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2nd ICGAB 2018

International Conference on Green Agro-Industry and Bioeconomy

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PROCEEDING

THE 2nd INTERNATIONAL CONFERENCE ON GREEN AGRO-INDUSTRY AND BIOECONOMY

"Sustainable Development and Strengthening Tropical Resources for National Welfare"

18 – 20 September 2018

Widyaloka Convention Hall – Universitas Brawijaya, Malang

FACULTY OF AGRICULTURAL TECHNOLOGY
UNIVERSITAS BRAWIJAYA

PROCEEDING

THE INTERNATIONAL CONFERENCE ON GREEN AGRO-INDUSTRY AND BIOECONOMY
Faculty of Agricultural Technology
Universitas Brawijaya, Malang, Indonesia

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WELCOMING SPEECH FROM CAIRMAN AND DEAN FACULTY OF AGRICULTURAL TECHNOLOGY, UNIVERSITAS BRAWIJAYA

Assalamu'alaikum wr.wb.

Dear distinguished guests and ICGAB participants,

It is a great honor for me to cordially welcome you all in Malang, and to our campus Universitas Brawijaya. And as an organizing committee of this conference, Faculty of Agricultural Technology gratefully thanks the Rector of Universitas Brawijaya for his continuous support.

Last year, International Conference on Green Agro-Industry and Bioeconomy (ICGAB) was successfully held and attended by a total of 310 participants from 8 countries. This year event has brought together nearly 400 delegates (from 7 countries) coming from national and international universities, research intitutions, and industries. This is our second ICGAB as we are aiming to organise the event on a regular basis. This is because ICGAB is very relevant with the vision, mission and strategic planning of our faculty. The Faculty aims are becoming a centre of excellence in the field of Agricultural Technology both nationally and internationally and giving a significant contribution towards sustainable development for strengthening the national welfare in Indonesia.

As we know that the water-food-energy nexus is critical and central to sustainable development. A rising of global population, urban expansion, changing diets and consumption behaviours causes an increase for all three nexus. The complex linkages between these critical nexus need integrated aprocahes to sustain water and food security, and to ensure a sustainable agriculture and energy production. Bioeconomy may bring us new hope for fulfil those needs through various range of approaches that can be implemented in agriculture and forestry, food, renewable energy, chemical, and pharmaceutical, as well as in creating innovative materials.

Furthermore, as part of the local, national and global communities, our faculty have continuously been making significant contribution in finding solutions towards national problems through research, developing technology, machinery, and conducting community service to educate people outside university. We take very seriously national problems such food security and food safety, developing renewable energy resources, waste management, and environmental degradation. Our faculty has also contributed in participating and winning the international research and scientific competition aiming to tackling the global problems. In addition, all aspects of agricultural technology integrated within our six (6) undergraduate study program offered in our faculty are also represented in the ICGAB conference.

Therefore, it is an honour for our faculty to host ICGAB conference to disseminate knowledge, research results and technology advances, as well as to exchange ideas and share success stories among all of you. It is our hope that this conference will be inspiring and deliver fresh inspiration and motivation to all participants. Thus, we can contribute to foster our national welfare by developing and implementing green-agroindustry and bioeconomy based on local and tropical commodities, while sustaining the environmental sustainability.

Last but not least, we would like to sincerely thanks all of our speakers for contributing to the conference program. Furthermore, we would like to express our most sincere appreciation to all contributing organisations include PERMI, FKPT-TPI, KBI, SEARCA SEAMEO, PATPI, PERTETA and APTA. We would also like to express sincere gratitude to the conference organising committees who have been working hard and with full dedication to make this conference possible.

We wish you all to have a fruitful conference that can integrate holistic aproaches in tackling our national problems and can strengthen our collaboration nationally and internationally. Thus, we can contribute in creating a safe, healthy and eco-friendly world for our future generation.

Wassalamu'alaikum wr.wb.

Dr. Sudarminto Setyo Yuwono

Chair of ICGAB2018
Dean of Faculty of Agricultural Technology

WELCOMING SPEECH FROM RECTOR UNIVERSITAS BRAWIJAYA

Assalamu'alaikum wr.wb.

Excellency's, Distinguished Delegates, Ladies and Gentlemen,

On behalf of the University members, it is a great honour for me, to extend to you all, a very warm welcome to Universitas Brawijaya, to Malang – East Java, and to Indonesia.

I would also to take this opportunity to express my sincere gratitude to The Conference Committee and Faculty of Agricultural Technology for organizing The Second International Conference on Green Agro-Industry and Bio-economy.

This conference an important conference to address Sustainable Development and Strengthening Tropical Resources for National Welfare through implementation of circular bioeconomy and green agro-industry.

Both in global world and in Indonesia, sustainable development is critical to tackle problems of poverty, climate change, and environmental degradation. Therefore, as a major global key producer of various agricultural tropical products, Indonesian government commits to deal those global concerns and to increase development partnerships among relevant stakeholders to ensure sustainable development goals can be sucessfully achieved. Despite many intensive activities and collaboration have been implemented by the government with concerned bodies; however, a lots remains to be done.

Universitas Brawijaya, as one of the state universities in Indonesia is also committed to contribute in finding solutions for major problems faced by the nation and the world today.

Indonesia, as part of the global communities are in transitioning toward a more industrialized country. Thus, many natural resources exploitation, high demand for fossil fuel, green-house gas emission and deforestation are happening in the country, which damaging environment and impeding the sustainable development. Therefore, the creation of bioeconomy through adopting green agro-industries and industrial biotechnology may stimulating technological innovation, industrial competitiveness and sustainable development in Indonesia, and at the same time perserving the natural resources. Also, not to forget, for integrating the concept of green agro-industries 4.0. and society 5.0 to bring new values to industry and society.

Universitas Brawijaya plays an important role in supporting the sustainable development through various research findings and community service programs, which integrated within our roadmap of food security; energy security; good governance; afroforestry; and health, nutrition and medicine. We have also supporting the development of green agroindustries by providing assistance, training, and technical supports. However, we realized that our efforts for the better world will make a bigger impact with more collaboration involving various concerned stakeholders.

Therefore, it is an honour for Universitas Brawijaya to host the second ICGAB conference to disseminate knowledg, research results, and technology, exchange ideas and share success stories among us and stakeholders from around the globe.

Finally, I wish you all enjoying the conference, having a fruitful experience and networking from the conference, as well as having a pleasant stay in Malang.

Wassalamu'alaikum wr.wb.

Prof. Nuhfil Hanani

Rector of Universitas Brawijaya

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Study of making siger rice from cassava (*Manihot esculenta*) in various harvest age on physical, chemical and organoleptic siger rice

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Abstract. CASSAVA is a food crop commodity that can be processed into siger rice. Siger rice is the term of the Lampung community to mention artificial rice from cassava which has a white color with granular forms such as rice. Siger rice is made so that people psychologically consume siger rice with rice. This study aims to determine the age of cassava harvest which is appropriate in producing the best physical, chemical and organoleptic properties of siger rice. The treatment was arranged in a Complete Randomized Block Design with 4 replications. The treatments consisted of cassava aged 6, 7, 8, 9, 10, 11 and 12 months of harvest. Data were analyzed by variance to obtain variance estimation errors and significance test between treatments and further analyzed by Honestly Significant Difference Test at the level of 5%. The results showed that the difference in cassava harvest age significantly affected the swelling power and amylose levels of siger rice, as well as the hardness, texture, color, preference, and overall acceptance of siger rice. Cassava 6 months of harvest yield the best siger rice with swelling power value of 13.61 and amylose content of 18.61%, and rice hardness of siger 0.57 kg/(10x5mm), rice texture score of 3.29 (same as white rice), rice color score was 3.40 (slightly yellowish white), flavor preference and rice aroma 3.09 (somewhat like), overall acceptance score of rice 3.20 (somewhat like), water content 10.80%, ash content 0,23%, protein content 1.22%, fat content 0.88%, crude fiber content 1.18%, and carbohydrate levels 85.96%.

