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# Physicochemical and organoleptic properties of gebang (*Corypha utan*) starch-based analogous rice with dolichos bean (*Lablab purpureus*) flour supplementation

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**Abstract.** *Lalel HJD, Mahayasa INW, Mukkun L, Abidin Z, Ata ARB. 2022. Physicochemical and organoleptic properties of gebang (*Corypha utan*) starch-based analogous rice with dolichos bean (*Lablab purpureus*) flour supplementation. Intl J Trop Drylands 6: 45-49.* This study underpins the physicochemical and organoleptic properties of analogous rice made from gebang (*Corypha utan* Lamk) starch (GS) in combination with dolichos bean (*Lablab purpureus* L.) flour (DB). There are five combinations of the flours, i.e., (A) 100% GS, (B) 95% GS + 5% DB, (C) 90% GS + 10% DB, (D) 85% GS +15% DB, and (E) 80% GS + 20% DB. The rice was processed using an extruder. The results showed that GB supplementation increased the content of protein as well as the total ash of the analogous rice. Most of the rice has a yellowish-brown to brown color. The rice thickness ranged from 2.6 mm to 4.3 mm, while the rice length ranged from 6.5 mm to 7.0 mm. The rice's length-to-thickness ratio ranged from 1.64 to 2.47. The weight of 1000 kernels of analogous rice ranged from 17.34 g to 34.17 g, whereas the bulk density ranged from 0.46 to 0.50 g/mL. The kernels of analogous rice A, C, D, and E mostly (52-70%) had 2.4-3.3 mm thick, while 88% of Analogous rice B had 3.4-4.7 mm thick. Cooking could double the size (volume) of all analogous rice. The organoleptic test of the analogous rice gave a positive response for all products in the range of more than 4.8 to 5.5 scores (like) for the overall response of hedonic value.

**Keywords:** Analogous rice, dolichos bean, gebang starch, organoleptic, physicochemical

## INTRODUCTION

During the last few years, Indonesia has had to import rice every year due to the increase in its demand because of insufficient domestic rice production. In addition, rice import tends to increase due to the increase in the Indonesian population. For example, in 2020, Indonesia imported the rice 214,380 tons of, or equal to 107.61 million US Dollars, mostly from Pakistan, while in 2021 (January to September), it reached 252,367 tons, or equal to 120.56 million US Dollars (Badan Pusat Statistik 2021). Its dependency of Indonesia on the import of rice leads to the low food security of the country. Therefore, some efforts are being intensively carried out to overcome this problem. One of the efforts is to find other potential sources of food that are locally available.

Gebang (*Corypha utan* Lamk) is a kind of palm tree wildly grown in most regions of Indonesia with a wide range of soil types. Gebang can grow well from 0 to 1000 m above sea level (Partomiharjo and Naiola 2009). In Kupang District, the population of gebang is mostly found in East Kupang Sub-district, with a total of about 2000 mature trees (Naiola 2008; Eagleton 2016; Lalel and Kaho 2018). The stem of mature trees aged 20 years or more have a pit rich in starch. One tree can produce about 281 kg of dry starch on average (23% of the yield), with the composition of amylose and amylopectin being 24.4% and 75.6%, respectively, which is almost similar to sago starch (Lalel et al. 2018).

Gebang starch has traditionally been used by Timorese and other local communities in Eastern Indonesia for making local food such as 'akabilan,' a kind of unfermented thin bread, and 'akasone,' a kind of dry grits. However, the use of gebang starch as a food source is sometimes negatively reported by mass media as a condition of poor economic condition, especially for those who consume these traditional foods. This negative perception arises because the pit of the gebang is also usually used as feed for pigs and remanence animals. As a raw food material, gebang starch has been used for noodles and cake products (Yamamoto et al. 2015; Lobo et al. 2017). It also has the potency to be used as the main raw material for analogous rice. The analogous rice may help fulfill the demand for rice in Indonesia, especially for people living in East Nusa Tenggara Province. It may also help increase people's appreciation of gebang starch and its potency as a food material.

