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Physicochemical Characteristics of Three Local Sweet Potato Flour from East Kalimantan

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Abstract. The character of local sweet potato flour is needed to give good results in food production. This research aims to investigate the physicochemical and functional properties of three verieties of sweet local potato flour from East Kalimantanr i.e Sawenter, White and Purple Kutim. The flour making process includes sorting, cleaning, peeling, soaking in metabisulfite 0.3%, draining, slicing, drying, milling and sieving. The results has a yield ranging from 26.93 to 28.86%; water content of 2.53 to 3.75% w/w ; ash content of 1.95 to 5.11% w/w ; protein content of 1.63 - 2.38% w/w; fat content of 0.6 to 1.15% w/w ; fiber content from 2.72 to 3.3% w/w and carbohydrate by difference 85.13 to 88.6%, color (L = 73.15 to 95.63; a = -1.97 to +11.93, b = + 1,92- +16.52). The gelatinization temperature range 78.5 - 79,75^{O}C; the maximum viscosity 596 - 1157 cP; breakdown viscosity 63-366 cP; setback viscosity 116-309 cP and final viscosity 436-972 cP. The granular form is polygonal and size between 2-12µm. This research is important because it can be applied as a mixed raw material in the manufacture of products that don't require a high level of development such as brownies and biscuits.

1. Introduction

Sweet potato is a potential source of carbohydrates as raw materials processed food products Indonesian society. The use of sweet potatoes as a step in product diversification efforts, so that people can better know and use them optimally. Thus, it can reduce dependence on imported flour. In 2018, sweet potato production in Indonesia was 1,806,000 tons with a productivity of 199.15 Ku/Ha (up 10.51% from 2017), while in East Kalimantan, sweet potato production reached 11,447 tons (up 16.83% from 2017) with a productivity of 116.96 Ku/ha (up 5.45% from 2017) [1]. The largest sweet potato producer in East Kalimantan in 2015 is the district of Kutai (5.528 tons), then were occupied by Kutai Timur and Penajam Paser Utara (which each production amounted to 1.378 tons and 1.094 tons) [2].

The high carbohydrate content of sweet potatoes makes sweet potatoes a source of calories. According to [3], the carbohydrate content of sweet potatoes is classified as a low glycemic index, which is a type of carbohydrate that if consumed will not drastically raise blood sugar levels. In addition, the anthocyanin content in purple sweet potato can be useful as an antioxidant [4]; [5]. According to [6] red, orange, yellow, and purple vegetables contain vitamins C, E, A, lutein, lycopene, selenium, carotenoids, and -carotene which are useful as sources of antioxidants. The content of antioxidants in foodstuffs will be able to reduce the risk of cancer [6], preventing aging, degenerative diseases, antimutagenic and anticarcinogenic, antihypertensives and lower blood sugar levels [5]. Therefore, processing sweet potatoes into flour has the potential to be developed as a functional food source with a low glycemic index and rich in antioxidants. Various types of products that can be made from the sweet potato base chart include cake [3], biscuits [7], instant noodles [4], waffles [8], wet noodles [9], and many traditional cakes. Sweet potato processing in the form of flour can extend the shelf life, easy of application, storage and distribution and expanding a variety of applications. The use of local sweet potato flour in processed food products must be following the character of the flour used to give good results.

Applications flour in a product is influenced by its ability to shape the characteristics of the desired end product. The different characteristics such as physicochemical of granular form, the ratio of amylose/amylopectin, starch molecular characteristics and the presence of other components is the cause of the differences like the functionality [10][11]. A variation of the functional properties of the flour in a species causing problems in processing due to the inconsistency of raw materials. Characterization and comparative study of physicochemical and functional properties of flour in a variety because it is necessary to predict similarities and differences in behavior at the application stage [12]. Knowledge related to the characteristics of local sweet potato flour, can be used to predict the potential of the product that can be produced. The aim of this research is to investigate the physicochemical and functional properties of sweet potato flour locally from East Kalimantan. This research can be used as a raw material blending for making bread, especially brownies.

2. Materials and Methods

2.1. Raw materials

Raw materials are sweet potatoes of Sawenter, White and Purple Kutim varieties that obtained from farmer in Kutai Kartanegara. Tubers obtained from 3 month old plants of sweet potato. Equipment used include process equipment for the production of sweet potato flour and analysis equipment including the Rapid Visco Analyzer and polarizing microscope.

2.2. Flour-making

The flour manufacturing process includes sorting 2 kg of sweet potato samples, stripping, immerse in 0.3% sodium bisulfite solution for 10 minutes, draining, slicing, drying at 60°C for 10-12 hours, and sieving with 80 mesh size. Sweet potato flour was analyzed to include yield (gravimetric), water content (AOAC methods), ash content, protein, fat, fiber using AOAC methods [25], carbohydrate (*by different*), pasting properties (RVA instrument), color (Chromameter), shape and size of the granules (polarizing microscope).