I. Introduction

Indonesia is a country with high rice consumption. The results of the 2015 National Socio-Economic Survey by the Central Statistics Agency (BPS) [1] stated that per capita rice consumption as of March 2015 was 98 kg per year. This number increased compared to the previous year which was only 97.2 kg per year. This situation proves that the culture of eating rice is difficult to change so that the need for rice is increasing every year in line with population growth. This is the cause of national food security has decreased. Data from FAO in 2016 states that as many as 19.4 million Indonesians are still experiencing hunger due to national food needs not being met. One solution to solve these problems according to Presidential Regulation No. 22 of 2009 is to diversify food by reducing people's dependence on staple foods derived from rice.

Cassava (*Manihot esculenta*) is one of the substitute for rice which is important enough to support food security. Cassava as an alternative food superior commodity in Lampung Province with a production level of 8,038,963 tons and an area of 301,684 ha makes the government develop it into a potential food source besides rice [2]. Cassava is the third food crop commodity in Indonesia after rice and corn. Cassava contains high levels of macro and micro nutrients that have the potential to be used as functional food [3].

Siger rice is an artificial rice product from cassava which adopts the process of making tiwul but with better appearance and taste. Siger rice is made from a mixture of cassava flour and tapioca in the form of granules such as rice. Siger rice grain size is made to resemble rice size so that psychologically the community when consuming rice is the same as eating rice from rice [4]. The advantages of Siger rice products as staple foods for rice substitutes are that they have characteristics as functional foods, especially for someone who runs a diabetic diet. According to Subeki et al. [5] that the administration of siger rice in mice with a composition of 50% in the ration did not cause liver and kidney damage and could reduce blood glucose levels of normal mice again by 168.50 mg / dL on the 22nd day after alloxan induction. In addition, blood glucose levels of 2 hours post prandial after consuming rice siger is 96.43 mg / dL lower than consuming white rice of 119.37 mg / dL. Administration of siger rice in diabetic patients can stabilize blood glucose levels of less than 200 mg / dL [6].

Siger rice products currently produced still have drawbacks, namely physically cooked rice from siger rice has a sticky, chewy texture, and easily hardens after cold. These characteristics are not favored by the community because they do not give the same impression as rice from rice [7]. This happens because the amylose content in cassava starch is quite high. Amylose has an important role in the process of gelatinization and retrogradation of starch. The shape of the amylose linear chain facilitates the meeting of hydroxyl groups through hydrogen bonds and forms a matrix so as to increase the viscosity of the starch paste. The unstable amylose linear chain causes the gelatinized starch paste to easily retrograde, which is the process of re-forming the starch crystalline structure which causes the product to harden [8].

The characteristics of siger rice products are influenced by the amylose and amylopectin content of the material. The age of harvesting cassava can affect the content of the material, so selection of the right harvest age is important. The age of cassava harvest used as raw material for tapioca industry ranges from 9-12 months. At the age of harvest will produce high levels of starch [9]. According to Nurdjanah et al. [10] that the highest cassava starch content was found at the age of 10 months, which was 23.6%.

In making siger rice, cassava with high starch content is not a consideration in choosing raw materials to make siger rice. The selected raw material is cassava with low amylose content and high amylopectin content. According Susilawati et al. [11] that amylose and amylopectin levels will change in line with increased harvest age. At the age of 7 months, amylose levels of cassava were 12.07% and continued to increase to 20.26% at the age of 9 months. While cassava amylopectin at the age of 7 months was 87.93% and at the age of 9 months it decreased to 79.74%. This proves that harvest age affects the ratio of cassava amylose and amylopectin.

The time to harvest cassava as raw material for making siger rice which can produce the best physical, chemical and organoleptic properties is unknown. Therefore, there will be research on the manufacture of siger rice using cassava from various age levels of certain crops and their effects on the physical, chemical, and organoleptic properties of siger rice produced. This study aims to obtain the best physical, chemical, and organoleptic properties of siger rice from cassava at the right age of harvest.

2. Materials and Methods

2.1. Place and time of research

This research was carried out at the Agricultural Product Processing Laboratory and the Agricultural Product Analysis Laboratory, Department of Agricultural Product Technology, Faculty of Agriculture, University of Lampung. This research will be held from February to April 2018.

2.2. Materials and tools

The ingredients used to make siger rice are cassava harvesting age (6 months, 7 months, 8 months, 9 months, 10 months, 11 months, and 12 months), glycerol Monostearate (GMS), cooking oil, salt, acid ascorbate, and water. The ingredients for analysis are HgO, K2SO4, H2SO4, NaOH-Na2S2O, H3BO3, HCl 0.02 N, 1N NaOH, iodine, distilled water, hexane, water destilate, buffer Na-acetate, α-galactosidase, dinitrosalicylic, amylose, ethanol , acetic acid, acetone, and other ingredients for analysis. The tools used are extruder machines, ovens, scales, sieves, pans, basins, filters, grater machines, stoves, pans, soxhlet, furnaces, analytical balance, filter paper, and
glassware for analysis.

2.3. Research methods

This study uses a Completely Randomized Design (CRD) with 3 replications. The study was conducted with the treatment of age of cassava harvest U1 (6 months), U2 (7 months), U3 (8 months), U4 (9 months), U5 (10 months), U6 (11 months), and U7 (12 months) . The data obtained were tested for homogeneity by Bartlet test and data addition by Tuckey test. The data was then analyzed by variance to obtain variance estimation errors and significance test between treatments. Furthermore, to find out the differences between treatments the data was tested further with the smallest real difference test (LSD) at 1% and 5% real levels.

2.4. Research Implementation

2.4.1. Raw Material Preparation

The raw material used is cassava meal with a harvesting age of 6, 7, 8, 9, 10, 11, and 12 months. Cassava is peeled, washed and grated with a grater. The grated cassava is then soaked in water (1: 3) for 12 hours then squeezed until it is obtained filtrate and cassava pulp. The filtrate is allowed to stand for 1 hour until the tapioca precipitate is obtained. The tapioca precipitate is then dried in an oven at a temperature of 60 ° C until the moisture content is <13% and ground into tapioca. Cassava pulp is also dried in the oven at 60oC until the moisture content is <13% and ground into cassava pulp. The process of making cassava and tapioca pulp can be seen in Figure 1.

2.4.1. Making Siger Rice

Siger rice is made by using 1: 4 cassava and tapioca pulp mixed with additional ingredients such as emulsifier. Siger rice mixture is then homogenized using a mixer. The mixture is then steamed in a pan for 30 minutes at 90 ° C. The dough is cooled for 1 hour and then printed using an extruder. The material enters the movement of the rollers to be forced out in a 2 x 6 mm elliptical hole equipped with cutting blades. The rice granules obtained are then aerated and then dried using an oven at a temperature of 60 ° C until 8% moisture content is obtained. The rice grain formed is then sorted. The process of making rice can be seen in Figure 2.

Siger rice obtained was analyzed by swelling power using the method of Leach et al. [12], as well as amylose and amylopectin levels using the method of Apriyanto [13]. Siger rice is then cooked into rice and the organoleptic properties of color and texture will be analyzed using a scoring test. Organoleptic properties in the form of taste, aroma, and overall acceptance were analyzed using hedonic tests. The best siger rice from the results of organoleptic test was then analyzed proximate using the AOAC method [14].

