, filer paper, macerator, beaker glass, Erlenmeyer tube, petri dish, shaking water bath, vacuum rotary evaporator, scale glass tube, stirrer, incubator, drop pipette, colony counter, autoclave, and other laboratory devices.

Method

This research was conducted in two stages. The first stage was to prepare ceara rubber extract samples, and bacteria isolation from mackerel tuna fish. The second stage was to do the research including colony count test of *E.coli, Salmonella sp, Vibrio Sp* and *Staphylococcus aureus*, microbe inhibiting zone test, and reduced count test for *E.coli, Salmonella sp, Vibrio sp* and *Staphylococcus aureus*. The experiment used completely randomized design with two factors and three repetitions. This research used four levels of ceara rubber extract-ethanol 70% concentrations consisting of 25%, 50%, 75%, and 100%. Collected data were analyzed with analysis of variance to find out error variance predictor and significance test to find out any difference between treatments. Data homogeneity was tested with Bartlett test and data addition was tested with Tukey test, and finally data analysis was followed with least significant difference (LSD) test.

RESULT AND DISCUSSION

Ceara rubber cassava extracts

Ceara rubber cassava was taken in the morning and then washed and dried to remove dirt in this material, and then shredded roughly into small sizes. Grated cassava was dried to remove the water content in the material to facilitate extraction. 500 gram of dried ceara rubber cassava was extracted with ethanol 70% solvent.

Figure 1. Ceara rubber cassava extractions

Ceara Rubber Anti-Microbe Inhibiting Zone

According to Hilda (2011), ceara rubber contains of saponin bioactive component. Saponin is a strong and active surface compound, it produces foams on shaking in the water, and in a low concentration it causes red blood cell hemolysis. Saponin works as an anti-microbe, so that it will produce inhibiting zones in the testing. The inhibiting zone testing was conducted in a sterile NA medium, which was given with bacteria adjusted with a half/0.5 Mc Farland solution standard of 100 µl. Bacteria was then poured into a dish and spread. A dish paper had been dipped into the extract was then pasted.

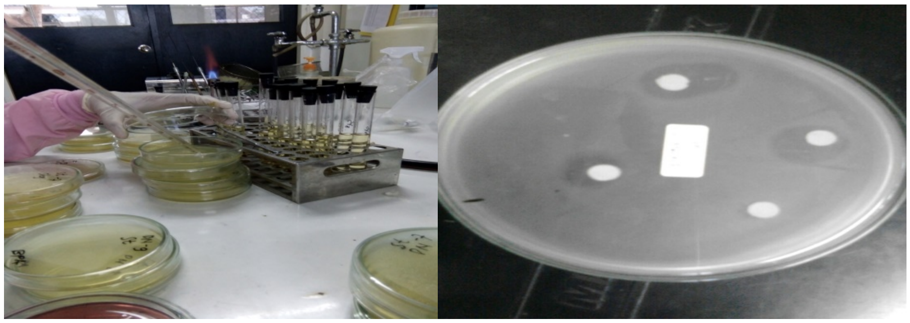


Figure 2. Inhibiting zone of ceara rubber extract

The dish paper pasted in the medium was left aside for a while and then entered into an incubator for 24 hours to see the bacteria growth and the formation of inhibiting zone of microbe activities (Lay, 1994).

Table 1. Inhibiting zone of ceara rubber extract

Bacteria	**Concentration**			
	100%	**75%**	**50%**	**25%**
E.coli	13.00	12.08	9.93	8.09
Salmonella	12.78	10.93	9.51	8.09
Staphylococcus	10.69	9.67	9.25	8.68
Vibrio	11.07	9.60	8.45	7.25

The 100% concentration of ceara rubber extract formed the biggest inhibiting zones of 13.0mm in *Escherichia coli*, and then followed by 12.78 mm in *Salmonella sp*, 11.07 mm in *Vibrio sp*, and the lowest was 10.69 mm in *Staphylococcus aureus*. The ceara rubber extract was most effective in forming inhibiting in *Escherichia coli* bacteria. The least significance different (LSD) test result at 5% level in the formations of inhibiting zones by ceara rubber extract showed that at 100% concentration there were significant differences compared to 75%, 50%, and 25% concentrations. These differences are presented in Figure 3.

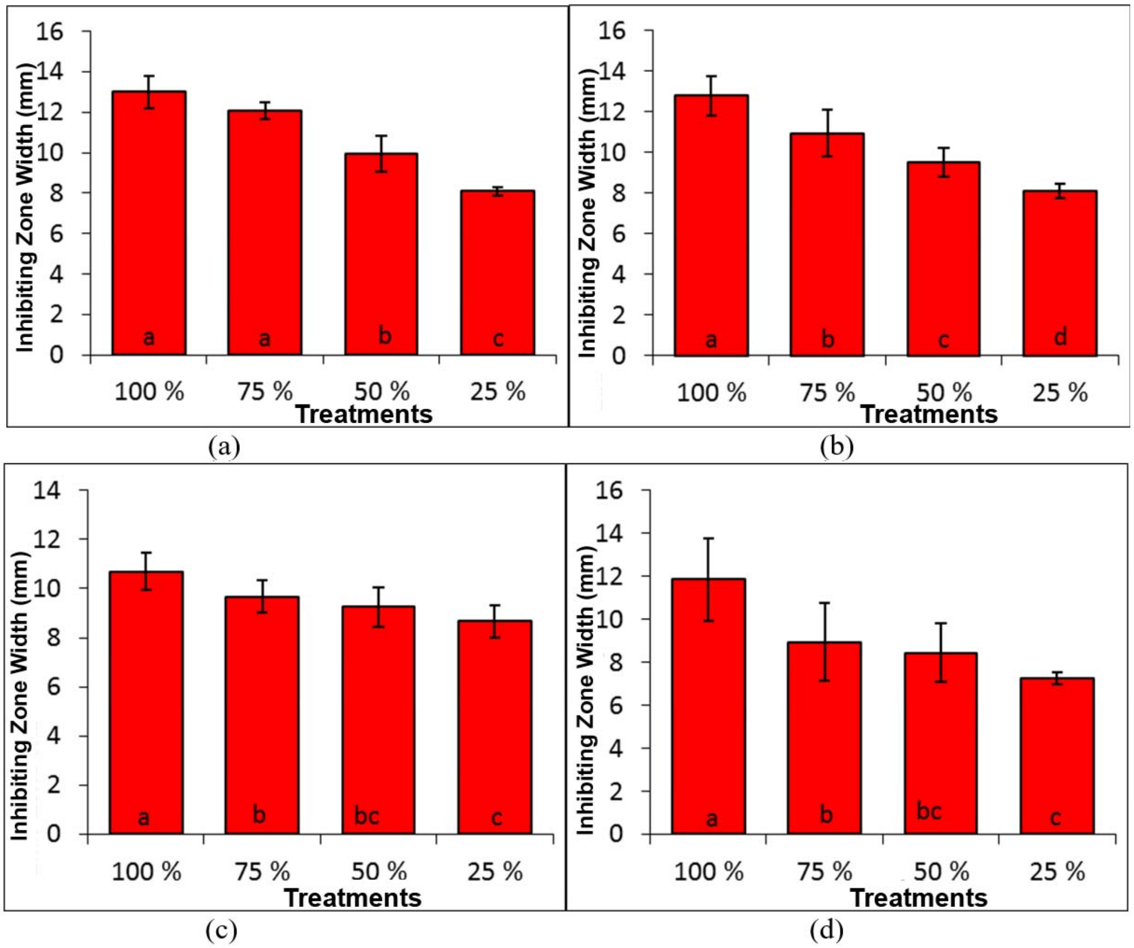


Figure 3. Graphics of ceara rubber extract inhibiting zones to microbes: (a) *Escherichia coli,* (b) *Salmonella sp,* (c) *Staphylococcus aureus* dan (d) *Vibrio sp*

***The Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli* Reduced Count Tests**

The reduced count test were conducted to the mackerel tuna fish had been added or contaminated with bacteria in two shakers; the first shaker was without anti-microbe and the second shaker was with ceara rubber extract. The observations were conducted at the bacteria colony counts growing at 10^4 dilution (Fardiaz modification, 1989).

Table 3. The reduced counts of *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli* bacteria

Microbe	**Ceara rubber extract**										**Reduced Count**	
	U1		**U2**		**U3**		**Avergae**					
	30'	90'	30'	90'	30'	90'	T 30'	T 90'	R 30'	R 90'	Total	Average
E.colli	240	189	130	86	70	64	440	339	146,67	113,00	101	33,67
Salmonella	83	54	188	94	98	80	369	228	123,00	76,00	141	47,00
Staphylococcus	81	57	233	162	160	125	474	344	158,00	114,67	130	43,33
Vibrio	230	186	188	123	209	150	627	459	209,00	153,00	168	56,00

The reduced count test results showed that ceara rubber extract is more effective to reduce *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli* bacteria counts in mackerel tuna fish. The most effective bacteria reduced count outcome is in *Vibrio sp* of about 1.68 x 10^6 cfu/ml with average of 5.6 x 10^5 cfu/ml, and then followed by *Salmonella sp* of 1.41 x 10^6 cfu/ml with average of 4.7 x 10^5 cfu/ml, *Staphylococcus aureus* of 1.30 x 10^6 cfu/ml with average of 4.3 x 10^5 cfu/ml, and finally *Escherichia coli* of 1.01 x 10^6 cfu/ml with average of 3.3 x 10^5 cfu/ml. These data show that ceara rubber extract is optimal in reducing *Vibrio sp* and *Salmonella sp* bacteria counts.