Analogous rice, also known as artificial rice, is mechanically produced using starch other than rice flour with a size and shape similar to rice grain (Adelina et al. 2019). It is, therefore, possible to be fortified with other nutrient resources to increase the nutrient value of the rice. One of the important nutrients is the protein that may be acquired from other food resources, such as the seed of legumes, including the dolichos bean (*Lablab purpureus* L.). Many research works have been reported on combining starch and protein resource flours in producing analogous rice (Fitriyanto and Putra 2013; Franciska et al. 2015;

Adelina et al. 2019). It has been reported that the average production potency of the dolichos bean is 100 to 120 quintals of green pods per hectare (My Agriculture Information Bank 2018). The protein content of the dolichos bean varies from 22.4% to 31.3% (Deka and Sarkar 1990). Dolichos bean is well known and grown in Timor Island, and hence it has the potential to be used in making gebang starch-based analogous rice in this region.

Research on combining gebang starch (GS) and dolichos bean flour (DB) in making analogous rice has not been reported yet. Therefore, it is important to know the physicochemical and organoleptic properties of the analogous rice resulting from the combination of gebang starch and dolichos bean flour.

## MATERIALS AND METHODS

### Materials

Gebang starch was extracted from the pit of the gebang stem according to the wet method described by Lalel et al. (2018). The gebang pit was obtained from the Kupang District, East Nusa Tenggara Province of Indonesia. Dolichos bean flour was prepared from local dolichos beans purchased from the local market in Kupang City. Chemicals for analyses were purchased from several chemical providers, including Sigma-Aldrich company.

### Procedures

Starch extraction was done with several steps, as briefly described next. First, the gebang pit was cut into small pieces about 5 cm long and 2 cm thick. Next, the loave of the pit was added with water at the proportion of 1:1, then crushed with a chopper machine and mixed to get a watery dough. Then, the watery dough was put on double cloth filters to pass the starch solution. Furthermore, the solution was kept for about 30 minutes to let the starch be decantated. Finally, the supernatant was poured out, and the starch was sundried for about six hours. The starch was then ready to be used for making analogous rice.

The analogous rice was prepared in five combinations of gebang starch and dolichos bean flour by using an extruder. The combinations of gebang starch (gs) and dolichos bean flour (DB) studied were A (100% GS), B (95% GS + 5% DB), C (90% GS + 10% DB), D (85% GS + 15% DB), and E (80% GS + 20% DB). Each combination was added with water (900 mL per 2.5 kg of composite flour) and glycerol monostearate (2%) to get a dough. The dough was then fed into the extruder (Berto Industries) with the cutter, auger, and screw speeds being 50.1 Hz, 30.5 Hz, and 35.1 Hz, respectively. The temperature of the extruder was set at 90ºC. Extrudes were dried in an oven at 60 ºC for about 1 hour.

The analogous rice was analyzed for its chemical properties (water, protein, lipid, carbohydrate, and ash) by proximate analyzes according to AOAC (1984). Water content was measured using the thermogravimetric technique; protein content was estimated using the micro-Kjeldahl apparatus; lipid content was measured using a reflux system; ash content was obtained by weighing the ash of the analogous rice after heating them in a furnace at the temperature above 500°C, and the carbohydrate was calculated using the by different consideration. Furthermore, the physical properties of analogous rice recorded were color, size similarity (IRRI 1980), bulkiness (Singh et al. 2012), and expanding volume after cooking (Singh et al. 2012). The rice's color and whiteness were recorded using a Samsung digital camera (16 megapixels) fitted with constant light (2800 lx). The camera was equipped with On Color Measure software (Potatotreesoft Company) to record real-time RGB value, HSV value, Hex code, and HTML color name. RGB values were. The RGB values were then converted to CIE Lab values using Colormine software (Colormine.org). For the organoleptic test, the preference of 20 trained panelists on color, aroma, texture, and overall response to the analogous rice was recorded with 9 hedonic scores starting from extremely dislike (1) to extremely like (9) (Lim 2011).

### Data analysis

Chemical and physical data were duplicated and presented on average, while organoleptic data were statistically analyzed (Analysis of variance followed by Duncan's multiple rank test at P $\alpha$=0.05) using SPSS version 20.

## RESULTS AND DISCUSSION

### Chemical properties (proximate content)

The result of proximate analyses of analogous rice (Table 1) shows that the water content of all analogous rice was less than 10% (in the range of 5.47 to 9.05%), which meets the Indonesia Standard for Rice (maximum 14%; BSN 2008), which was dry enough to be stored. That means the rice can be safely kept for some months in dry and clean storage with a low risk of microbial deterioration. The protein content of the analogous rice was slightly lower than that of most natural rice (6.7-7.6%), as reported by Muttagi and Ravindra (2020). However, the increase of dolichos bean flour supplementation contributed to the increase of protein in the analogous rice of up to 4.7% at 20% of dolichos bean flour supplementation. This trend indicates that there is a possibility to increase the content of protein in the rice by adding more dolichos flour. The lipid content was also lower than that of natural rice (0.6-7.6%), as reported by Muttagi and Ravindra (2020). The high lipid content may decrease rice storability due to a high rancidity rate, which may easily occur. Table 1 also clearly shows that carbohydrate is the major content of the analogous rice, ranging from 85.89 to 90.26%, which may ensure it is an energy resource for consumers.