2.5. Observation

2.5.1. Characteristics of Siger Rice

2.5.1.1. Sensory Test

Sensor tests are performed to see the characteristics of siger rice after being cooked into rice on the texture, color, taste and aroma, and overall acceptance. Assessment of texture and color using a scoring test, while the taste and aroma and overall acceptance using hedonic tests [15]. Sensory testing was carried out by 20 semi-trained panelists. The sensory test scale can be seen in Table 1.

2.5.1.2. Swelling Power

The ability to expand rice is determined by the method of Leach et al. [12]. Samples of 0.1 g of siger rice which have been mashed are put into a test tube. The sample is then added 10 ml of distilled water and heated in a water bath at a temperature of 70ºC for 30 minutes while stirring continuously. The supernatant was separated from the solution by means of a test tube containing a centrifuged sample at a speed of 2500 rpm for 20 minutes and then decanted. The resulting paste is then taken and weighed

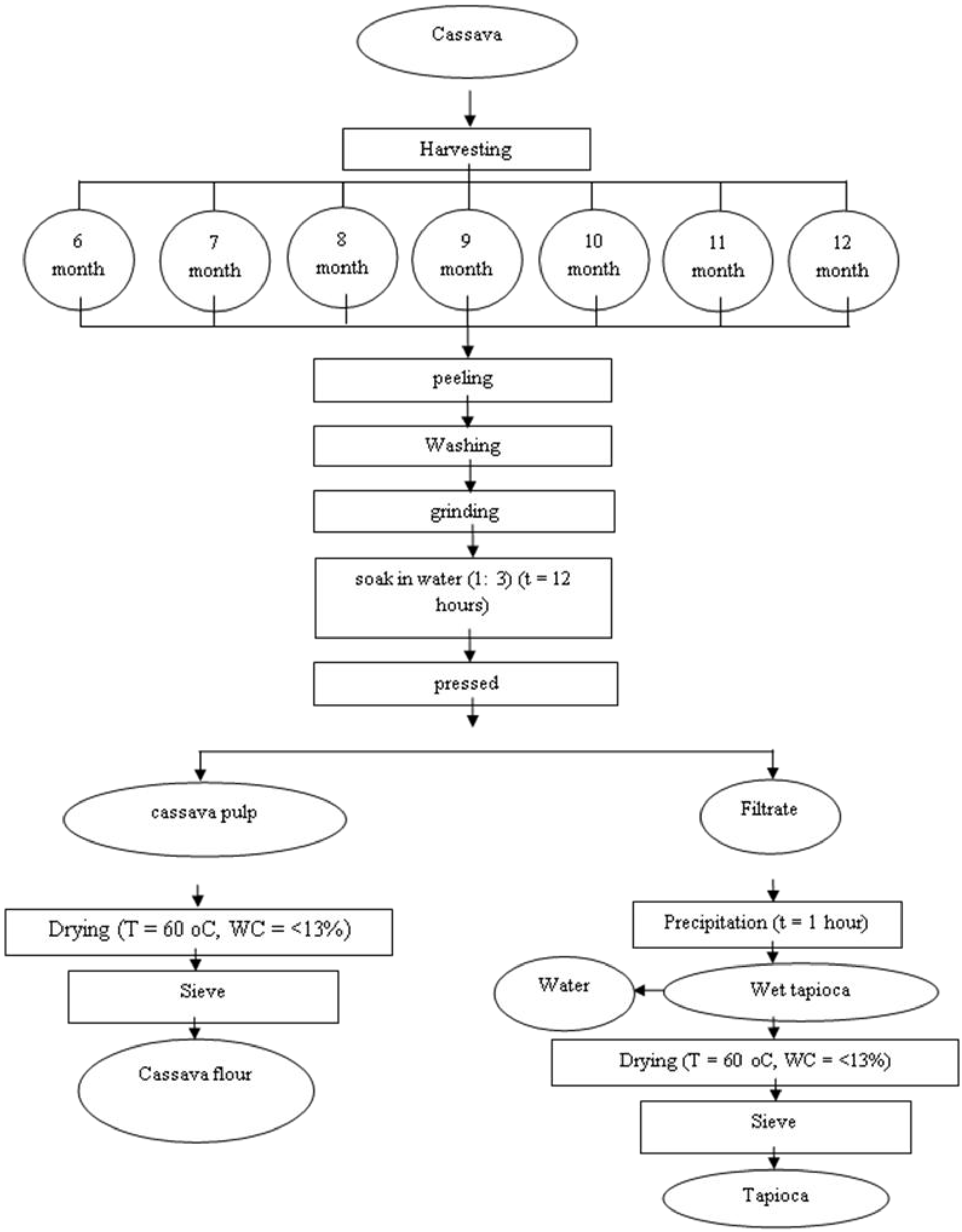

Figure 1. Making cassava and tapioca pulp [7]

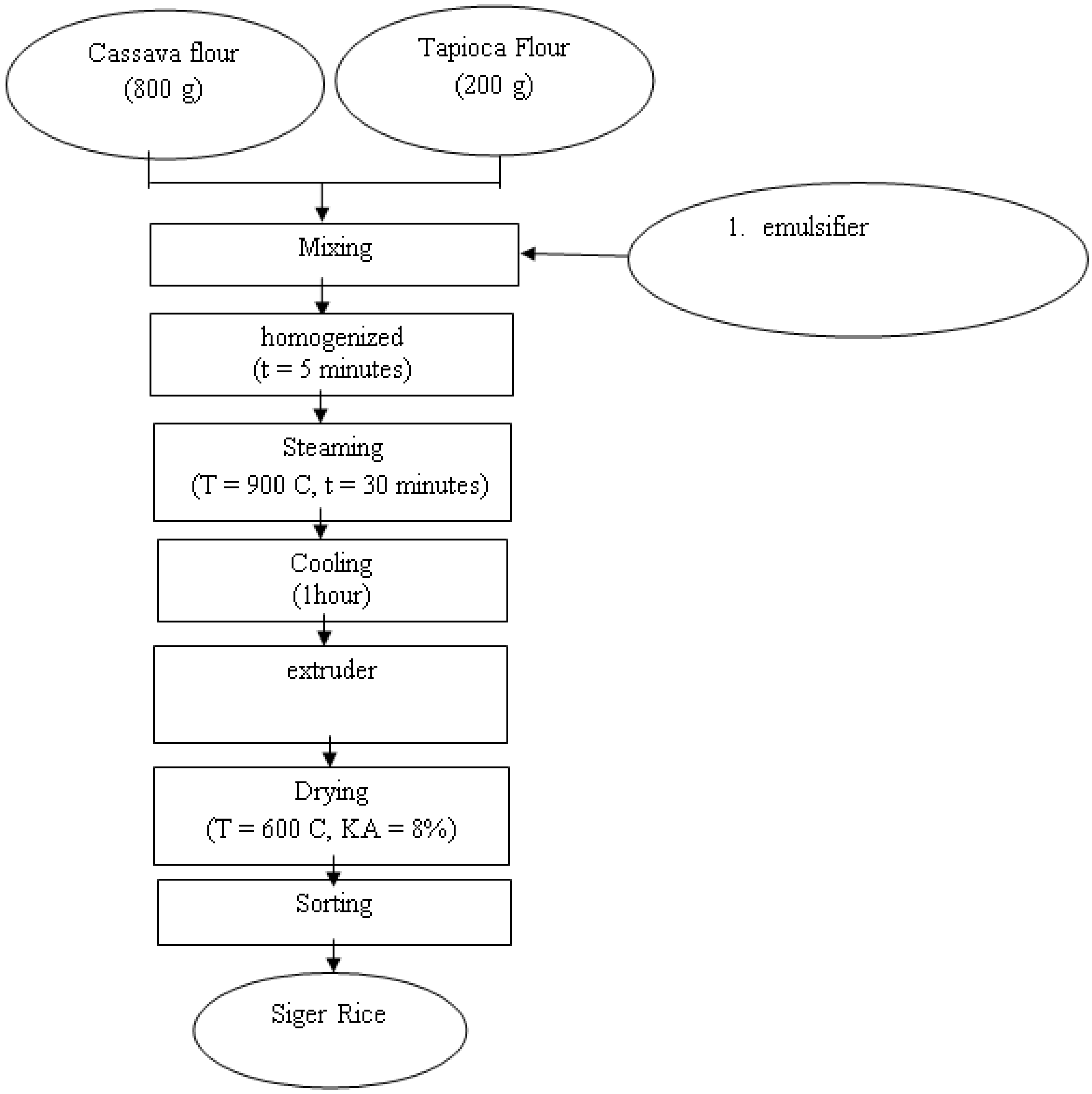

Figure 2. The process of making siger rice [7]

.