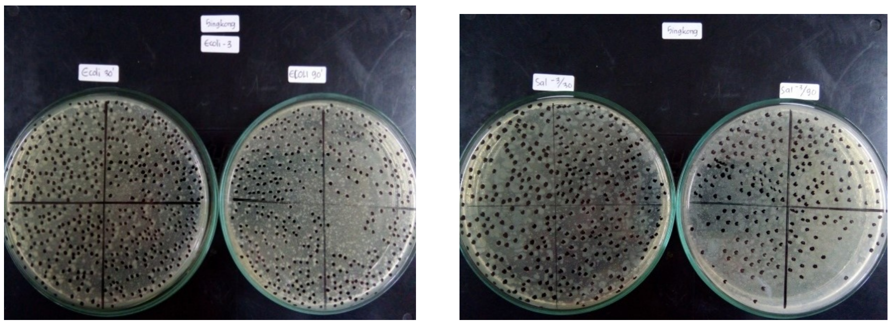
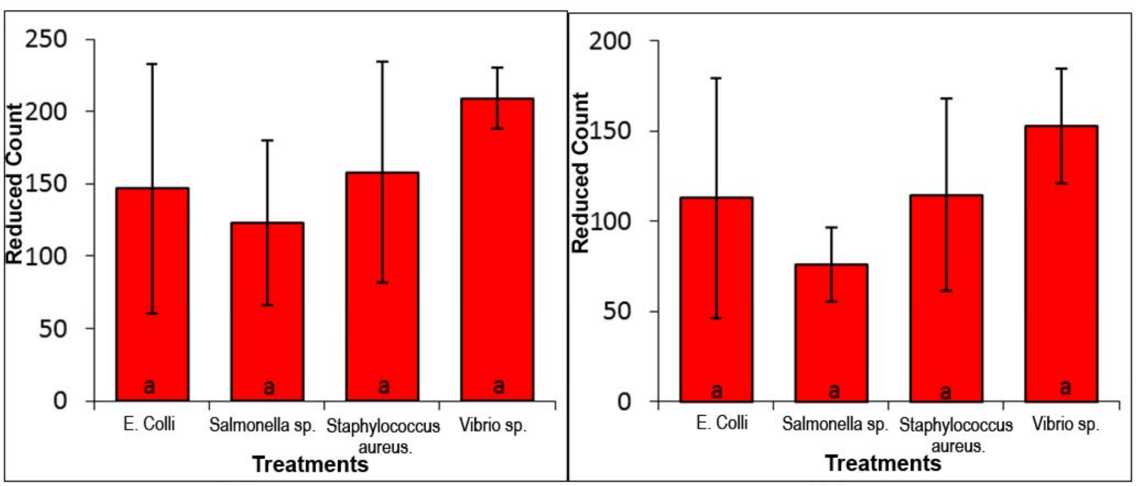


Figure 4. Microbe reduced counts in mackerel tuna fish.

The result of least significance difference (LSD) test at 5% level at the preliminary experiment to the total counts of *Staphylococcus aureus, Salmonella sp, Vibrio sp* and *Escherichia coli* bacteria in mackerel tuna fish with 10^4 dilution showed that the 10^3 dilution was too much to count, while 10^5 dilution made bacteria unable to grow and too small to count. The following is the bacteria colony count in mackerel tuna fish. The highest count is *Vibrio sp* bacteria and the lowest is *Salmonella sp* in 30 minutes shaker and no ceara rubber extract is added whitin this time period. Figure 5 shows that ceara rubber extract produces insignificant differences on the reduced bacteria counts.



(a) (b)

Figure 5. The Microbe Reduced Counts at (a) 30 minutes shaker and (b) 90 minutes shaker

CONCLUSION

The research results indicated that ceara rubber extract could be used for a natural anti-microbe because it formed inhibiting zones. The highest inhibiting zone is 13.0mm in *Escherichia coli*, and then followed by 12.78 mm in *Salmonella sp*, 11.07 mm in *Vibrio sp*, and the lowest is 10.69 mm in *Staphylococcus aureus*. The biggest reduced bacteria count is in *Vibrio sp* of about 1.68 x 10^6 cfu/ml with average of 5.6 x 10^5 cfu/ml, and then followed by *Salmonella sp* of 1.41 x 10^6 cfu/ml with average of 4.7 x 10^5 cfu/ml, *Staphylococcus aureus* of 1.30 x 10^6 cfu/ml with average of 4.3 x 10^5 cfu/ml, and finally *Escherichia coli* of 1.01 x 10^6 cfu/ml with average of 3.3 x 10^5 cfu/ml. Microbe reduced counts by using ceara rubber extract do not differ significantly.

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THE ROLE OF SUPPORTING ENVIRONMENTAL FACTORS ON THE USE OF CYBER EXTENSION BY FARMERS OF FOOD CROPS AND HORTICULTURE IN LAMPUNG PROVINCE

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ABSTRACT

The use of information and communication technology (ICT) in agriculture (cyber extension) can accelerate the process of innovation by farmers. But in developing countries its success depends on its supporting factor.This paper reviews a study that aims to analyze the availability of supporting environmental factors in the use of cyber extensions and their relation to communication behavior of horticultural farmers in accessing ICT-based information sources. The research design used was quantitative research. The research was conducted in Lampung Selatan and Metro municipalities.The study was conducted in July 2017 to November 2017. The study population is farmers of food crops and horticulture. A sample of 207 people was taken at random. Data were analyzed descriptively and inferentially with Rank Spearman Test. As a result, there was no significant relationship between supporting environmental factors and communication behavior of horticultural farmers.Conversely there was a significant relationship between the level of availability of information access facilities and the level of availability of conventional information sources in accordance with access to agricultural information based on ICT. The authors described the implications of this research, particularly on the policy of cyber extension for agriculture.

Keywords: Cyber extension, support factor, communication behavior, information access, horticulture

INTRODUCTION

The development of technology in the era of globalization, especially related to the utilization of ICT (Information and Communication Technology) has been very rapid. Every business sector should benefit from the utilization of ICT. Faster and progressive business sector actors in adopting ICT innovations will benefit from ICT first. Sajda et al's research (2014) concluded that the use and application of ICT is an important component in developing countries such as Indonesia. The use of ICT in India increases as a mean of increasing farmers' income and capability. Large agribusiness organizations, government and private companies have set up telecenters to meet their goals. Use of ICT can help cope. Some of the ICT challenges faced by developing countries in development. The study also said differences in geographic conditions need to be taken into account to support the development and growth of telecenters.

Agriculture is a business field that has promising prospect in Indonesia especially in Lampung Province. The potential of human and natural resources which is equipped with adequate facilities and infrastructure is the main capital to run the agricultural business in rural areas and will promise better life for the people in rural areas. Some of the Department of Agriculture programs related to ICT utilization are very relevant to meet farmers' need for agricultural information.

Cyber is a new media in the form of various communication technologies that share the same features, which in addition to the new is also possible with digitalization and wide availability for its use as a personal communication tool. New media are diverse and not easily defined, but in their application new media enter the realm of mass communication or directly and indirectly have an impact on "traditional" mass media. The main focus is on collective activity called Internet (Denis 2011). Sharma (2005) says there are several potential uses of cyber extensions that are: (1) Providing information continuously, (2) Rich information, (3) Offering rapid international achievement, (4) Cutting steps from traditional processes and (5) oriented to the recipient.

The role of ICT is indispensable in the agricultural sector to increase the productivity of the farms produced. To manage farming, farmers need a variety of information on agriculture, such as government policies, research results from various disciplines, other farmers' experiences, and current information on market prospects related to production facilities and agricultural products. Sources of such information can they get one of them by accessing the internet. By accessing the internet, farmers can get a variety of information about agriculture. Not only that, they can also find up-to-date information on international market prospects related to the means of agricultural products and production. Utilization of ICT can overcome the problem of lack of access to information about agricultural innovation. ICT in agriculture can prepare farming information that farmers need in a timely and appropriate manner

This study aimed to (1) analyze the availability of environmental factors supporting the use of cyber extension information in Lampung Province and (2) analyze the correlation between the availability of supporting environmental factors with communication behavior of horticultural farmers in Lampung Province. Hypothesis proposed in this research was there was relation between availability of supporting environmental factors with communication behavior of horticulture farmer.

RESEARCH METHODS

This research was designed as a quantitative research tian "which gives more weight to the use of quantitative method (Sugiyono 2013). Quantitative research was done by descriptive survey method causality. The research was conducted in Lampung Selatan and Metro municipalities. The location of this research was in 8 villages which have affordability to internet network that is two villages in sub-district Jati Agung, two villages in Natar sub-district of South Lampung Regency and two villages in West Metro Municipality and two villages in South Metro Subdistrict. Site selection was deliberately determined with consideration of these two districts having potential for developing food crops and horticulture (fruits, vegetables and ornamental plants) (BPS Lampung Province 2012) and having a good internet network. The study was conducted in July 2017 until November 2017. The research population was farmers of food crops and horticulture in Lampung Province. Vegetable crops are seasonal so that information obtained from information sources allows for application. Samples were deliberately taken as many as 207 people. Data used in this research were primary data and secondary data. Primary data were data obtained directly from the respondents through a structured interview using a questionnaire. Secondary data were data obtained from relevant agencies and the results of the literature study. The data obtained were analyzed descriptively and inferentially with Rank Spearman Test.

RESULTS AND DISCUSSION

The relationship between supporting environmental factors with communication behavior of vegetable farmers. Bivariate analysis of correlation between supporting environment factor (X2) with communication behavior was done with Rank Spearman correlation which result can be seen in Table 1. Table 1 shows no significant relationship between supporting environmental factors with communication behavior of horticultural farmers at 90 percent confidence level. But there is a very significant relationship between the level of availability of agricultural information access facilities with farmers communication behavior toward ICT-based information sources.

Rank Spearman correlation value of some supporting environmental factor indicator was greater than $\alpha = 0.01$ which meant that there was no correlation between indicator of potential supporting environmental factors with the variable of communication behavior. However, the significance of the indicator level of the availability of ICT-based agricultural information access facilities and the level of availability of traditions in accordance with ICT-based agricultural information access was smaller than α = 0.01 which meant there was a relationship between the availability of ICT-based agricultural information access facilities and the availability of traditions on communication behavior toward the source ICT-based information. This means that the better the availability of ICT-based agricultural information access facilities and the appropriateness of tradition with ICT-based agricultural information access, the better the farmer's communication behavior toward ICT-based information sources (Table 1).

Table 1. Rank Spearman correlation coefficient showing the relationship between supporting environmental factors with communication behavior

Supporting Environment	Spearman Rank Correlation Coefficient (Rs) Communication Behavior		
	ICT-based information resources	Conventional information resources	Total
Supporting Environment	0.118	-0.042	0.107
Level of availability of ICT tools	0.512**	0.019	0.388**
Level of availability, quality, and accessibility of ICT network infrastructure	- 0.027	0.017	0.014
Availability level of conventional agricultural information access	-0.074	-0.059	- 0.037
Level of availability of traditions appropriate to ICT-based agricultural information access	-0.226**	-0.014	-0.098
The level of family support that supports the use of information-based resources ICT and conventional	-0.026	-0.087	-0.104

Description: ** significant at 99 percent confidence level

Based on this data analysis it could be concluded to use ICT-based information source hence there must be guarantee of availability of ICT-based agricultural information access facilities and the appropriateness of tradition to ICT-based information source. This was different from farmer communication behavior in using conventional information sources. Communication behavior in using conventional information sources was considered a part of farmer's life, so there is no need for conformity with tradition. The source of conventional information was already a tradition in society. Based on the opinion of farmers that the condition of cellular network in South Lampung Regency is quite good. In more detail Table 2 shows the relationship between communication behavior indicators.