**Table 1**. Proximate content of the analogous rice

| No | Product | Formulas (%GS+%DB) | Water (%) | Protein (%) | Lipid (%) | Ash (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|---|
| 1 | Rice A | 100 + 0 | 9.05±0.21 | 2.18±0.09 | 0.14±0.07 | 0.75±0.11 | 87.88±1.02 |
| 2 | Rice B | 95 + 5 | 5.47±0.77 | 3.29±0.11 | 0.12±0.05 | 0.86±0.0.09 | 90.26±1.57 |
| 3 | Rice C | 90 + 10 | 7.00±0.42 | 3.87±0.16 | 0.12±0.08 | 0.92±0.07 | 88.09±0.67 |
| 4 | Rice D | 85 + 15 | 7.08±0.51 | 4.11±0.08 | 0.13±0.10 | 1.11±0.12 | 87.57±1.14 |
| 5 | Rice E | 80 + 20 | 8.00±0.79 | 4.7±0.14 | 0.14±0.07 | 1.27±0.13 | 85.89±1.03 |

Based on the chemical properties of the analogous rice, it can be noticed that the nutrition of the rice can still be improved by adding more dolichos bean flour or other food resource flour. Furthermore, adding dolichos flour itself might also improve some micronutrients (especially minerals), as indicated by the increased ash content (total minerals). Ademola and Abioye (2017) reported that the dolichos bean is rich in potassium, phosphor, calcium, magnesium, zinc, and iron. Therefore, the rice could be designed to fulfill the need for these important minerals for people in the East Nusa Tenggara Province, which is still dealing with insufficiency of some important minerals that cause stunting for the children. Recently, some studies have been conducted to find rice cultivars that have a high content of micronutrients (Indrasari and Kristamtini 2018); however, there still are some problems of mineral loss when the rice is polished because most of the micronutrients are concentrated in the very thin aleurone layers of natural rice. Therefore, the analogous rice technology can be one of the solutions to increasing the content of micronutrients in staple food.

**Physical properties**

*Color and whiteness*

Table 2 shows that the color of analogous rice from all combinations of gebang starch and dolichos bean flour ranges from yellowish-brown to brown with saturated values higher than 70%. They align with their L (lightness) values, which are more than 66 but lower than 90. As generally known that more people prefer polished white rice than non-polished rice. Nevertheless, the L values of the studied analogous rice were higher than that of the analogous rice reported by Sede et al. (2015). The appearance of the brown color of the analogous rice is mainly due to the impact of the color of raw materials and the reaction of browning during the heating of the rice that occurred in the extruder. Heating may cause a Maillard reaction on food containing reducing sugars and amino acids (Shipar 2009). Therefore, more efforts should be made to increase the rice's lightness by using some ingredients such as other whiter flour or to treat/whiten these two flour (gebang starch and dolichos bean flour) before use.

*Size and bulkiness of the rice*

The analogous rice thickness ranged from 2.6 mm to 4.3 mm, while the rice length ranged from 6.5 mm to 7.0 mm. The rice's length-to-thickness ratio ranged from 1.64 to 2.47 (Table 3). Based on rice length classification from FAO, these analogous rice are classified as long rice. In contrast, the overall size of the rice is classified as a medium based on the standard length-to-thickness ratio of natural rice reported by Narvarnikova et al. (2018). The thickness and length of artificial rice are lower than most natural rice, as reported by Susiyanti et al. (2020), but they are higher than those of the PR-106 rice variety (Ghadge dan Prasad 2012). The weight of 1000 kernels of analogous rice ranged from 17.34 g to 34.17 g. The weight was higher than those of some natural rice reported by Susiyanti et al. (2020). That indicates that all types of artificial rice are more compact and heavier than natural rice. All these properties of analogous rice have resulted in the value of bulk density ranging from 0.46 to 0.50 g/mL, which is almost similar to the bulk density of analogous rice developed from corn flour (Kurniasari et al. 2020). As known, bulk density is one of the important data for handling and storing materials, including food such as rice. Materials with high bulk density may need more energy for carrying or handling; on the contrary, materials with low bulk density need more space for storing, carrying, and handling. Therefore, the bulk density of this studied analogous rice may give some insights for storing, carrying, or handling consideration of the product.