Table 1. Scale of sensory test

Parameter	Criteria	Score
Texture	Very chewy	5
	chewy	4
	Rather chewy	3
	Not chewy	2
	Very not chewy	1
Color	White	5
	Brownish white	4
	Rather yellowish white	3
	Brownish yellow	2
Taste and Aroma	Chocolate	1
	Really like	5
	Like it	4
	Rather like	3
Overall reception	Do not like	2
	Very dislike	1
	Really like	5
	Like it	4
	Rather like	3
	Do not like	2
	Very dislike	1

2.5.1.3. Amylose and Amylopectin levels
Amylose content is analyzed based on Apriyanto method [13]. The analysis begins with the manufacture of a standard amylose curve, which is 40 mg of pure amylose put into a test tube and then added 1 mL of absolute ethanol and 9 mL of 1M NaOH. The mixture was heated in boiling water (100ºC) for 10 minutes and then transferred to a 100 mL measuring flask. Gel is added with destilated water and homogenized, then held up to 100 mL using distilled water.

The solution obtained was taken with pipettes of 1, 2, 3, 4 and 5 ml, respectively, then put in a 100 mL measuring flask and acidified with acetic acid 1 N as much as 0.2, 0.4, 0.6, 0, 8, and 1.0 mL. Each measuring flask was added with 2 mL of Iod and distilled water until the tera mark. The solution was homogenized by hand until evenly distributed and left for 20 minutes, then its absorption was measured by UV Vis spectrophotometer at a wavelength of 620 nm. The results obtained are then made a relationship curve between amylose levels and its absorbance.

Amylose content measurement in the sample was carried out by as much as 1 mL absolute ethanol, 9 mL 1N NaOH solution and 100 g of sample were mixed and heated for 10 minutes on boiling water bath. After 5 mL of cold the sample was added 2 mL of 1 mL iodine solution and 1 N HCL and then treated with destilated water in a 100 mL flask, then left for 20 minutes. The absorbance is measured at a wavelength of 620 nm. Amylose content is calculated based on the standard curve equation obtained. Amylopectin levels are obtained by by difference, namely by reducing the value of 100% with amylose content or can be written with the following equation:

$$\text{Amylopectin (\%)} = 100\% - \text{amylose content (\%)}$$

3.5.2. Proximate Analysis of the Best Siger Rice
Water, ash, fat, protein, carbohydrate content testing using the oven method [14].

3. Results and Discussion

3.1. hardness

The results of variance analysis (Table 2) show that the difference in cassava harvest age has a very significant effect on the hardness of siger rice produced.

Table 2. Effect of cassava harvest age on siger rice hardness based on BNJ test level of 5%

Treatment	Hardness value (kg / (10x5 mm)
A1: Cassava 6 months	0.565[c]
A2: Cassava 7 months	0.573[c]
A3: Cassava 8 months	0.695[b]
A4: Cassava 9 months	0.728[b]
A5: Cassava 10 months	0.798[a]
A6: Cassava 11 months	0.795[a]
A7: Cassava 12 months	0.733[b]
BNJ (0.05) = 0.049	

Remarks: The numbers followed by the same letter show no significant difference in the 5% Honest Honest Difference Test (BNJ)

The value of the Siger rice hardness test that was tested with penetrometer ranged between 0.798 to 0.565. Siger rice made from cassava with a 10-month harvest is rice with the highest hardness value, which is 0.798. The lowest hardness value is in Siger rice which is made from cassava in the age of 6 months of harvest, which is 0.565. Siger rice hardness is related to starch retrogradation that occurs during the cooling process after heating (gelatinization). Starch gel if left idle for a while, there will be an expansion of the crystal area and result in shrinkage of the gel structure followed by the release of water from the gel and make the texture of the rice hard. Gel hardness is also influenced by the crystallinity of starch which depends on the amount of amylose and amylopectin in starch [8].

Based on Table 7, it can be seen that the results of BNJ further test of 5% level on rice siger hardness showed that cassava treatment at 6 months of harvest was significantly different from the cassava treatment of harvesting ages 8, 9, 10, 11, and 12 months. The cassava treatment at 10 months of harvest was significantly different from the cassava treatment at 6, 7, 8, 9, and 12 months.

Increased harvest age can increase the hardness of siger rice, but the highest level of hardness is found in cassava aged 10 months, and after that the violence of rice has decreased. This is due to the fact that in this study, cassava siger rice was harvested with the highest amylose content and in the cassava treatment at 11 months of harvest the amylose content of siger rice had decreased, so that the level of violence of Siger rice decreased, although the value of the violence was not different. real with rice siger from cassava aged 10 months harvest. The amylose component plays a major role in the retrogradation process which causes siger rice to harden after cold. In the retrogradation process, free amylose forms hydrogen bonds with fellow amylose and some branching of amylopectin extends from the swollen granule [16]. The grains of the starch incorporated into a kind of nets form microcrystals and settle [17]. Amylose has the ability to form crystals because of its simple polymer chain structure. This simple structure can form strong molecular interactions. The formation of hydrogen bonds is easier to occur in amylose than amylopectin [18].

3.2. Swelling Power

Swelling power shows the ability of starch to expand in water. High swelling power indicates the higher the ability of starch to expand in water [19]. Swelling power value of siger rice from various harvesting ages ranged between 11,076 - 14,350. The results of the analysis of variance showed that differences in the age of cassava harvest had a very significant effect on the swelling power value of Siger rice, so it was necessary to do further testing of BNJ at the level of 5% to determine the differences between treatments. The effect of cassava harvest age on the swelling power value of siger rice based on BNJ test level of 5% is presented in Table 3.

Table 3. Effect of cassava harvest age on rice siger texture based on BNJ test level of 5%

Treatment	Swelling power score
A1: Cassava 6 months	13.612^{abc}
A2: Cassava 7 months	13.791^{ab}
A3: Cassava 8 months	14.350^{a}
A4: Cassava 9 months	14.195^{ab}
A5: Cassava 10 months	12.767^{bcd}
A6: Cassava 11 months	12.339^{cd}
A7: Cassava 12 months	11.976^{d}
BNJ (0.05) = 1.502	

Note: The numbers followed by the same letter show no significant difference in the 5% Honest Honest Difference Test (BNJ)

BNJ test results of 5% level on swelling power value of siger rice at various harvesting ages showed a significant difference in the treatment of cassava aged 6 months of harvest with cassava aged 12 months of harvest. Swelling power of cassava treatment at 6 months of harvest was the same as cassava treatment at harvesting ages 7, 8, 9, 10, and 11. The treatment of cassava for 10 months of harvest was significantly different from cassava treatment at 8 months of harvest. Siger rice made from cassava 11 months of harvest has a swelling power value which is significantly different from siger rice from cassava with a harvesting age of 7, 8 and 9 months. Swelling power of cassava treatment at 12 months of harvest was the same as in cassava treatment at 10 and 11 months of harvest, but it was significantly different from the age treatment of cassava 6, 7, 8, and 9 months.