Table 2. The correlation coefficient of Rank Spearman correlation between indicator of communication behavior variable of farmer of food crop and horticulture

Communication Behavior	Spearman Rank Correlation Coefficient (Rs)		
	ICT-based information resources	Conventional information resources	Total
ICT-based information resources	-	0,308**	Total
Conventional information resources	0.308**	-	0.723**
Total	0.765**	0.723**	-

Description: ** significant at 99 percent confidence level

Rank Spearman analysis showed that there was a significant correlation between horticultural farmer communication behavior indicator in using the available information source in the research area. Farmers who were intensive enough to use ICT-based information resources would be more intensive as well in using conventional information sources. Similarly, the less intensive farmers used ICT-based information resources, it would be increasingly not intensively using conventional information sources. This meant that both ICT-based information sources and conventional information sources were playing an equally important role in meeting farmers' need for information. Farmers will use an information resource that was affordable and available at all times, qualified, easy to use and understandable. This meant that efforts to increase the use of ICT-based information resources could be made using conventional information sources.

Supporting Environmental Factors

Supporting environmental factors were analyzed with indicators of the availability of ICT-based information facilities, the level of availability of ICT network infrastructure, the level of availability of conventional agricultural information access facilities, the level of availability of traditions compatible with ICT-based agricultural information access, the level of family support available in the use of ICT and conventional information. Figure 1 shows the environmental factors supporting the availability of ICT-based information facilities and the level of infrastructure availability, in the research area is still relatively low. This is a significant constraint to develope the use of cyber extension as an alternative source of agricultural information. This is in accordance with the results of research done by Kurniasih et al. (2013) that the completeness of facilities and infrastructure that support the implementation of e-government in Cimahi determine the success of the apparatus to exercise their rights and obligations. Other indicators such as the suitability of tradition and family support are good. This is a big enough capital for farmers.

Communication behavior of vegetable farmers

Based on the results of interviews with farmers, it was known that the ability of farmers to buy ICT services was still low. Communication behavior of horticultural farmers had not been fully interested in the use and utilization of ICT services. This is in accordance with the results of Djauhari (2011). Communication behavior 78.30 percent of farmers to search for agricultural information from ICT-based information sources was low. This happens because new farmers recognize ICT as a source of agricultural information.

Farmers first recognize HP surf followed by internet cafe, HP did not surf and internet computer. Average Internet surfing was known 2.86 years ago and the most recent known was the HP did not surf 0.14 years ago. The same thing also happened on the indicator of communication behavior duration where 92.70 percent of farmers were classified briefly and 80.00 percent of farmers frequency was classified briefly utilizing ICT. Arief (2013) said in its implications in the public the use of new media known as the Internet can convey information and news that can shape public opinion.

The use of information coming from internet cafes/telecenters in South Lampung District is only one way, while for Metro municipality the largest percentage in two directions. The results showed that information obtained from ICT would be directly absorbed by horticultural farmers without conducting information selection first.

CONCLUSION

There was a significant relationship between the indicator of the availability level of ICT-based agricultural information access facilities and the level of availability of traditions appropriate to access to ICT-based agricultural information with farmers communication behavior toward ICT-based information sources; and supporting environmental factors were low while the availability of conventional information sources was high.

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OCCURRENCE OF MOSQUITOCIDAL *Bacillus thuringiensis* SEROVAR *entomocidus* IN THE SOIL OF INDONESIA

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ABSTRACT

In recent years, the need for environmentally safe pesticides has encouraged the search for new strains of *B.thuringiensis* with unique insecticidal spectra. Theses isolates will augment the current commercial *B.thuringiensis* strains that exhibit various degrees of activity toward larvae of insect orders of Lepidopteran, Diptera, and Coleoptera. Five 1-g soil samples were separately suspended to 9 ml of distilled water. After allowing the suspension to stand for 5 minutes, 3-4 ml of the the suspension were taken. One half of the suspension was transferred to a test tube and heated in a waterbath of 80^{o}C for 15 minutes, so that all microorganisms were killed except *Bacillus* and other sporeforming bacteria, then allowed to cool at room temperature. Ten-fold serial dilutions of the heated suspension in sterile distilled water were placed on nutrient agar (NA-pH 7.5). After two days of incubation at 28^{o}C, *Bacillus* colonies were recorded. After 2 to 3 days incubation, crystalliferous sporeforming bacteria were determined in phase contrast microscope. A Loopful of the sporulated bacterial cultures from NA were dissolved in 10 ml sterile distilled water and shaken using a magnetic stirrer until a uniform suspension was obtained. it is found that *B.thuringiensis* serovar *entomocidus* INA288 (belonging to serotype H 6) isolated from soil in Indonesia, posses novel mosquitocidal activity toxin. It was observed that *B.thuringiensis* serovar *entomocidus* INA288 has cuboidal shaped crystal proteins, while serovar *entomocidus* (original strain) has bipyramidal and irregular shaped ones. However, *B.thuringiensis* serovar *israelensis* ONR60A has irregular shaped crystal protein.
Keywords: *B.thuringiensis*, serovar *entomocidus*

INTRODUCTION

There are thousands of isolates of *B. thuringiensis* producing protein parasporal bodies. Some of them belong to the *B. thuringiensis* species. *B. thuringiensis* spores and/or inclusion bodies usually express insecticidal activities. Several *B. thuringiensis* strains have been used for control agents of agricultural important insect pests on global agent for miccobial control of insect pests of agricultural and medical importance (Luthy *et al*., 1982). In recent years, the need for environmentally safe pesticides has encouraged the search for new strains of *B. thuringiensis* with unique insecticidal spectra. These novel isolates will augment the current commercial *B. thuringiensis* strains that exhibit various degrees of activity toward larvae of insect orders of lepidopteran, diptera, and coleoptera.

The crystal proteins produced from *B.thuringiensis* serovar *israelensis* are toxic to the larvae of mosquitoes (Golberg and Margalit, 1977; De Barjac, 1978) and black flies (Undeen and Nagel, 1978; Undeen and Berl, 1979). From both health and economic standpoints, control of these dipteran species is important, because they are vectors for human diseases such as malaria and onchocerciasis (Margalit and Dean, 1985).

Bacillus thuringiensis is a gram-positive, spore-forming bacterium that produce parasporal crystal during the sporulation stage. The crystal is made of one or more proteins toxic to some insect spesies. Goldberg and Margalit (1977) isolate a *Bacillus* strain possessing a high larvicidal activity, specific for mosquitoes, from the soil of a mosquito-breeding site in Israel. However, de Barjac (1978) established *B. thuringiensis* serovar *israelensis* (H antigen 14) as highly mosquitocidal activity. Another investigators have repoted the occurrence of highly mosquitocidal *B. thuringiensis* starins belonging to serovar *israelensis* (Balarman *et al*., 1981; Zhang *et al*., 1984; Shim *et al*., 1990; Abdel-Hameed *et al*., 1990). To date, most strains of *B.thuringiensis* produce inclusion toxic to dipterans insects, though there are subspecies such as serovar *morrisoni* PG-14 (Padua *et al*., 1984), *fukuokaensis* (Yu *et al*., 1991), *darmstadiensis* (Kim *et al*., 1984), *kyushuensis* (Held *et al*., 1990), *jegathesan* (Kawalek *et al*., 1995), *higo* (Ohba *et al*., 1995), and *canadensis* (Ishii and Ohba, 1997), which produce toxin that are predominantly toxic to dipteran insects.

MATERIAL AND METHODS

Isolation of *B. thuringiensis*

Soil samples were collected in the soil of Indonesia following multistage random sampling. Soil samples were collected at random in a 1- hectare area for a total of 5 kg. The soil sample were taken from the top 1 cm of the soil layer. The 5-kg soil samples were mixed thoroughly and composite sample of 1 kg was taken from which isolation were made for as long as one month. The samples were labeled denoting date, place of collection.

Five 1-g soil samples were separately suspended to 9 ml of distilled water. After allowing the suspension to stand for 5 minute, 3-4 ml of the the suspension were taken. One half of the suspension was transferred to a test tube and heated in a water bath of 80°C for 15 minutes, so that all microorganisms were killed except *Bacillus* and other spore forming bacteria, then allowed to cool at room temperature. Ten-fold serial dilutions of the heated suspension in sterile distilled water were placed on nutrient agar (NA-pH 7.5). After two days of incubation at 28°C, *Bacillus* colonies were recorded. After 2 to 3 days incubation, crystalliferous spore forming bacteria were determined in phase contrast microscope.

Biological activity

A Loopful of the sporulated bacterial cultures from NA were dissolved in 10 ml sterile distilled water and shaken using a magnetic stirrer until a uniform suspension was obtained. Bacterial suspension (10^{+1} spore per ml) with a corresponding optical density reading were tested on second instar larvae. Prior to treatment, larvae were starved for two hours before colonizing them on petchey dipped in desired bacterial suspension for three minute. Ten larvae were used per isolate. Mortality was noted from 24 hours after treatment. Larvae death was determined by touching them gently with a toothpick to detect any movement. In one treatment the leaves were dipped only in distilled water before feeding them to the test insects. The last treatment served as the control.

RESULTS AND DISCUSSION

Isolation of *B. thuringiensis* in the Soil of Indonesia.

Isolates was isolated from the soil of Indonesia identified as *B.thuringiensis* based on phase contrast microscope examination for the presence of parasporal inclusion bodies. In order to identify INA288 strains by H-serotype cell with broth, they were dropped to glass slide and the motility of cels was observed under phase-contrast microscope. Since isolate of *entmocidus* INA288 gave positive reaction in the H 6 serum agglutination test, it was identified as *B.thuringeisis* serovar *entomocidus*. Morphology of the crystal from serovar *entomocidus* (original strain) has been reported by Iizuka *et al*., (1982) and Faust *et al*., (1982) and the crystals are bipyramidal-formed. On the other hand, interestingly, *entomocidus* INA288 produced large cuboidal-form crystals.

Biological activity.