*The similarity of the rice*

Table 4 shows that most analogous rice, except rice B, has 2.4-3.3 mm thick for more than 50 percent, with the highest value found on rice E (70%). On the other hand, Rice B has 88% similarity and falls in the range of 3.4-4.7 mm thick or mostly thicker than other analogous rice in the present study. In other words, all analogous rice is high in similarity. That indicates that the extruder may not have big problems forming and cutting those doughs to form the rice-like dimensions. It may also give the promising note that the analogous rice made from a mixture of gebang starch and dolichos bean flour could meet the standard for rice (BSN 2008). Hence, the studied analogous rice could be acceptable for consumers. However, factors influencing this phenomenon may need to be studied to increase the similarity of the analogous rice.

*Swelling value after cooking*

The technique to analyze the swelling value, about 10 grams of analogous rice from each treatment (rice A-E) were measured for their volume before and after being immersed in boiled water for 5 minutes and drained. Data from Table 5 show that cooking can increase the size (volume) of all analogous rice to double. The data indicate that the analogous rice should be porous, allowing them to absorb water in a similar volume to the rice kernel. This ability may be important to be used in developing a kind of food to meet the need of people who want to fulfill their hunger quickly. One more advantage of analogous rice is it can reduce the cooking time, and even it can be treated like a cereal which is not needed to be cooked, just immersed in milk or other edible liquid, whether cold or hot. It is also can be designed to be eaten without any additional treatment. This potency may need further study to be underpinned.

**Organoleptic properties**

Table 6 shows that except for aroma, most organoleptic parameters have a score of around 5, which means most panelists like the color, texture, and taste of the analogous rice, even though the color of all analogous rice is a bit brown (Table 2). The preference of panelists is more noticeable on the overall response scale of all analogous rice which is statistically not significantly different within all treatments. Therefore, all analogous rice resulting from this experiment has the potency to be used as a complementary to natural rice. The intervention of this analogous rice may reduce rice import and increase food security in East Nusa Tenggara Province.

**Table 2.** Color and whiteness of the analogous rice

| Product | HTML color name | Hex code | RGB value | HVS value | CIE lab value |
|---|---|---|---|---|---|
| Rice A | Yellowish brown | #ffe2c192 | 226, 193, 146 | 35º, 35%, 88% | L 80.09332; a* 6.90622; b* 20.9761 |
| Rice B | Pale golden rod | #ffe4cda5 | 228, 205, 165 | 38º, 27%, 89% | L 83.37564; a* 2.04177; b* 22.8735 |
| Rice C | Yellowish brown | #ffc6ae8c | 198, 174, 140 | 35º, 29%, 77% | L 72.34286; a* 3.51936; b* 20.6553 |
| Rice D | Fallow brown | #ffc19c65 | 193, 156, 101 | 35º, 47%, 75% | L 66.56115; a* 6.66441; b* 33.8944 |
| Rice E | Yellowish brown | #ffd5b381 | 213, 179, 129 | 35º, 39%, 83% | L 74.80683; a* 5.44045; b* 30.1059 |

**Table 3**. Size and bulk density of the rice

| Product | Thickness (mm) | Length (mm) | Length to thickness Ratio | Weight of 1000 kernels (g) | Bulk density (g/mL) |
|---|---|---|---|---|---|
| Rice A | 2.64±0.22 | 6.50±0.27 | 2.46±0.15 | 23.60±1.53 | 0.49±0.11 |
| Rice B | 4.27±0.31 | 7.00±0.19 | 1.64±0.09 | 34.17±1.21 | 0.49±0.07 |
| Rice C | 3.03±0.17 | 6.56±0.21 | 2.16±0.11 | 20.87±0.97 | 0.50±0.09 |
| Rice D | 2.87±0.24 | 6.58±0.17 | 2.29±0.13 | 17.34±1.31 | 0.46±0.05 |
| Rice E | 2.66±0.15 | 6.57±0.23 | 2.47±0.14 | 20.68±0.75 | 0.50±0.13 |