The highest swelling power value was found in cassava siger rice with 8 months of harvest, which was 14.350. The lowest swelling power value is found in cassava siger rice with 12 months of harvest, which is 11.976. The swelling power value of a starch-based material is based on the amylose and amylopectin content of the starch. Amylose and amylopectin ratios affect the value of swelling power. High amylose causes the amorphous region of starch to be higher and makes water easier to enter the granule [20]. Increased amylopectin will increase the strength of the crystalline structure and inhibit granular swelling [21]. Research by Charles et al. [22] showed an increase in swelling power and solubility with increasing amylose levels. In mung bean starch also reported an increase in amylose levels can increase the solubility and power of starch blooms [23].

4.3. Amylose

The results of the analysis of variance (Table 4) showed that the differences in the age of cassava harvest had a very significant effect on the levels of siger rice amylose, so it was necessary to conduct further testing of BNJ at the level of 5%. Based on the BNJ further test the 5% level of the amylose content of siger rice from cassava in various harvesting ages showed significant differences between treatments. The cassava treatment at harvesting ages of 6 and 7 months had amylose content significantly different from the cassava treatment at 8, 9, 10, 11 and 12 months. Siger rice from cassava at 8 months of harvest was the same as cassava treatment at 11 and 12 months of harvest, but it was significantly different from the cassava treatment of 6, 7, 9 and 10 months of harvest. The cassava treatment of harvesting ages 8 and 9 months was significantly different from the cassava treatment at harvesting ages of 6, 7, and 8 months. The cassava treatment of harvesting ages 11 and 12 months was significantly different from the cassava treatment at 6 and 7 months of harvest.

Table 4. Effect of cassava harvest age on amylose content of siger rice based on BNJ test level of 5%

Treatment	Amilosa
A1: Cassava 6 months	18.605[c]
A2: Cassava 7 months	19.171[c]
A3: Cassava 8 months	22.691[b]
A4: Cassava 9 months	25.219[a]
A5: Cassava 10 months	25.351[a]
A6: Cassava 11 months	24.132[ab]
A7: Cassava 12 months	23.698[ab]
BNJ (0.05) = 2.339	

Note: The numbers followed by the same letter show no significant difference in the 5% Honest Honest Difference Test (BNJ)

The highest amylose content obtained in siger rice is made from cassava in the 10 months of harvest, which is 25.351%. The lowest amylose content is found in siger rice which is made from cassava in the age of 6 months, which is 18.605%. The difference in age of cassava harvest will affect the amylose content in the tuber. Sriroth et al. [24] stated that the levels of amylose and starch in cassava will generally be lower in plants that are still in the growth phase (not ready for harvest). Susilawati et al. [11] stated that, the high levels of amylose in cassava at a certain harvest age was caused because at that age cassava had a high starch content. The starch is thought to have a longer α 1,4 D-glycoside chain compared to cassava at other harvesting ages. The longer the α 1,4 D-glycoside chain contained in the starch, the higher the amylose content contained in it [25].

In the growth phase the growing amylose molecule with a glucose unit having a C-4 reaction group at the end joins the C-1 glucose added from ADPG, while the branch on amylopectin between C-6 in the main chain and C-1 in the branch chain is formed by various isoenzymes of several enzymes which are concisely called branching enzymes or Q enzymes [26]. According to Thomas and Atwell [27], the formation of amylopectin occurs due to the cutting of the amylose chain which is then connected to the α-1.6 bond in one of the amylose chain D-glucose molecules. At the beginning of starch synthesis, amylose molecules have a longer chain and along with the age of the plant, the amylose chain will experience branching to form amylopectin so that the amylose content in starch will decrease.

Based on Table 4. it can be seen that increasing the age of cassava harvest can increase amylose levels in siger rice, but at the age of harvesting cassava that is too old can reduce levels of siger rice amylose. In the cassava treatment of 6 to 10 months of harvest, the amylose content of siger rice had increased respectively from the ages of 6.7.8.9, and 10 months at 18.605%, 19.171%, 22.691%, 25.691%, and 25.351%. In the cassava treatment at 11 months of harvest, the amylose content of siger rice decreased to 12 months of cassava treatment to 24,132% and 23,698%. Increased levels of amylose siger rice are influenced by amylose content in the raw material for making siger rice, namely cassava. This is supported by research by Susilawati et al. [11] stated that at 7 to 8 months of harvest, cassava has increased amylose levels, from 12.07% to 20.82%. At higher harvesting ages, ie 9 to 10 months of harvest, cassava has decreased amylose content to 20.26% and 18.03%.

4.4. Organoleptic Test

Organoleptic test for rice siger from cassava in various harvesting ages using scoring, hedonic and multiple comparison tests. Parameters observed by scoring method include color, while the parameters of aroma and taste, as well as overall acceptance of rice siger are tested by hedonic. Multiple comparison tests are used to determine the organoleptic value of texture parameters.

4.4.1. Texture

Siger rice texture is assessed based on the level of hardness of rice when chewed. Assessment of the texture of rice siger using the multiple comparison organoleptic test with reference samples (R) in the form of white rice from rice rice. The texture score obtained is 4.875 (worse than R) – 3.288 (equal to

R). The rating scale is based on rank, so the high value indicates that Siger rice has a worse quality than R. The results of the analysis of variance showed that differences in the age of cassava harvest gave a very significant effect on rice siger texture scores so that further testing of BNJ was needed with a 5% confidence interval. The effect of cassava harvest age on rice siger texture based on BNJ test at 5% level is presented in Table 5.

Table 5. Effect of cassava harvest age on rice siger texture based on BNJ test level of 5%

Treatment	Texture score
A1: Cassava 6 months	3.288[d]
A2: Cassava 7 months	3.363[cd]
A3: Cassava 8 months	3.438[cd]
A4: Cassava 9 months	3.913[bc]
A5: Cassava 10 months	4.088[b]
A6: Cassava 11 months	4.375[ab]
A7: Cassava 12 months	4.875[a]
BNJ (0,05) = 0,618	

Note: The numbers followed by the same letter show no significant difference in the 5% Honest Real Difference Test (BNJ). Texture score (1) Very better than R, (2) better than R, (3) equal to R, (4) worse than R, (5) very worse than R.

Table 5 presents the results of the BNJ texture score test at the 5% level which shows the real differences between treatments. Siger rice made from cassava with a 6-month harvest has a different texture score with rice siger made from cassava with a harvest age of 9, 10.11, and 12 months. The cassava treatment at harvesting ages of 7 and 8 months was not significantly different from the cassava treatment at 6 and 9 months of harvest. The cassava treatment at 9 months of harvest was not significantly different from the cassava treatment at harvesting ages of 7, 8, 10, and 11 months, but it was different from the cassava treatment at 6 and 12 months of harvest. Siger rice from cassava for 10 months of harvest had a texture score that was not significantly different from the cassava treatment at 9 and 11 months of harvest. Treatment of cassava at 11 months of harvest is the same as cassava treatment at 12 months of harvest.

The highest texture score is owned by cassava treatment at 12 months of harvest, which is 4,875 and is a worse score with criteria worse than R. The best score from the assessment of rice texture with criteria equals R is found in siger rice made from cassava harvesting age 6 month, which is 3.288. The difference in the results of panelists' assessment of the texture of Siger rice made from cassava of various ages is affected by the retrogradation process of Siger rice. Siger rice is cooked and undergoes gelatinization to Siger rice. After the gelatinization process, the cooled siger rice will undergo a process of retrogradation and cause the rice to turn hard due to amylose chains that re-bond. Amylose molecules will bind with each other and also with the amylopectin branch on the outer edges of the granule. These molecules connect the starch grains that were previously swollen during the gealtinization process. The grains of the starch incorporated into a kind of nets form microcrystals and settle [17].