The strain were examined for their larvicidal against the larvae of the silkworm, *Plutella xylostella* and *Spodoptera litura*. The insect's cultures were maintained in this laboratory. Toxicity test with the Leppidopteran insect, *B. mori*, *P. xyloetella* and *S. litura*, were done by introducing ten 3rd-intar larvae were fed on an articial diet dropped with 0.3 ml of the bacterial suspension and rear at 25°C for 48 hr to determine mortality. The *B. thuringiensis* isolates were examined for oral insecticidal activity against the insects were prepared by the following procedures. Overnight culture of *B. thurngiensis* serovar *entomocidus* (original strains), *entomocidus* INA288, and israelensis ONR60A were grown on 2 ml of nutrient broth at 30°C using tube glass. Then, 200 ul of the overnight culture was plating on nutrient agar, reincubated for 4 days at 30°C. Sporulated cultures were harvested by centrifugation at 10,000 g for min at 4°C. The pellet was washed three times by centrifugation in mM Tris-HCl and 1 M NaCl at 4°C, the bacterial suspensions were finally suspended in 500 ul of sterile distilled water. The bacteria were also tested against larvae of the mosquitoes, *Aedes aegypti*, *Aedes japonicus* and *Culex quinquefasciatus*. Ten 2nd-instar larvae were placed in a test tube containing 10 ml of the spore-parasporal inclusion suspension, respectively, under levels 1 ul/ml. The tubes were kept at 22°C for 24 hr without feeding.

Table 1. Toxic activity of three *B.thuringiensis* strains against some insect species

Strain	Lepidopteracidal			Dipteracidal		
	C.b.	*P.x.*	*S.l.*	*A.j.*	*A.a.*	*C.q.*
Entomocidus orginal	+	+	+	-	-	-
Entomocidus INA288	-	-	-	+	+	+
Israelensis ONR60A	-	-	-	+	+	+

C.b : Crocidolomia binotalis, P.x: Plutella xylostella, S.l: Spodoptera litura
A.j: Aedes japonicas, A.a: Aedes aegypty, C.q: culex quinquefasciatus

CONCLUSION

In recent years, formulation of mosquitocidal *B. thuringiensis* serovar *israelensis* and *B. sphericus* had been used on a large scale in the field and in the various countries. This inisitial succsess has been tempered by result obtained for resistance to *B. thuringiensis spharicus*. In the search for potential alternatives to the application of *B. thuringiensis* serovar *israelensis*, isolation of novel mosquitocidal strains is very important. In the present research, it is found that *B. thuringiensis* serovar *entomocidus* INA288 (belonging to serotype H 6) isolated from soil in Indonesia, posses novel mosquitocidal activity toxin. It was observed that *B. huringiensis* serovar *entomocidus* INA288 has cuboidal shaped crystal proteins, while serovar *entomocidus* (original strain) has bipyramidal and irregular shaped ones. However, *B. thuringiensis* serovar *israelensis* ONR60A has irregular shaped crystal protein. In this study, the parasporal inclusions from *B. thuringiensis* serovar *entomocidus* INA288 were separated and compared its insecticidal activity to those species from two orders (Lepidopteran and Dipteran). This result was suggested that *B. thuringiensis* serovar *entomocidus* INA288 will be examined by Scanning Electron Microscope (SEM).

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ECOPHYSIOLOGICAL RESPONSES OF CASSAVA PLANTS (*Manihot esculenta* L. Crantz) GROWN UNDER SALINE CONDITIONS ELEVATED CO_2 LEVELS

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ABSTRACT

We investigated ecophysiological responses of cassava grown under saline conditions to elevated CO_2. Four months old cassava plants were grown under saline conditions (100 mM, 50 mM and 0 mM NaCl solutions) and exposed to elevated CO_2 level of 760 ppm, 580 ppm, and 370 ppm (ambient). After four weeks exposure to 50 mM NaCl and treated with elevated CO_2 of 760 ppm, plant increased its dry weight (37%), total number of leaves (14,36%), catalase (CAT) activity (113,6%), and proline content in root (25%) compared to control,and the plant was able to form storage roots, while in non-saline and at ambient CO_2 level, no storage roots was formed. Elevated CO_2level of 760 ppm alleviated negative effect of 50 mM NaCl to plant growth.
Keywords: cassava, ecophysiological responses, salinity, elevated CO_2 level

INTRODUCTION

Cassava is an important agriculture commodity in Indonesia as it can be used as an alternative of staple food. According to data released by Kementerian Pertanian, cassava harvested area in 2015 covered more or less 0,95 million hectares and its productivity reached 22,95 ton/ha (Anonymous, 2016). Cassava are known able to adapt to marginal environment thus it become a potential source of carbohydrate in that region.

Saline soil is one type of marginal soil which has low fertility and relatively high salt content due to poor irrigation and excessive fertilization (Krisnawatie & Adie, 2009). Saline soil is characterized by the presence of salt (NaCl) dissolved in the soil, which causes a decrease in the production of the plant due to osmotic, ionic and oxidative disturbance. Salinity affects the imbalance in the absorption of water and nutrients, affects the activity of photosynthesis, and reduces plants growth (Pérez-López *et al.,* 2012).

Beside problem of marginal land such assaline area, cassava production also faces problem of global warming as a result of the increase of CO_2 levels in the atmosphere. Human activity contributes to generate emissions of greenhouse gases derived from fossil fuel and industry. It was predicted that the level of CO_2 in the atmosphere will increase to 800 ppm by the end of this century, compared to the current level of CO_2 that ranges between 360 to 400 ppm (IPCC, 2014). The increase of CO_2 levels in the environment could alter physiological activity of plant (Huyskens-Keil and Herppich, 2012).

The effect of increasing CO_2 levels of 700 ppm in C3 plants that include important agricultural crops, such as rice, wheat, beans, cotton, potatoes and cassava, causes CO_2 molecules to actively bond with rubisco to boost the rate of photosynthesis (Allen & Prasad, 2004). Papadimitropoulos and Klapa (2015) suggested that CO_2 is a carbon source for plants; its increase in a given period of time benefits the growth of the plant. The study of the response of cassava at a high level of 750 ppm of CO_2 showed plants increased its total dry mass by 61% under conditions of stress due to drought (Cruz *et al.,* 2016). High levels of CO_2 drive plants to use water effectively to maintain their productivity in conditions of water deficit.

The objective of this research is to analyze the effect of elevated CO_2 levels on ecophysiological responses of cassava plants under saline conditions.

MATERIALS AND METHODS

The experiment was conducted in the screen house ITB Jatinangor, Sumedang. Cassava var. Jampang (from stem cuttings ± 15 cm length) was grown in 45 x 50 cm polybag (d:45 cm, l:50 cm) containing 1:1 husk and cocopeat. Four months old cassava plants were treated with three salinity levels (0 mM, 50 mM, 100 mM NaCl solutions) and elevated CO_2 levels (ambient 370 ppm, 580 ppm, 760 ppm). During treatment, plants grown in transparent plastic chamber (2,1m x 1,5 m x 1 m). Treatment with elevated CO_2levels was performed three times a day between 08.00-09.00; 12.00-13.00; 15-16.00, for a period of 30 days (Taufikurahman *et al.,* 2017). For salinity treatment, plants watered by 100 ml NaCl solutions once per three days (Gleadow *et al.,* 2016) and supplemented by modified Hoagland's nutrient solutions (Taiz and Zeiger, 2003) once per six days. Plants watered by 300 ml distilled water every ten days to avoid salt accumulation.

Growth parameter measured were total number of leaves, percentage of dead leaves, shoot height, and dry weight, proline content (Bates *et al.,* 1972), catalase (CAT) and ascorbate peroxidase (APX) enzyme activity (Maksimović & Živanović, 2012), cyanide content (Haque & Bradbury, 2002; Makkar *et al.,* 2007), and stomatal resistance (Beadle *et al.,* 1993). Two-way analysis of variance using SPSS software was carried out. Differences between means (p<0.05) were assessed by Tukey's post hoc test.

RESULT AND DISCUSSIONS

Growth responses

Salinity stress decreased plant growth response of cassava plants. It was observed from the decrease of number of leaves (p=0,000) and the increasing percentage of dead leaves at 100 mM NaCl compared with control. Plants treated with elevated CO_2levels of 760 ppm increased their number of leaves by 14,36% at 50 mM NaCl, and 24% at 100 mM NaCl (p=0,012). Furthermore plants treated with elevated CO_2level of 760 ppm increased dry weight by 37% (p=0,017) compared to ambient CO_2 levels. Elevated CO_2 levels did not affect plants height.

The reduction of plant grown under saline condition was caused by the decrease in water potential that may disturbed process of photosynthesis. Under saline conditions, plants attempted to conserve water to prevent water loss. This was observed by the decrease of dry weight of the plant under saline conditions, as the reduction of photosynthetis will reduce carbon assimilation (Gleadow *et al.,* 2016). The reduction of carbon assimilation may be caused by a decrease of changes in carbon uptake into the plant tissue.

Elevated CO_2 levels improve plant growth response that grown under saline conditions by increasing photosynthesis rate. That was observed by the increase in dry weight of plants grown under saline conditions compared to that grown in ambient CO_2 levels. According to Péréz-López *et al.* (2012), elevated CO_2 levels in the air could increase CO_2 intracellular diffusion in plant tissues (*Ci*), and leaves response to it by closing their stomata. Differences in CO_2 gradient inside and outside of the leaf drives CO_2 to enter leaf tissue. Therefore, the plant can regulate carboxylation in the regeneration of ribulose-1,5-bisphosphate during carbon fixation (Taiz and Zeiger, 2003). Cassava plants were able to form storage roots at elevated CO_2 levels of 760 ppm under 0 mM and 50 mM NaCl, this indicates that cassava plants at a young age can regulate the balance of water and nutrients (Gleadow *et al.,* 2016).