**Table 4**. The similarity of analogous rice

| Product | % kernels with < 1.7 mm thick | % kernels with 1.7-2.3 mm thick | % kernels with 2.4-3.3 mm thick | % kernels with 3.4-4.7 mm thick | % kernels with > 4.7 mm thick |
|---|---|---|---|---|---|
| Rice A | 0 | 32 | 52 | 16 | 0 |
| Rice B | 0 | 0 | 4 | 88 | 8 |
| Rice C | 0 | 12 | 56 | 32 | 0 |
| Rice D | 0 | 16 | 64 | 20 | 0 |
| Rice E | 0 | 24 | 70 | 6 | 0 |

**Table 5**. The swelling value of analogous rice

| Product | Swelling volume (%) |
|---|---|
| Rice A | 107.02 |
| Rice B | 113.27 |
| Rice C | 103.17 |
| Rice D | 154.72 |
| Rice E | 112.27 |

**Table 6.** Hedonic value of analogous rice

| Product | Color (scale) | Aroma (scale) | Texture (scale) | Taste (scale) | Overall (scale) |
|---|---|---|---|---|---|
| Rice A | 5.15 a | 4.45a | 5.70 b | 5.45 b | 5.40 a |
| Rice B | 5.95 b | 4.25a | 5.75b | 5.25 ab | 5.50 a |
| Rice C | 5.45 ab | 4.05a | 4.85a | 4.60 a | 5.10 a |
| Rice D | 5.5 ab | 3.80a | 4.50a | 4.75 a | 4.80 a |
| Rice E | 5.65 ab | 3.90a | 5.10ab | 5.00 ab | 5.30 a |

Note: Different small letters following numbers of the same column means significant difference at the level of α 5%.

It can be concluded that the analogous rice made from five combinations of gebang starch and dolichos bean flour using an extruder has all macronutrients with the maximum carbohydrate content of 90.26%, which was found in the rice B (95% GS + 5% DB) and maximum protein content (4.7%) was found in the rice E (80% GS + 20% DB) dolichos flour supplementation increased the protein content and total ash (total minerals) of the analogous rice. Most of the rice has a yellowish-brown to brown color. The rice thickness ranged from 2.6 mm to 4.3 mm, while the rice length ranged from 6.5 mm to 7.0 mm. The rice's length-to-thickness ratio ranged from 1.64 to 2.47. The weight of 1000 kernels of analogous rice ranged from 17.34 g to 34.17 g, whereas the bulk density ranged from 0.46 to 0.50 g/mL. Most analogous rice, except rice B, had 2.4-3.3 mm thick; mild and short cooking could double all analogous rice's size (volume). All panelists liked (average of the overall hedonic score was about 5 out of 9) all analogous rice made from a combination of gebang starch and dolichos bean flour.

## REFERENCES

Adelina F, Estiasih T, Widyaningsih TD, Harijono. 2019. Cassava based artificial rice: A review. J Teknologi Pertanian 20 (1): 11-24. DOI: 10.21776/ub.jtp.2019.020.01.2. [Indonesian]

Ademola OA, Abioye OR. 2017. Proximate composition, mineral content and mineral safety index of *Lablab purpureus* seed flour. Intl J Sci Health Res 2 (4): 44-50.

AOAC. 1984. Official Methods of Analysis (14th Edition). Association of Official Analytical Chemists, Washington DC.

Badan Pusat Statistik. 2021. Indonesia Dalam Angka. BPS, Jakarta. [Indonesian]

Badan Standardisasi Nasional (BSN) 2008. SNI 6128:2008 Beras BPS, Jakarta. [Indonesian]

Deka RK, Sarkar CR. 1990. Nutrient composition and antinutrient factors of *Dolichos lablab* L. seeds. Food Chem 38 (4): 239-246. DOI: 10.1016/0308-8146(90)90180-C.

Eagleton GE. 2016. Review: Persistent pioneers; *Borassus* L. and *Corypha* L. in Malesia. Biodiversitas 17: 716-732. DOI: 10.13057/biodiv/d170247.

Fitriyanto M, Putra SR. 2013. Karakterisasi beras buatan (artificial rice) dari campuran tepung sagu (*Metroxylon* sp.) dan tepung kacang hijau. J Sains dan Seni Pomits 2 (1): 1-3. [Indonesian]

Franciska CY, Waluyo Y, Tamrin S, Warji, 2015. Pembuatan dan uji karakteristik fisik Beras analog dengan bahan baku tepung cassava yang diperkaya dengan protein ikan tuna. Artikel Ilmiah Teknik Pertanian Lampung 4 (2): 39-44. [Indonesian]

Ghadge PN, Prasad K. 2012. Some physical properties of rice kernels: Variety PR-106. J Food Process Technol 3: 8. DOI: 10.4172/2157-7110.1000175.