Based on Table 10. it is known that the texture quality of Siger rice will be worse than the white rice of rice rice along with the age of cassava harvest. This occurs because cassava with a lower harvest age has a lower amylose content [24]. Amylose affects the retrogradation process of Siger rice. This is in accordance with the statement Noviasari et al. [28] that the amylose content contained in the raw material for making analog rice affects the nature of rice and rice produced, such as the level of crispness (texture) and functional properties. The higher the amylose content found in rice, the more rice it will produce with low pulses, and vice versa. The higher the composition of starch in analog rice, the higher the amylose content, and the more dry or hard texture of rice [29].

4.4.2. Color

Color is the first factor in human consideration in choosing food. A food with high nutrient content, good taste, and good texture, will likely not be chosen if it has an unattractive or distorted color. Organoleptic color test results showed a score ranging from 1.66 (brownish yellow) - 3.25 (yellowish white). The scale used is suspension so that the higher the value, the better the quality of the color of Siger rice.

The results of the variance analysis showed that the difference in the age of cassava harvest was significantly different for the Siger rice color score made from cassava, so that further BNJ testing was needed with a 5% confidence interval. The effect of cassava harvest age on rice siger color based on BNJ test level of 5% is presented in Table 6.

Table 6. The effect of cassava harvest age on rice siger color based on BNJ test level of 5%

Treatment	Colour score
A1: Cassava 6 months	3.400[a]
A2: Cassava 7 months	3.250[a]
A3: Cassava 8 months	3.325[a]
A4: Cassava 9 months	3.350[a]
A5: Cassava 10 months	2.713[b]
A6: Cassava 11 months	1.613[c]
A7: Cassava 12 months	1.663[c]
BNJ (0.05) = 0.360	

Note: The numbers followed by the same letter show no significant difference in the 5% Honest Real Difference Test (BNJ). Color score (1) brown, (2) brownish yellow, (3) yellowish white, (4) yellowish white, (5) white.

Based on the results of the BNJ 5% further test, it is known that the color of siger rice made from cassava at 6 months of harvest is not significantly different from the color of rice siger from cassava in the age of 7, 8 and 9 months, but it is significantly different from the harvested cassava. 10, 11 and 12 months. The treatment using cassava for 10 months of harvest was significantly different from all other treatments. The color of Siger rice made from cassava 11 months of harvest is not significantly different from rice siger from cassava with a 12-month harvest, but significantly different from rice siger from cassava with a harvesting age of 6, 7, 8, 9, and 10 months.

The highest color score in this study is owned by rice siger made from cassava with a 6-month harvest age, which is 3.400 and is the best score with yellowish white criteria. The lowest color score in this research is owned by nasi siger which is made from cassava 11 months of harvest, which is 1.613 and is the worst score with the criteria of brownish yellow. The color of siger rice is influenced by the raw material of siger rice. Siger rice is made from yellow cassava flour and tapioca which tends to be white. This color is produced because the results of the process of drying the material into flour [30]. Siger rice also undergoes a heating process in order to experience gelatinization into Siger rice. High heating temperature has an impact on the brightness level of Siger rice [31].

Based on Table 6, the increase in the age of harvesting cassava makes the siger product color score decreases. This is influenced by the starch content in the material. These chemical components can cause changes in color in the material due to reaction with oxygen and water vapor [31]. Increasing the age of cassava harvest causes an increase in starch levels [10]. High starch levels increase carbohydrate content. Siger rice which contains high carbohydrates will experience discoloration during heating due to browning reactions. The browning reaction that occurs is a non-enzymatic Mailard reaction that involves reducing sugars with amines from amino acids or proteins. Amino acids which are the main constituent of peptides and proteins will react with reducing sugars which contain aldehyde and ketone groups, resulting in a brown color [31].

4.4.3. Taste and Aroma

Taste and aroma are one of the parameters in determining the quality of a food product. The taste and aroma of food can be felt by the human senses in the sense of smell and taste senses (tongue). The organoleptic score of the taste and aroma of Siger rice ranged from 1.613 (not like) – 3.400 (rather like) with the assessment criteria very like to very dislike.

The results of variance analysis showed that the difference in cassava harvesting age was significantly different from the flavor and aroma score of siger rice made from cassava, so that further BNJ testing was needed with a 5% confidence interval. The effect of cassava harvest age on the taste and aroma of rice siger based on BNJ test level of 5% is presented in Table 7.

Table 7. Effect of cassava harvesting age on the taste and aroma of Siger rice based on BNJ further test at 5% level

Treatment	Aroma and taste Scores
A1: Cassava 6 months	3.085^{a}
A2: Cassava 7 months	2.800^{ab}
A3: Cassava 8 months	2.675^{bc}
A4: Cassava 9 months	2.508^{bc}
A5: Cassava 10 months	2.400^{cd}
A6: Cassava 11 months	2.163^{d}
A7: Cassava 12 months	1.810^{e}
BNJ (0.05) = 0.294	

Notes: The numbers followed by the same letter show no significant difference in the 5% Honest Real Difference Test (BNJ). Taste and aroma scores (1) very dislike, (2) dislike, (3) rather like, (4) likes, (5) really like.

BNJ further test results at 5% level on the taste and aroma of siger rice in Table 12. shows that rice siger from cassava aged 6 months is not significantly different from the cassava treatment at 7 months old, but significantly different from the cassava plant age of harvest 8, 9, 10, 11 and 12 months. The level of panelists' preference for the taste and aroma of cassava rice treated with cassava at the age of 7 months was the same as that of cassava rice with cassava age of 8 and 9 months of harvest. The cassava treatment of harvesting ages 8 and 9 months was significantly different from the cassava treatment of harvesting ages 6, 11, and 12 months. The cassava treatment at 10 months of harvest had the same taste and aroma score as the cassava treatment at 8, 9 and 10 months of harvest. The taste and aroma score of the panelist's preference for cassava treatment at 12 months of harvest was significantly different from all treatments.

The highest flavor and aroma score in this study was obtained in cassava treatment at 6 months of harvest, which was 3.085 and was the best score with the criteria rather like. The lowest taste and aroma score in this study was obtained in cassava treatment at 12 months of harvest, which was 1,810 and was the worst score with criteria of dislike. The taste and aroma of Siger rice depends on the ingredients of the product. Siger rice is a product made from a mixture of cassava flour and cassava pulp that has a distinctive taste and aroma. The taste and aroma of cassava can be influenced by the content of volatile compounds in cassava. The specific aroma of rice siger made from cassava and tapioca pulp and other additives such as emulsifire and glycerol can occur due to oxidation or due to Mailard reaction during the process of making rice. Oxidation can occur against lipids and proteins in the ingredients [32]. The Mailard reaction occurs from the reaction of reduced sugar carbonyl groups with amino acid (amino groups) formed from nitrogen substituted by glycosylamine or fructosylamine [33]. This reaction will produce scented volatile compounds such as furan, pyridine, and pyrazine [34]. These compounds are the cause of the distinctive aroma of siger rice which is less preferred by consumers.

Based on Table 7 Increasing age of cassava harvest makes the taste and aroma score of siger rice products lower. This is influenced by the content of chemical components in the material. Harvest age differences affect the nutritional content of tubers [35]. Nutrient content such as carbohydrate, protein and fat content in cassava can increase or decrease depending on variety, harvest age, climate, and soil fertility [36]. In the growth phase (not ready for harvest), generally some of the plant's nutrient content is lower than plants that are ready for harvest [24]. The higher carbohydrate, protein and fat content in cassava in a certain harvest age can affect the volatile formation reaction in the tubers, so that their distinctive taste and aroma are stronger and it turns out that the taste is less preferred by consumers.