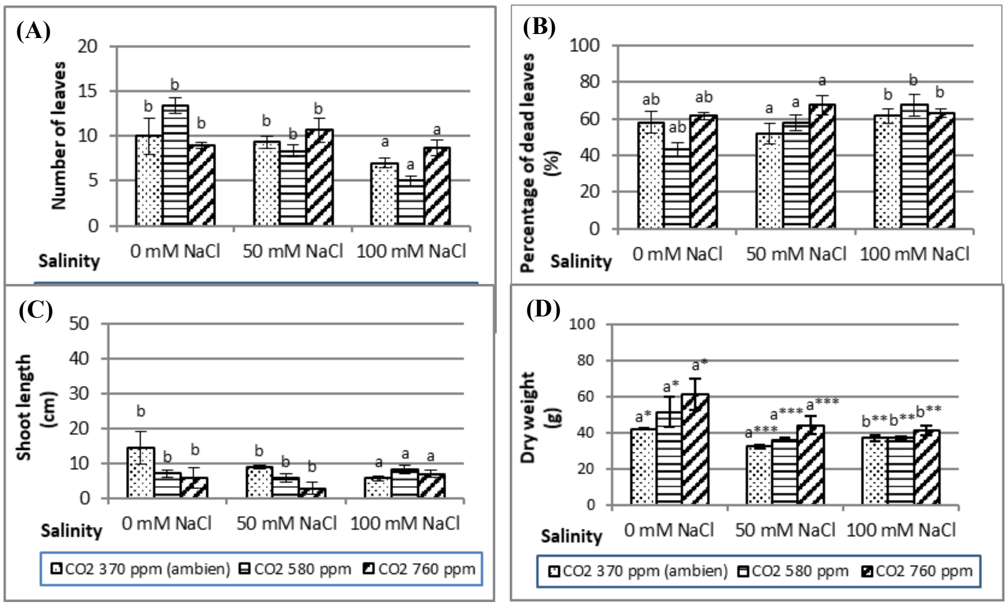

Figure 1. The effects of elevated CO_2 levels on growth responses of cassava plants under saline conditions. (A) Number of leaves, (B) Percentage of dead leaves, (C) Shoot length, (D) Dry weight. Significant differences in salinity treatment were indicated by different letters, while the asterisks showed significant differences in elevated CO_2 levels treatments based on the Tukey test with $p \leq 0.05$.

Physiological responses

Increased CAT enzyme activity occurs as salinity increases (p= 0.006). The highest CAT enzyme activity (4177,4 units) was occurred at plant treated with 580 ppm CO_2 level under 100 mM NaCl, which is three times greater than the CAT enzyme activity under ambient CO_2 level. At elevated $CO_2$of 760 ppm grown under 50 mM NaCl, CAT enzyme activity increased113,6%, while in 100 mM NaCl CAT enzyme activity increased 45,97%. However, it seems that elevated CO_2 and salinity stress did not affect APX enzyme activity.

Salinity stress causes ROS to increase due to the perturbation of transport electron in cells. As an antioxidant enzyme, the activity of the CAT enzyme increases to reduce oxidative stress due to ROS. CAT enzyme activity protects cells from oxidative damage to increase plant tolerance to salinity stress. Research by Mittal *et al.* (2012) in *Brassica juncea* suggested that salinity stress increase oxidative enzymes CAT, APX, and SOD, with APX showed highest enzyme activity. In this study, CAT enzyme activity was higher that APX enzyme activity which indicated that CAT enzyme plays as major oxidative enzyme in degrading ROS significantly in response to salinity stress.

Another plant physiological adaptation to salinity is formation of proline. In this experiment, cassava roots of cassava plant increased its proline content as salinity and level of elevated CO_2 increased (p=0,000). Elevated CO_2 levels of 760 ppm under 50 mM NaCl increased root proline content by 25 %. However, elevated CO_2 and salinity stress did not affect leaves proline content; this indicates that plant can manage stress sufficiently (Hameed *et al.,* 2015).

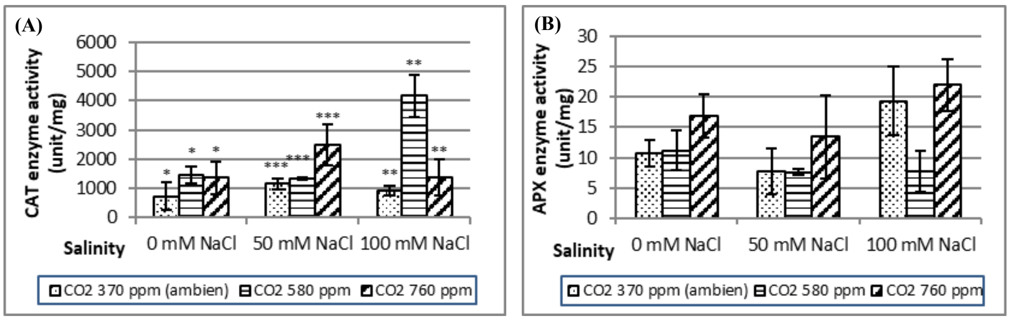

Figure 2. The effects of elevated CO_2 levels on CAT and APX enzyme activity of cassava plants under saline conditions. (A) CAT enzyme activity, (B) APX enzyme activity. Significant differences in salinity treatment were indicated by different letters, while the asterisks showed significant differences in elevated CO_2 levels treatments based on the Tukey test with $p \leq 0.05$.

Cassava plants accumulated proline in the roots. This is related to the function of the root as the entrance of water and nutrients, moreover, the root tissues must be able to survive and protected from damaged due to the accumulation of Na^+ ions. The accumulation of proline in the roots plays a role in maintaining osmotic adjustment (Bojórquez-Quintal *et al.,* 2014).

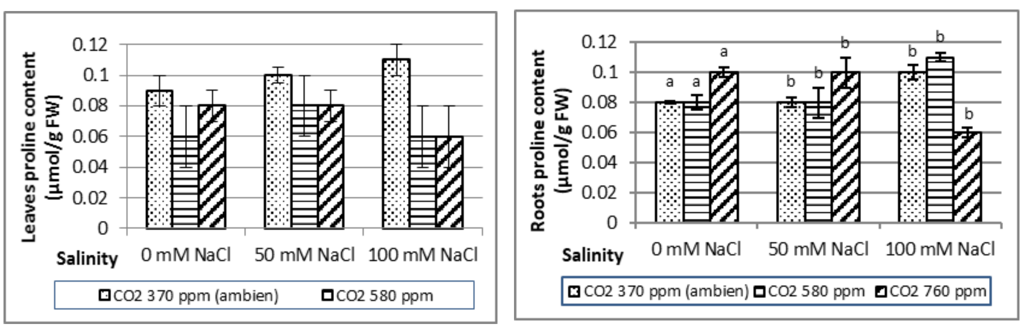

Figure 3. The effects of elevated CO_2 on proline content of cassava plants under saline conditions. (A) Leaves proline content. (B) Roots proline content. Significant differences in salinity treatment were indicated by different letters, while the asterisks showed significant differences in elevated CO_2 levels treatments based on the Tukey test with $p \leq 0.05$.

HCN content in root increased by 3,78% at elevated CO_2 760 ppm and 50 mM NaCl, whereas at salinity 100 mM NaCl, HCN content decreased by 36,39%. However, elevated CO_2 level and salinity stress did not affect HCN content in cassava leaves. The content of HCN in the leaves was higher than in the roots due to cyanogenic glucoside synthesized in the leaves and then transported to the root (Gleadow *et al.,* 2016). Study on cyanogenic glucoside in cassava plants, suggested that high levels of HCN in the leaves and the reduced levels of

HCN in the roots following the increase in salinity was correlated with the capacity of the plant to tolerate stress. Salinity stresses cause the reduction of the Calvin cycle, leading to an increase in xanthophyll and photorespiratory cycles that induce secondary metabolites of CNglcs (cyanogenic glycoside). The decomposition of CNglc metabolite results in the formation of β-glucosidase which is the source of HCN formation. The catabolism of CNglc will return N as ammonia or amino acids that may be involved in greater detoxification of ROS during stress (Gleadow *et al.,* 2016).

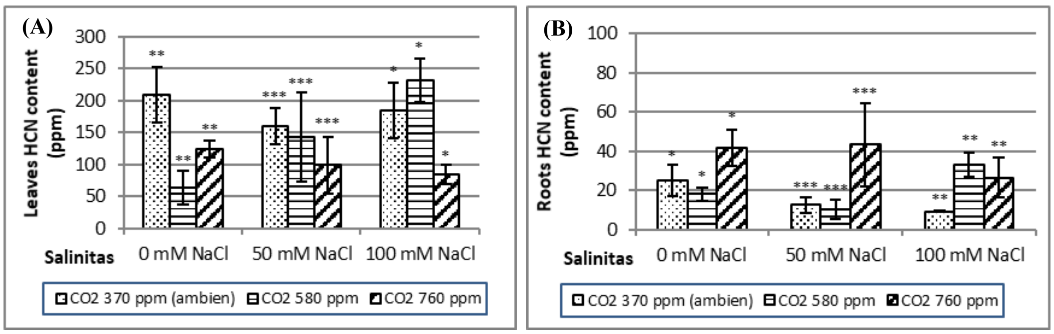

Figure 4. The effects of elevated CO_2 levels on HCN content of cassava plants under saline conditions. (A) Leaves HCN content, (B) Roots HCN content. Significant differences in salinity treatment were indicated by different letters, while the asterisks showed significant differences in elevated CO_2 levels treatments based on the Tukey test with $p \leq 0.05$.

Ecophysiological responses of cassava plants to combination of elevated CO_2 under salinity stress

Elevated CO_2 under salinity stress conditions affects plant growth and physiological responses of cassava plants. However, the combination of elevated CO_2-NaCl treatments leads to an increase in the growth and physiological responses of cassava plants to face the stress (Table1.). The response shown by the plants may vary due to difference in variety, the duration of CO_2 exposure, and NaCl concentration (Chen *et al.,* 1999; Geissler *et al.,* 2009; Cruz *et al.,* 2016).

Table 1. Effect of Elevated CO_2 and Salinity Stress on Cassava Plants
Sign (-) means reduce, and (+) mean increase

Parameter	NaCl	Elevated CO_2	Elevated CO_2-NaCl	Description
Dry weight	-	+	+	CO_2 760 ppm, 50 mM NaCl
Number of leaves	-	+	+	CO_2 760 ppm, 50 mM NaCl
CAT enzyme activity	+	+	+	CO_2 760 ppm, 50 mM NaCl
Proline content in root	+	+	+	CO_2 760 ppm, 50 mM NaCl
HCN content in root	-	+	-	CO_2 760 ppm, 100 mM NaCl
Formation of storage roots	+	+	+	CO_2 760 ppm, 0 mM dan 50 mM NaCl

Salinity stress reduced the number of leaves and dry weight of plants due to the low availability of water in environment. Furthermore, plant decreased potential water for water retrieval from roots (Péréz-López *et al.,* 2012). Meanwhile, plants minimize water loss by regulating stomatal closure. Closing of stomata will reduce transpiration rates which correlated with decreased in stomatal resistance (Geissler *et al.,* 2009). In this study, stomatal resistance at all treatments was not different, but there was a tendency that stomatal resistance decreased with increasing salinity concentration. In addition, more stomata are closed under salinity conditions (Figure 5. B2). This observation supports the results of the study that the combination treatment of elevated CO_2 760 ppm and 50 mM NaCl increased number of leaves and dry weight of the plants.