Indrasari SD, Kristamtini. 2018. Biofortifikasi mineral Fe dan Zn pada beras: Perbaikan mutu gizi bahan pangan melalui pemuliaan tanaman. J Penelitian dan Pengembangan Penelitian 37 (1): 9-16. DOI: 10.21082/jp3.v37n1.2018.p9-16. [Indonesian]

IRRI. 1980. Standard Evaluation System for Rice. International Rice Research Institute, Los Banos, Philippines.

Kurniasari I, Kusnandar F, Budijanto S. 2020. Karakteristik fisik beras analog instan berbasis tepung jagung dengan penambahan k-karagenan dan konjak. Agri Tech 40 (1): 64-73. DOI: 10.22146/agritech.47491. [Indonesian]

Lalel HJD, Kaho NPLBR. 2018. Integrasi Penggunaan Drone dan Free & Open Source Softwares (FOSS) Sistem Informasi Geografis dalam Kajian Sebaran dan Kondisi Lingkungan Pohon Gewang (*Corypha utan* Lamk.) di Kabupaten Kupang. Research Report, Universitas Nusa Cendana, Kupang. [Indonesian]

Lalel HJD, Rubak YT, Kaho NPLBR. 2018. Gebang (*Corypha utan* Lamk): The promising source of starch. Proceeding of The IAFT-SEAFAST International Conference; Science-based Ingredients: The Future for Food in Asia. Jakarta, 3-5 October 2018.

Lim J. 2011. Hedonic scaling: A review of methods and theory. Food Qual Prefer 22: 733-747. DOI: 10.1016/j.foodqual.2011.05.008.

Lobo RL, Lalel HJD, Markus JER. 2017. Karakteristik Mutu Mie Basah Substitusi Tepung Terigu dengan Pati Gewang. Laporan Penelitian. Faperta Undana, Kupang. [Indonesian]

Muttagi GC, Ravindra U. 2020. Chemical and nutritional composition of traditional rice varieties of Karnataka. J Pharmacogn Phytochem 9 (5): 2300-2309. DOI: 10.20546/ijcmas.2020.905.006.

My Agriculture Information Bank. 2018. Cultivation of Indian Bean (*Dolichos lablab*). https://agriinfo.in/cultivation-of-indian-bean-dolichos-lablab-894/ Accessed on 6 June, 2022.

Naiola E. 2008. Amylolitic microbes of nira and laru from Timor Island, East Nusa Tenggara. Biodiversitas 9 (3): 165-168. DOI: 10.13057/biodiv/d090302.

Narvarnikova, Banou J, Herak D, Verner V. 2018. Evaluation of physical properties of rice used in traditional Kyrgyz Cuisine. Food Sci Nutr 6: 1778-1787. DOI: 10.1002/fsn3.746.

Partomiharjo T, Naiola BP. 2009. Ekologi dan peresebaran gewang (*Corypha utan* Lamk.) di Savana Timor, Nusa Tenggara Timur. Berita Biologi 9 (5): 637-647. [Indonesian]

Sede VJ, Mamuaja CF, Djarkasi GSS. 2015. Kajian sifat fisik kimia beras analog pati sagu baruk modifikasi HMT (Heat Moisture Treatment) dengan penambahan tepung komposit. J Ilmu dan Teknologi Pangan 3 (2): 24-35. [Indonesian]

Shipar AH. 2009. A General Review on Maillard Reactions in Foods. [Thesis]. Toronto Institute of Pharmaceutical Technology, Toronto.

Singh AK, Singh PK, Nandan R, Rao M. 2012. Grain quality and cooking properties of rice germplasm. Ann Pl Soil Res 14 (1): 52-57.

Susiyanti, Rusmana, Maryani Y, Sjaifuddin, Krisdianto N, Syabana MA. 2020. The physicochemical properties of several Indonesian rice varieties. Biotropia 27 (1): 41-50. DOI: 10.11598/btb.2020.27.1.1030. [Indonesian]

Yamamoto Y, Pasolon YB, Rembon FS. 2015. Estimation of Starch Productivity and Quality of Starch. Accumulating Palms in The Tropics. Research Report. Kochi University, Japan.