4.4.4. Overall acceptance

Analysis of variance results shows that the difference in age of cassava harvest has a very significant effect on the overall score of siger rice, so it is necessary to do further testing of BNJ with a 5% confidence interval. The effect of cassava harvest age on the overall acceptance of siger rice based on BNJ test level of 5% is presented in Table 8.

Table 8. Effect of cassava harvest age on overall acceptance of siger rice based on BNJ test level of 5%

Treatment	Score for overall acceptance
A1: Cassava 6 months	3.200^{a}
A2: Cassava 7 months	3.050^{ab}
A3: Cassava 8 months	2.900^{ab}
A4: Cassava 9 months	2.588^{bc}
A5: Cassava 10 months	2.513^{bcd}
A6: Cassava 11 months	2.063^{cd}
A7: Cassava 12 months	1.950^{d}
BNJ (0.05) = 0.567	

Notes: The numbers followed by the same letter show no significant difference in the 5% Honest Real Difference Test (BNJ). Overall acceptance scores (1) very dislike, (2) dislike, (3) rather like, (4) likes, (5) really like.

The results of the BNJ further test of the 5% level presented in Table 8 show that Siger rice made from cassava for 6 months of harvest did not differ significantly from the overall acceptance score with cassava age of 7 and 8 years old. The cassava treatment of harvesting ages 7 and 8 months was different from the cassava treatment of harvesting ages 9, 10, 11, and 12 months. The cassava treatment at 9 months of harvest was significantly different from the cassava treatment at 6 and 12 years of harvest, but the same as the cassava treatment at 7, 8, 10 and 11 months of harvest. The cassava treatment at 10 months of harvest was significantly different from the cassava treatment at the age of 6 months. Cassava treatment at 12 months of harvest has the same acceptance score as cassava treatment at 10 and 11 months of harvest.

The highest score was found in cassava treatment at 6 months of harvest, namely 3.200 with the category of rather like and the best score. The lowest score was found in cassava treatment at 12 months of harvest, which is 1.950 with the category of dislike and the worst score. The overall acceptance of the product is influenced by the organoleptic properties of other parameters. The panelist will assess the product as a whole. The results of the assessment of all organoleptic parameters in this study did show the best results in the treatment of cassava aged 6 months of harvest.

Based on Table 8, it is known that increasing the age of cassava causes the overall acceptance score to decrease. This is due to changes in other sensory parameters, such as color, taste and aroma, and texture. The longer the age of harvesting cassava, the raw material for making siger rice will also change its characteristics, such as the color of siger rice which is more brown when made from cassava with a higher harvest age. Cassava with an older harvest age tends to have a higher chemical content, so the reaction caused by the component is also getting bigger. Mailard reaction is a reaction that can affect the color, taste and aroma, and the texture of cooked siger rice [32].

4.5. Selection of the Best Treatment

This study aims to get the highest quality siger rice that consumers like. Determination of the best treatment from this study focused more on the results of organoleptic tests on the parameters of texture, color, taste and aroma, and overall acceptance. The determination is based on the assumption that if the panelist has liked a particular product because of its organoleptic properties, then the product can be well received by other consumers.

The best texture parameters are determined based on the lowest value of the treatment. The result of organoleptic texture showed that the best texture of Siger rice is Siger rice made from cassava with a 6-month harvest. The treatment produces a texture value of 3.288 with the same texture criteria as the reference (R). The reference used in the organoleptic test of this texture is white rice from rice rice. Color, taste and aroma parameters, and overall acceptance are best determined based on the highest value of each parameter. Organoleptic test results of the best color of Siger rice are on cassava treatment aged 6 months of harvest with 3,400 color criteria yellowish white. The results of organoleptic taste and aroma, as well as overall acceptance were best found in cassava treatment at 6 months of harvest with a flavor and aroma score of 3.085 with a rather favorable criteria, and an overall acceptance score of 3.200 with somewhat like criteria. Organoleptic test results showed that Siger rice made from cassava aged 6 months was siger rice which was the most preferred and accepted by panelists. The results of the recapitulation of the results of organoleptic test of rice siger from cassava in various harvesting ages are presented in Table 9.

Table 9. Recapitulation of organoleptic test results of Siger rice

Results	Harvest Age Treatment						
Observation	A1	A2	A3	A4	A5	A6	A7
Texture	**3.288d***	3.363cd	3.438cd	3.913bc	4.088b	4.375ab	4.875a
Color	**3.400a***	3.250a	3.325a	3.350a	2.713b	1.613c	1.663c
Taste and aroma	**3.085a***	2.675bc	2.800ab	2.508bc	2.400cd	2.163d	1.810e
Overall acceptance	**3.200a***	3.050ab	2.900ab	2.588bc	2.513bcd	2.063cd	1.950d

Notes: (*) The best treatment for these parameters, (A1) cassava with 6 months of harvest, (A2) cassava with 7 months of harvest, (A3) cassava with 8 months of harvest, (A4) Cassava with 9 months of harvest, (A5) Cassava is 10 months old, (A6) Cassava is 11 months old, (A7) Cassava is 12 months old.

4.6. Proximate analysis

Proximate analysis was carried out on the best treatment siger rice made from cassava with a 6-month harvest yielding nutrient content which can be seen in Table 10. Proximate analysis carried out included water content, ash content, fat content, protein content, crude fiber content, and carbohydrate levels.

Water is an important component in food that can affect the quality of materials, especially the durability of the product. Siger rice made from cassava pulp powder for 6 months of harvest has a water content of 10.8010%. The water content of siger rice still meets the standard specifications for rice quality requirements based on SNI 6128-2015, ie rice water content is less than 14%. Siger rice made from cassava pulp flour in the 6 months of harvest has ash content of 0.2346%. Ash content is closely related to the mineral content of a substance [37]. However, ash content is not always equivalent to all the mineral content available in the material, because there are some minerals that are lost during combustion and evaporation.

Table 10. Results of proximate analysis of the best treatment siger rice

Parameters	Content(%)
Water content	10.80 10
Ash	0.2346
Protein	1.2190
Fat	0.8787
Fiber	1.1764
Carbohydrate	85.6903

Siger rice made from cassava with a 6-month harvest has protein content of 1.2190%, fat content of 0.8787, crude fiber content of 1.1764%, and carbohydrate content of siger rice at 85.6903%. These results indicate that the value is not much different from the results of previous studies on the proximate content of siger rice added with ascorbic acid. Protein content, fat content and levels as well as coarse obtained greater value respectively were 3.82%, 2.42%, and 1.13%. Meanwhile, the previous carbohydrate research content is much smaller, namely 81.11% [7]. The difference in the results of this test can be caused by the type of cassava as a material for making different siger rice.

4. Conclusions

The difference in age of cassava harvest affects the quality of siger rice. Siger rice made from cassava 6 months of harvest produces the best quality with the same texture characteristics as white rice, yellowish white color, 10.80% moisture content, 0.23% ash content, 1.22% protein content, 0.88% fat content, 1.18% crude fiber content, and 85.69% carbohydrate content.

References

[1] Badan Pusat Statistik. 2017. *Rata-Rata Konsumsi Per Kapita Seminggu Beberapa Macam Bahan Makanan Penting di Indonesia (2011-2015)*. Badan Pusat Statistik Indonesia. Jakarta.

[2] Badan Pusat Statistik. 2016. *Tingkat Produksi Ubi Kayu Lampung*. Badan Pusat Statistik Provinsi Lampung. Bandar Lampung.

[3] Kementerian Pertanian. 2016. *Outlook Komoditas Pertanian Sub Sektor Tanaman Pangan : Ubi Kayu*. Pusat Data dan Sistem Informasi Pertanian. Kementerian Pertanian. Jakarta.

[4] Halim. 2012. Beras Siger, Nasi atau Singkong?. http://www.polinela.ac.id/. Acessed on 1 Desember 2017.