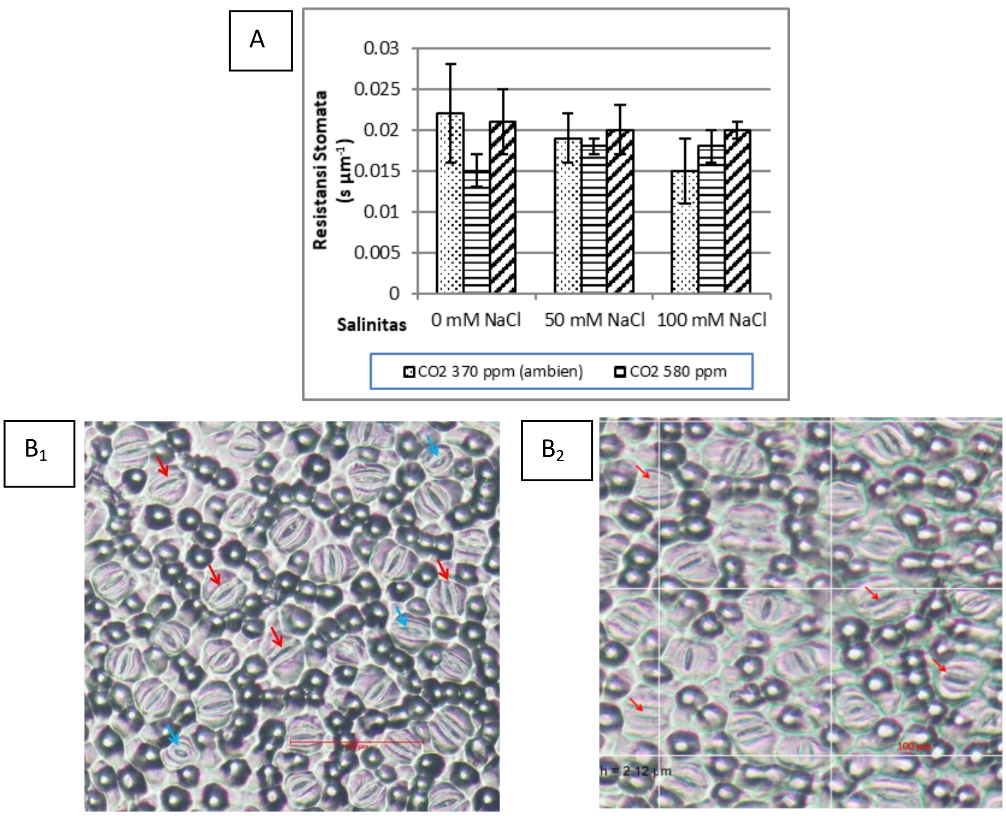

Figure 5. The effects of elevated CO_2 levels on stomatal resistance under saline conditions. (A) Stomatal resistance. (B) Stomata at abaxial leaf epidermis under 0 mM NaCl (B1) and 100 mM NaCl (B2) at CO_2 ambien levels. Red arrow showed stomatal closure, blue arrow showed stomatal opening. Bar= 100 µm.

CONCLUSION

Elevated CO_2 level of 760 ppm alleviated negative effect of 50 mM NaCl as plant growth increased compared to control. Elevated CO_2 level increases number of leaves and dry weight of cassava plants under salinity stress. The plant responded the treatment by its physiological adaptation as indicated by increased in proline content and CAT activity.

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PHYSICO-CHEMICAL PROPERTIES EVALUATION OF TALAS BENENG STARCH (*Xantosoma undipes* K. Koch) AS LOCAL FOOD BIODIVERSITY OF PANDEGLANG

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ABSTRACT

Talas beneng is one of the local biodiversity in Pandeglang Banten which has the potential to be developed into various food products. The aim of this study was to characterize physico-chemical properties of Talas Beneng Starch that is local root from Pandeglang, Banten. Proximate analysis, whiteness, total starch, and pasting characteristic were determined. This research was carried out in Laboratory of Food Technology Department, Agricultural Engineering Faculty, IPB. The result showed that water content, ash, fat, protein, and carbohydrate respectively 13.79%, 0.38%,0.13%, 0.22%, 89.27%. Talas Beneng starch was characterized by an early gelatinization at 78.50^0C with peak viscosity as 4615 cP. The setback of Talas Beneng starch as 1208 cP, it meant high retrogradation tendency. Talas Beneng starch could be made into product that need low protein starch and had characteristic as not heat resistant.
Keywords: talas beneng, starch

INTRODUCTION

The population of Banten province was officially estimated at 11,248,947 people. The average growth rate of the population of Banten in 2012 was 2.16% (BPS, 2012). Banten Province is a new province formed in 2000 resulted from the expansion of the province of West Java. Bantenas development province is expanding economic sectors, the one of them is food security. The increasing population growth in Banten province needs further balance in food supply. The various types of food are developed to improve the quality and quantity. Besides increasing the number of food, it also needs food diversification.

The natural resources of Banten Province have the potential availability of abundant local food. The local source from Banten Province which can be used as an alternative food diversification is Talas Banten (*Xanthosoma undipes* K. Koch.) or better known as Talas Beneng. Talas beneng means "besar dan koneng" (big and yellow).

Juhut is a village where Talas Beneng is growth but it is not cultivated optimally yet. Talas beneng has a large tuber that reached 30 kg within 2 years of planting. Talas beneng can grow up to 120 cm in length and weigh up to 42 kg and the outer about 50 cm. Talas Beneng is a type of taro that has flour fiber content of food is higher than other types of taro. Talas Beneng has a good nutritional content. Protein 6.29%, carbohydrates 84.88%, fat 1.12%, starch 75.62%, and calories of 374.69 kcal (Apriani *et al*., 2011).

Starch is a carbohydrate consisting of amylose and amylopectin. Amylose is part of linear polymer with α-1,4 D-glucosidic bond. Amylopectin is a polymer α-1,4 glucose unit with a branch chain α-1,6 D-glucosidic. The structure of the starch granules is arranged in a ring. The number of rings on the starch granules is approximately 16 pieces, consisting of an amorphous layer ring and a semi-crystal layer ring (Herawati, 2010).

Preparation of starch through peeling, washing, soaking, dissolving, rasping and extraction process, precipitation, washing, drying and grinding process.

Talas beneng has potential as a substitution of wheat flour. Because it has a very high value of starch, therefore it is necessary to research the characterization of physicochemical properties of Talas Beneng (*Xanthosoma* undipes K. Koch.) for economic added value.

MATERIAL AND METHOD

Material

Talas beneng (*Xanthosoma undipes* K. Koch) from Juhut village, Pandeglang Banten Province. Taro beneng used 2 years after planting.

Method

The production of Talas Beneng starch comprises the steps such as peeling, washing, soaking, dissolving, extraction, precipitation, drying and grinding. The peeling aimed to soften tuber tissue and tuber cells. Rasping aimed to disruption of cell tissues which therefore release the starch. The further process is extracted, the extraction aimed to separate the starch from the water and sludge. Subsequent draining was conducted to produce starch with specific moisture content (Richana, 2004).

Determination of Test Analysis

Proximate Analysis (SNI-2891-1992)

The proximate analysis was performed on Talas Beneng starch (*Xanthosoma undipes* K. Koch) including analysis of moisture content by oven method, ash content, protein content of Kjeldahl method, Soxhlet and carbohydrate fat content (determined by difference).

Starch Pasta Characteristics (Pasting Properties) (AACC 61-02.01)

Paste characteristics of the sample were measured using Rapid Visco-Analyzer with AACC method 61-02.01. Parameters measured include peak viscosity (PV = highest viscosity during heating), gelatinization temperature (SG = gelatinization initial temperature), trough (T = lowest viscosity after PV achieved), breakdown (BD = PV-T), final viscosity (FV = ultimate heating viscosity) and seatback (SB = FV-PV). All values are expressed in cP.

Total Starch (Anthrone Method)

Weigh 1 g starch sample then put in 50 ml threaded tube and added 25% HCl. Hydrolysis for 2 hours in a boiling waterbath. Cool and neutralize with 40% NaOH then Add5 ml acetate pb. Suspense into a 100 ml measuring flask and dilute it to the boundary mark and add sodium oxalate. Pipette 5 ml of filtrate obtained into the test tube and add 5 ml anthrone reagent. Boil until 10 minutes. Cool immediately on running water and then measured the absorbance at $\lambda = 630$ nm.

$$\text{Total starch} = \frac{\frac{y-a}{b} \; x \; FP \; x \; 0.9}{c \; x \; 1000} \; x \; 100\%$$

a = Coeficient x from standard curve
b = Constants
c = Initial weightl (mg)
d = sample absorbance

White Degrees

White degree is measured by Kett Whitenesmeter with white standard ($BaSO_4$ 100%). The white degree is read on the needle and the measurement number.

RESULTS AND DISCUSSION

Chemical Characterization

Proximate analysis

The average of Talas Beneng starch water content was 13.79 ± 0.03%. Based previous research, The water content of starch ranges 10,03% (Suheri, 2015) and 11,13% (Ridal, 2003). It was complied with SNI standard, maximum 14%.

The average Talas Beneng starch ash was 0.38 ± 0.03%. In previous research the content of Talas starch ash is 0.25 ± 0.01% (Uswah, 2015). The low ash content obtained is associated with the processing of starch, by repeated extraction with water so that the mineral content disappears with the pulp (Polnaya, 2015).

Table 1. Chemical Composition and White Degree of Talas Beneng Strach

Product	Water content (%)	Ash (%)	Fat(%)	Protein (%)	Carbohydrate(%)	White degree (%)
Starch	13,79±0,03	0,38±0,03	0,13±0,16	0,22±0,00	89,27±1,07	98,79±0,01

Protein of Talas beneng was 0.22 ± 00 % lower than previous study as 0.37% (Ridal, 2003). The low protein in starch means pure starch (without impurities). Uswah (2015) reported that protein content of Talas starch was 0.66% and Ardianyah (2014) reported pure protein content range under 0.6%. Low protein content in taro starch due to protein soluble in water. The loss of protein due to the extraction and washing process. The high protein content of starch may decrease viscosity which is not expected (Polnaya *et al*., 2015).

Fat content was 0.13 ± 0.16% (Table 1). The fat content in starch can affect the gelatinization process because the fat is capable of forming complexes with amylose which inhibits the gelatinization process of starch because most of the fat will be absorbed by the surface of the granules so that the fat layer is hydrophobic around the granule (Ridal, 2003). High fat content in starch will reduce the amilose tendency to bind, form gel and degenerate, thus inhibiting viscosity during heating. Talas beneng starch might be used as thickening product.

Carbohydrate content was 89.27 ± 1.07% (Table 1). A previous study the carbohydrate Talas starch ranged from 89.26 ± 0.00 (Uswah, 2015). The high content of carbohydrate in Talas beneng starch potential to substitute rice or diversification product.

Total Starch

The main constituents of starch polysaccharides are amylose and amylopectin. The total amount of starch is the amount of amylose and amylopectin in starch. Measurement of total starch content in taro starch showed a value of 90.45 ± 0.2%. The high amount of starch in starch due to the extraction process which results in pure starch content (Ridal, 2003). The high content of starch provide a compact gel character.

Physical Characterization

White Degree

The color of starch will greatly affect the appearance of the final product. The white degree of Talas Beneng starch was 98.79 ± 0.01% (Table 1). The color of starch due to the presence of polyphenolic compounds has impact on its quality (Ridal, 2003). Polyphenol causes the occurrence of enzymatic browning, which is polyphenolase and oxygen in the air. The enzyme would release in wounds on the tuber. White degrees in starch ranges from 92.03% (Ridal, 2003).

Characteristics of Pasta

Gelatinization profile and pasta determined by using Rapid Visco Analyzer (RVA). RVA was a equipment used to measure viscosity by using the heating and cooling methods as well as measuring the sample's resistance to the controlled mixing process.

In rheological properties, digestive starch has a flow properties so it can be measured viscosity. After the waxing process is complete, the properties of the gel will change elastic so that its gel strength can be measured (Kafah, 2012).

Gelatinization was important functional properties. When heated in water, starch undergoes a transition process, during which the granules break down into a mixture of polymers-in-solution become thickening then formed gel after cooling. It caused starch being able to absorb water when it heated then swelling that increase its viscosity. Gelatinization of starch is widely used in foodstuffs as thickening or gel forming (Kafah, 2012). The gelatinization profile of starch showed in Table 2. The gelatinization profile is characterized by a high enough peak viscosity value.

Table 2. Gelatinization of Talas Beneng Starch Profile

Parameter	Starch Talas Beneng
Peak Viscosity (cP)	4615
Heat Viscosity(cP)	1374
Setback(cP)	3241
Final Viscosity(cP)	2582
Breakdown(cP)	1208
Peak time(min)	6,40
Gelatinization temperature (^{o}C)	78,50

The initial temperature of gelatinization starts when starch granule begins to absorb water and increase its viscosity. The initial temperature was 78.50^{o}C (Table 2), Peak viscosity 4615 cP. The decrease in viscosity during heating (breakdown) on taro starch decreased sharply as 1374 cP. This shows that talas beneng no heat resistant. According to previous research Talas and garut starch have unstable starch granules due to heating (Uswah, 2015).

The setback was 1208 cP (Table 2). The tendency to form the gel is seen from the higher setback that is formed, this trend also indicates the high retrogradation. This phenomenon of retrogradation is due to there-forming of hydrogen bonds between amylose molecules and amylopectin. This shows that taro flour has undergone a high rate of retrogradation.

CONCLUSION

Talas Beneng is one of the local biodiversity in Pandeglang, Banten which has potential to be developed into food diversification. Talas beneng has a very high starch content that can be processed into flour and starch that has the quality as a substitution of wheat flour or rice. The result showed that water content, ash, fat, protein, and carbohydrate, and whiteness degree respectively 13.79%, 0.38%,0.13%, 0.22%, 89.27%. Talas Beneng starch was characterized by an early gelatinization at 78.50^{o}C with peak viscosity as 4615 cP. The setback of Talas Beneng starch as 1208 cP, it meant high retrogradation tendency. Talas Beneng starch could be made into product that need low protein starch and had characteristic not heat resistant.

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CASSAVA FARMING ANALYSIS AT DRYLAND IN LAMPUNG TENGAH REGENCY

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ABSTRACT

Cassava is a major food crop commodity developed by many farmers. Cassava plant is grown on dryland in Lampung. This study aims to analyze cassava farming in dryland in Lampung Tengah. The study was conducted in Lampung Tengah Regency from May to September 2017. Primary data were obtained from respondents of cassava farmers in 3 farmer groups, using survey methods through interviews and structured questionnaires. Secondary data obtained from the Office of related agencies and the Central Bureau of Statistics Lampung Province. Data were analyzed using financial analysis. The results showed that cassava farming in dry land of Lampung Tengah Regency is feasible to be cultivated with profit about Rp.2.450.000 to 19.940.000/ha/ planting season and R/C ratio >1. Farmers cultivate cassava due to easy cultivation, high selling prices, high production, and have a low risk chance of crop failure. Under normal conditions, farmers' income from cassava farming is prosperous and prospective to be done. In the future to anticipate the risk of crop failure and price risks of fluctuating cassava, it is advisable to plant cassava with cassava inline system with corn. This is in addition to saving costs, energy saving, cost-effective if the land, and efficient use of means of production also save time.

Keywords: farming, cassava, dryland

INTRODUCTION

Cassava plant has long been known by the community as a source of carbohydrate plants after rice and corn. According to botanists identified cassava plants are originally from the tropical American continent. The plant is widely developed and spread to several areas such as Africa, China, India, Madagascar and some countries that have the appropriate agro-ecosystem. The spread of cassava to Indonesia is estimated to occur since the 18^{th} century. The peak of the crop development occurs when cassava becomes an alternative source of food during the rice crisis. Cassava is an alternative food crop commodity developed by many farmers. Cassava has a higher energy source than rice, corn, sweet potatoes, and sorghum.

In its development, cassava becomes the third main source of staple food after rice and maize. Almost all areas in Indonesia there is the spread of cassava plants. Cassava other than as starch (Amin, 2006; Adegunwa e*t al*., 2011; Uyoh *et al*., 2009), whose particular flour characteristics (Rasulu *et al*., 2012), is also often a functional foodstuff because it deals with physiological and human health (Herlina and Nuraini, 2014), by first reducing the toxic cyanide acid compounds (Kobawila *et al*., 2005; Adamafio *et al*., 2010). Cassava can also be used as animal feed ingredients and industrial raw materials and even cassava is used for fuel sources in the form of bioethanol (Ginting *et al*., 2011; Balat *et al*., 2008). Bioethanol is used as an alternative fuel (Pranowo, 2007; Ginting *et al*., 2009).

Cassava crops in Lampung are widely planted on acid dry land. The cassava commodity has economic value for farmer community in Lampung, so it is commercial-oriented cultivation. The yield of cassava varies considerably depending on the level of soil fertility and climatic conditions. According to Wargiono *et al.* (2006) for optimal production cassava requires rain with an intensity of 150-200 mm at 1-3 months, 250-300 mm at the age of 4-7 months and 100-150 mm at the time of cassava before harvest. Moreover according to Nugraha *et al.* (2015) results showed that cassava planted in September-November and harvested in July-October resulted in the productivity of about 40-48 tons per hectare (61%).

Cassava harvested area in Indonesia in 2015 covering an area of 0.95 million hectares and its production achieved 21.80 million tons with a productivity of 22.95 tons/ha (Central Beaureu Statistics Indonesia, 2016). While, in Lampung province, the cassava harvest area in 2015 reaches 279.226 ha with the total production of 7.384.099 tons or an average productivity of 26.44 tons per ha (Badan Pusat Statistik Lampung, 2016). Even the projection of cassava demand for years up to 2020 is expected to increase by an average of 2.15% per year (Kementerian Pertanian, 2016).

The problems that are often encountered in agricultural commodity farming including cassava is a surplus of production. Cassava production surplus is actually a big export opportunity, but on the other hand, can result in declining prices of cassava if the consumption of cassava is not in line with the production supply. Nevertheless, cassava farming at on farm level is still running in Lampung, although often there is a question whether the cassava farming is still provided benefits for farmers. Therefore, the purpose of this study is to analyze the cassava farming in the acidic dryland in Lampung Tengah on cassava cultivation model of monoculture cropping system and by passing by farmers in Lampung Tengah.

MATERIALS AND METHODS

This study used case study method is research conducted by looking directly at the object of research in the field. The case study is a method that explains the type of research about a particular object over a period of time, or is a phenomenon found in a place and may not have been generalized or not necessarily the same for other areas.

Determination of Research Sites.

The research area was determined purposively in Sendang Ayu Village, Padang Ratu Sub-district, Lampung Tengah Regency. This area is one of the villages of cassava production center which is wide enough on acidic dryland. Research was conducted from May to September 2017.

Sampling Method.

The method used is sampling method. The samples in this study were 30 cassava farmers. Farmers who apply the planting system can be grouped into two: cassava monoculture and cassava with other crops.

Method of collecting data.

The data collected in this study consisted of primary data and secondary data. Primary data is the result of direct interviews to farmers of respondents by using questionnaires that have been prepared according to research objectives. Secondary data is complementary data obtained from related institution or institution related to this research.

Data analysis method.

To analyze and to answer the problems that are aligned with the purpose of research, the analysis tool used is the analysis of Revenue Cost Ratio (Ratio R/C) like this:

$$R/C = \frac{Total\ Revenue}{Total\ Cost}$$

Information:

If R/C = 1 Cultivation of cassava is feasible or improper (break even)
If R/C > 1 Cassava farming is feasible (efficient)

If R/C <1 Cassava farming is not feasible (inefficient) (Soekartawi, 1995).

RESULTS AND DISCUSSION

The condition of agro-ecosystem in Lampung Tengah

Based on agro ecological zone map (Badan Penelitian dan Pengembangan Pertanian, 2013) Lampung Tengah Regency is dominated by 2 Agro Ecological Zones, namely IVax and IIIax zones. In the zone of IVax has characteristics with an altitude of 0-700 meters above sea level, flat to a wavy area (0-8%), moisture to moisture, and good drainage. While the zone IIIax has characteristic with a height of 0-700 meters above sea level, flat to wavy (0-8%), moisture humidity, and good drainage. From soil type, Lampung Tengah Regency is dominated by ultisol, inceptisol, and entisol soils. The spread of ultisol soil percentage reaches 75% spreading in almost all districts in the district. Inceptisol soils are scattered in the west and around large rivers. As for the land entisol spread in the eastern region of Lampung Tengah Regency (Baehaqi, 2010).