[5] Subeki, T.P. Utomo, dan Muhartono. 2015. Penggunaan beras siger dari ubi kayu sebagai makanan pokok penderita diabetes di Indonesia. (Laporan Penelitian Hibah Bersaing Tahun Pertama). LPPM Universitas Lampung. Bandar Lampung.

[6] Subeki, T.P. Utomo, dan Muhartono. 2016. Effect of siger rice from cassava on blood glucose level and the pancreas in mice induced alloxan. The Usr International Seminar on Food Security (UISFS). Bandar Lampung.

[7] Saptomi, A. 2017. Kajian Penggunaan Asam Askorbat dan Lama Pengukusan terhadap Kualitas Beras Siger dari Ubi Kayu. (Skripsi). Jurusan Parto, S.T. 1985. Penilaian Organoleptik. Bharata Karya Aksara. Jakarta.

[8] Amin, N.A. 2013. Pengaruh Suhu Fosforilasi terhadap Sifat Fisiko Kimia Pati Tapioka Termodifikasi.(Skripsi). Program Studi Ilmu dan Teknologi Pangan. Universitas Hasanudin. Makassar.

[9] Kartasapoetra, A.G. 1994. *Teknologi Penanganan Pasca Panen*. Rineka Cipta. Jakarta.

[10] Nurdjanah, S., Susilawati, dan M.R. Sabatini. 2008. Prediksi Kadar Pati Ubi Kayu (*Manihot Esculenta*) pada Berbagai Umur Panen Menggunakan Penetrometer. *Jurnal Teknologi dan Industri Hasil Pertanian.*12(2):65-73.

[11] Susilawati, S. Nurdjanah, dan S. Putri.2008. Karakteristik Sifat Fisik Dan Kimia Ubi Kayu (*Manihot Esculenta*) Berdasarkan Lokasi Penanaman dan Umur Panen Berbeda. *Jurnal Teknologi Industri dan Hasil Pertanian*. 13(2):59-72.
[12] Leach H.W., L.D. Cowen, dan T.J. Schoch. 1959. Structure of The Starch Granules in Swelling and Sollubility Pattern of Various Starch. *Cereal Chem*. 36 : 534-544
[13] Apriyanto, A. 1989. Analisis Pangan. IPB Press. Bogor.
[14] AOAC (Association of Official Analytical Chemist). 2005. *Official Methods of Analysis Association of Official Analytical Chemists*. Chemist Inc. New York.
[15] Soekarto, S. T. (1985). *Penilaian organoleptik: untuk industri pangan dan hasil pertanian*. Bhratara Karya Aksara, Jakarta.
[16] Syamsir, E., Hariyadi, P., Fardiaz, D., Andarwulan, N., & Kusnandar, F. (2012). Pengaruh proses heat-moisture treatment (HMT) terhadap karakteristik fisikokimia pati [Effect of Heat-Moisture Treatment (HMT) Process on Physicochemical Characteristics of Starch]. *Jurnal Teknologi dan Industri Pangan*, *23*(1), 100.
[17] Winarno, F.G. 2002. *Kimia Pangan dan Gizi*. PT. Gramedia. Jakarta.
[18] Taggart, P. 2004. *Starch as an Ingredients : Manufacture and Applications. di dalam: Ann Charlotte Eliasson (ed). Starch in Food: Structure, Function, and Application.* CRC Press. Baco Raton. Florida.
[19] Suriani, A.I. (2008). Mempelajari Pengaruh Pemanasan dan Pendinginan Berulang terhadap Karakteristik Sifat Fisik dan Fungsional Pati Garut (Marantha Arundinacea) Termodifi kasi. Skripsi. Fakultas Teknologi Pertanian. Institut Pertanian Bogor, Bogor.
[20] Singh, N., Singh, J., Kaur, L., Sodhi, N. S., & Gill, B. S. (2003). Morphological, thermal and rheological properties of starches from different botanical sources. *Food chemistry*, *81*(2), 219-231.
[21] Chung, H.J., Liu, Q., Lee, L. and Wei, D., 2011. Relationship between the structure, physicochemical properties and in vitro digestibility of rice starches with different amylose contents. *Food Hydrocolloids*, *25*(5), pp.968-975.
[22] Charles, A.L., Chang, Y.H., Ko, W.C., Sriroth, K. and Huang, T.C., 2005. Influence of amylopectin structure and amylose content on the gelling properties of five cultivars of cassava starches. *Journal of agricultural and food chemistry*, *53*(7), pp.2717-2725.
[23] Abdel-Rahman, E.S.A., El-Fishawy, F.A., El-Geddawy, M.A., Kurz, T. and El-Rify, M.N., 2008. Isolation and physico-chemical characterization of mung bean starches. *International journal of food engineering*, *4*(1).
[24] Sriroth, K., Piyachomkwan, K., Santisopasri, V. and Oates, C.G., 2001. Environmental conditions during root development: Drought constraint on cassava starch quality. *Euphytica*, *120*(1), pp.95-102.
[25] Vandeputte, G.E., Vermeylen, R., Geeroms, J. and Delcour, J.A., 2003. Rice starches. I. Structural aspects provide insight into crystallinity characteristics and gelatinisation behaviour of granular starch. *Journal of Cereal Science*, *38*(1), pp.43-52.
[26] Lakitan, B. 2004. Dasar-Dasar Fisiologi tumbuhan. PT. Raja Gravindo Persada: Jakarta
[27] Thomas, D.J., W.A. Atwell. 1992. *Starches*. Eagen Press. St. Paul, Minnesota, USA.
[28] Noviasari, S., Kusnandar, F. and Budijanto, S., 2013. Pengembangan beras analog dengan memanfaatkan jagung putih [Development of White Corn-Based Rice Analogues]. *Jurnal Teknologi dan Industri Pangan*, *24*(2), p.194.
[29] Handayani NA, Cahyono H, Arum W, Sumantri I, Purwanto, Soetrisnanto D. (2017). Study characteristics of analog rice made from purple sweet potato (Ipomea batatasi) flour and starch. Jurnal Aplikasi Teknologi Pangan. 6(1), 12-19. Available Online: http://jatp.ift.or.id/index.php/jatp/article/view/210
[30] Rachmawati, R. 2010. Pengaruh Penambahan Tepung Jagung pada Pembuatan Tiwul Instan terhadap Daya Kembang dan Sifat Organoleptik. Universitas Muhammadiyah Malang. Malang. http://digilib.unimus.ac.id/.

[31] Kusnandar, F. 2011. *Kimia Pangan Komponen Makro*. PT. Dian Rakyat. Jakarta.
[32] Raharjo, S. 2006. Kerusakan Oksidatif pada Makanan. Gadjah Mada University Press. Yogyakarta.
[33] Belitz, H.D. and W.Grosch. 2009. Food Chemistry. Second Edition. Springer Berlin. Berlin.
[34] Friedman, M. (1996). Food browning and its prevention: an overview. Journal Agricultural and Food Chemistry, Vol.44, No.3, January, pp. 631-653.
[35] Felina, F., A.H. Laenggeng, dan F. Dhafir. 2014. Kandungan Gizi Dua Jenis Singkong (Manihot esculenta) Berdasarkan Umur Panen di Desa Siney Kecamatan Tinombo Selatan Kabupaten Parigi Moutung. Jurnal e- Jipbiol. 2: 1-14
[36] Nugraha, H, D, Suryanto, A, Nugroho, A. 2015. Kajian potensi produktivitas ubikayu (Manihot esculenta Crant.) di kabupaten pati. Jurnal Produksi Tanaman. 3(8):673-68
[37] Sudarmadji, S.; B. Haryono dan Suhardi. 1997. Prosedur Analisa Untuk Bahan Makanan dan Pertanian Edisi Keempat. Liberty. Yogyakarta.