Table 1. Farmers age description condition in Lampung Tengah (%).

No	Age of farmers	Percentage (%)
1.	18-30 years old	10,0
2.	31-55 years old	73,8
3.	>55 years old	16,2
	Average of farmers age = 45 years old	

Source: Primary data, 2017.

Table 2 shows that of cassava farmers (73.9%) graduated from senior high school.

Table 2. Distribution of education level of cassava farmers in Lampung Tengah (%)

No	Education	Percentage (%)
1.	Did not pass elementary school	3,1
2.	Elementary school	18,2
3.	Junior High School	3,2
4.	Senior High School	73,9
5.	Bechelor	1,6
	Total	100

Source: Primary data, 2017.

According to Baehaqi (2010), climate conditions of Lampung Tengah Regency categorized as tropical climate-humid. In areas that have a height of 30-60 meters of air temperature ranges from 26^{o}C - 28^{o}C. Based on the map of agro-climate zone criteria of Oldeman, the western region of Lampung Tengah Regency is dominated by climate type A (wet month rainfall (> 200 mm) > 9 months and dry months (<100 mm) <2 months throughout the year), B1 (wet month rainfall 7 - 9 months and dry months <2 months throughout the year), and C1 (wet month rainfall 5 - 6 months and dry months <2 months throughout the year). The most dominant climate zone in the district is climate type C2, with rainfall in wet months 5 - 6 months and 2 - 3 months of dry months throughout the year. Some areas of Lampung Tengah Regency also have climate type D2, with rainfall in wet months 3 - 4 months and 2 - 3 months of dry months throughout the year. Water deficit also occurs in Lampung Tengah region that occurs in June / July and ends in October / November (Hafif, 2016).

Description of Farmers in Lampung Tengah

The description of farmers in Lampung Tengah area 2017 shown in Table 1, that the average age of cassava farmers in Lampung region is 45 years old. The distribution of age level of most farmers (73.8%) was aged 31-55 years. This shows that cassava farmers in Lampung tend to be as productive age, which means a potential for agricultural development.

Table 3 shows the distribution of cassava farming land ownership to farmers in Lampung Tengah. The table shows that most of the cassava farmers are land owner (70,80%), while the labor around 20,73%.

Table 3. Distribution of farmland ownership by cassava growers in Lampung Tengah (%).

No	Farmland	Percentage (%)
1.	Owner	70,80
2.	Rent	1,85
3.	Work on	20,73
4.	Other	6,63
	Total	100

Source: Primary data, 2017.

The condition of the Cassava Cultivation Technique in Lampung Tengah

Preparing Seeds

The process of preparation of cassava seedlings in the research area is done sectarian and vegetative. Seeds of cassava prepared vegetatively are by stem cuttings. Good and old cassava stems harvested together with tuber harvest. The old trunk is a good source of cuttings. The trunk feature is woody. Cuttings from the cassava stems are young or still green although can grow, the results are low. For that selected old rod where in a way to guarantee the results will be good production. The condition of the cassava stems to be seed is: (a) the age of cassava is old enough (aged) ranges 8-15 months and its production is high, (b) the cassava must be healthy and big (about 2 cm diameter), (c) the sides are flat and not defective. Observations in the research village that cassava farmers use seedlings from stem cuttings. According to farmers that the seeds that use these stem cuttings will result in the parent plant. In addition, it does not take a long time to move cassava cuttings to farmland.

Land preparation

For land preparation, farmers usually cultivate their land using large tractors assisted by hoes to tidy up. Tillage processing system usually with a wholesale system. In the processing of the soil is done plow and then rake and in the groove until ready for planting.

Cultivation

The process of cassava planting does not have a significant difference with the planting of plants in general that use cuttings. Seedling cuttings simply plugged into the soil on grooves that have been made during the soil processing with a depth of about 5 cm with a spacing of varies 60-80 cm x 70-100 cm. The number of seeds used by farmers ranges from 20-25 thousand cuttings per hectare of land.

Control of Plant Disturbing Organisms

During the period of plant growth, farmers only do several times weeding plant troublemakers (weeds) to maintain the cleanliness of the plant area. But in general weed cleaning is done once per planting season. Cassava plant is a plant that is not susceptible to pest disease and does not require intensive care like other plants. Weed control is done by spraying herbicides and combined with weeding when planting crops.

Fertilization

In order to produce optimal cassava production, the farmers do the fertilization twice during maintenance. How to fertilize cassava in the research site is done by sprinkling fertilizer done simultaneously during of weeding and packages.

Splitting Shoots

To produce a good cassava production, the farmers in the area of research to reduce the stem bud if the excessive growth or thinning stem by leaving 2-3 stems of cassava. Thinning of the stem is done when the cassava is about 3-4 months old.

Harvest

The farmers harvest cassava at the age of 8-12 months depending on the seeds used and the condition of the selling price of cassava. Tubers taken are tubers that are old enough. Harvesting is done once in planting. The harvested tubers are put into the jute, then collected and sold to the collecting merchant or wholesaler/agent or it can also be sold the sale of cassava in a slash (wholesale).

Analysis of cassava Farming in Lampung Tengah

Basically, the revenue and income of a farm depends on how the roles of farmers manage their farming. Farmers' income is the difference between the sale of cassava and the total cost of producing cassava produced by cassava growers. Results of field research indicate that the income earned by each farmer is different from each other. This is because the area of land used, production (sales), selling prices, production costs, receipts, and revenues received differently. Therefore, the average yield of production (sales), selling price, production cost, revenue and income of the sample farmers as shown in the farming analysis in Table 4.

In the farming analysis, there are 2 (two) models or farming system in which cassava is grown in monoculture and cassava is grown in an insert with maize. In monoculture cultivation system, only cassava is grown on farmland. The distance of cassava planting 70 cm x 80 cm so that the population of monoculture cassava plants as much as 17,900 stems cuttings. While on cultivation system intercropping cassava-corn spacing cassava fixed (70 cm x 80 cm) while the distance of corn planting 70 cm x 20 cm. Cassava planting system cassava-maize then after the soil processing is completed first planted the maize first then after the maize about 70 days done cassava planting. The results of calculation of the cropping model are time-saving, energy-saving, cost-effective if the soil, and efficient use of means of production. So it is very suitable implemented in land lease system.

Table 4. Analysis of cassava farming on monoculture system and cassava-corn intercroping system per hectare of land area in Lampung Tengah.

No	Description	Planting System	
		Monoculture Cassava	Intercropping Cassava+Corn
1.	Average land area Farm (ha)	1	1
2.	Main Plant Production Cost (IDR./ha)	14,650,000	13,400,000
3.	Production Cost of Insert Plants (IDR./ha)	-	10,360,000
4.	Production Cost of Farming (2 + 3) (IDR./ha)	14,650,000	23,760,000.
5.	Number of Main Crop Production (kg / ha)	24,000	24.000
6.	Price of Harvest of Main Plants (IDR/kg)	713	713
7.	Number of Insert Plant Production (kg / ha)	-	7,000
8.	Selling Price of Insert Plants Crop (IDR/kg)	-	3,800
9.	Main Plant Acceptance (IDR / ha)	17,100,000	17,100,000
10.	Acceptance of Insert Plants (IDR / ha)	-	26,600,000
11.	Total Agricultural Revenue (9 + 10) (IDR / ha)	17,100,000	43,700,000
12.	Net income (11-4) (IDR / ha)	2,450,000	19,940,000
13.	BEP main plant volume (kg)	20,547	18,794
14.	BEP main crop prices (IDR)	610	558
15.	BEP insert plant volume (kg)	-	2,726
16.	BEP price of insertion plant (IDR)	-	1,480
17.	R/C Ratio	1.17	1.84

Source: Analysis of Primary data, 2017.

Based on Table 4 it is known that the average land area used for cassava planting is 1 ha. The average production produced by cassava growers is 25,000 kg/ha/year with a selling price of 950 IDR/kg. However, it is usually affected by refraction of 33-25% sales so that the real average price is 713 IDR/kg so as to produce the acceptance of total cassava farming average - 17.100.000 IDR/season. The average production cost of 14.650.000 IDR/season, the cassava farmers earn an additional net income of an average of 2.450.000 IDR/season.

The production cost incurred consists of the cost of seeds, labor, fertilizers, drugs. A good seed is a key to achieving high results. Manpower is a human resource used to conduct cassava farming activities. Fertilizer is something that plants need in the form of stimulants for plant growth. Drugs are a weed-out of weeds in cassava plants. Nevertheless, cassava farming in dry-land of Lampung Tengah regency monoculture system is still feasible to be cultivated with R/C ratio of 1.17.

In cassava-maize-cropping intercropping systems provide total revenue from cassava and corn for Rp.43.700.000/season. The production cost of the insert system farming system is 23.760.000 IDR/planting season. Farming is able to provide additional revenue for 19.940.000 IDR/season. So that planting system bypassing way more give higher farming value than monoculture planting system, it is indicated by the value of R/C ratio which reaches value 1.84. So the farming system cassava-maize intercropping system is also feasible for cultivation.

CONCLUSION

Cassava cultivation of monoculture system in the dry land of Lampung Tengah Regency is still feasible to be cultivated with the value of revenue per hectare of 17.100.000 IDR/ha/season and R/C ratio of 1.17. Additional net profit from cassava system of monoculture system is 2.450.000 IDR/season. This shows that under normal conditions, farmers' income from cassava farming is prosperous and perspective to do. Farmers tend to cultivate cassava in monoculture by reason of easy cultivation, promising selling price, high production, and have a low-risk chance of crop failure. Meanwhile, cassava cultivation of inbreeding system with corn plant is also feasible to be cultivated with total revenue of 43.700.000 IDR/ha/season with R/C ratio of 1.84. The additional net profit from cassava-corn intercropping system gives additional 19.940.000 IDR/ha/season.

In the future to anticipate the risk of crop failure and price risks of fluctuating cassava, it is advisable to plant cassava with cassava system. This is in addition to saving costs, energy saving, cost-effective if the land, and efficient use of means of production also save time.

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