2.3. The Pasta Characterization

Observation of paste characteristics using by Rapid Visco Analyzer (RVA). The starch suspension (3.5 g of starch sample with 14% water content is mixed with 25 g of distilled water) in the sample container is rotated at a speed of 160 RPM. At the first minute is done preheating until the temperature reaches 50°C. Furthermore, the heating temperature is raised to 95°C in 8.5 minutes and kept constant at 95°C for 5 minutes. Then, the temperature is lowered back to 50°C (minute 21) and maintained at 50°C for 2 minutes (up to 23 minutes). From here obtained peak viscosity, temperature pasting (initial temperature rise in viscosity), the temperature peak viscosity, viscosity hot (viscosity after heating to 95°C for 5 minutes), the viscosity of the end (viscosity after cooling at 50°C for 2 minutes), the viscosity breakdown relative (the ratio between the difference in peak viscosity and viscosity hot with peak viscosity) and behind the relative viscosity (the ratio between the difference in the final viscosity and hot viscosity,). Breakdown viscosity is the difference between the peak viscosity and hot viscosity, while behind the viscosity is the difference between the final viscosities to the heat viscosity.

2.4 *Statistical analysis*

This research using a completely randomized design, the data were analyzed with Anova and continue with DMRT at $\alpha = 5\%$, using software SPSS 17.00.

3. Results and Discussion

3.1.Yield And Chemical Properties

The flour yield is calculated based on the percentage of flour weight divided by the weight of the fresh sweet potato tubers. Based on the Table 1 showed that White sweet potato produces the highest yield of 28.86% when compared to Purple Kutim (26.93%) and Sawenter (27.21%). This was due to highest levels of White sweet potato carbohydrate content of 88.6% compared to the carbohydrate of Sawenter was 85.13% and Purple Kutim was 86.68%. Carbohydrates are the main components of flour so that the higher the carbohydrate levels is likely to produce a large yield of flour that great anyway. According to [13], carbohydrate levels have an important role in determining the characteristics of a foodstuff, good taste, color, texture, and so forth. According to [3], differences in carbohydrate content in sweet potatoes are influenced by variety, harvest age and growing environmental conditions. This carbohydrate content has an important role in the characteristics of the resulting product.

Table l. Yield and chemical composition of local sweet potato flour

Component	Sweet Potato Flour Variety		
	Sawenter	White	Purple Kutim
Yield (% wb)	27.21a	28.86b	26.93a
Moisture (% wb)	3.35a	3.75b	2.53c
Ash (% db)	4.93a	1.95b	5.11a
Protein (% db)	2.12a	2.38b	1.63c
Fat (% db)	1.15a	0.6b	0.75c
Dietary (% db)	3.32a	2.72b	3.3a
Carbohydrate (% db)	85.13a	88.6a	86.68a

Description: Numbers followed by different letters in the same row are significantly different according to DMRT ($p<0.05$)

Kutim Purple flour had the lowest water content of 2.53% compared to the Sawenter flour (3.35%) and White flour (3.75%). Differences in water content is influenced by the degree of attachment of water which varies depending on the source material. The water content and water activity a major effect on the rate of microbial growth in food which eventually influential in determining the quality and shelf life of food products during storage [14]. Therefore, Sawenter flour and White flour can be predicted to have a shorter shelf life. The water content of these sweet potato flour relatively lower than of commercial wheat flour. According to the SNI 3751(2009), the maximum water content requirement for wheat flour is 14% [24]. This showed that the water content of flour has been following the standard requirements of SNI flour, which is not higher than tapioca water content (15% bb)

The ash content of White flour (1.95% db) was lower than of Sawenter flour (4,93%) and Purple Kutim flour (5,11%). . This indicates that the total total amount of minerals on White flour is higher than Sawenter and Purple Kutim flour. According to [8], ash content shows the mineral content contained in food ingredients. However the ash content of the three sweet potato flours were much higher than the ash content of flour by SNI 01-3751-1995 ie a maximum 0.6% (bb). The mineral content in sweet potatoes is generally quite high around 0.95%, because every 100 g of material contains calcium (152 mg), phosphorus (150 mg), and iron (2.4 mg) [15]. The minerals contained in the starch is a component of phosphorus in small quantities in the form of phosphate esterification and phospholipid [22]. The difference in the level of ashes can be caused by genetic factor and environmental factor such as the condition of land land pH, the height of the plantation location, the growing season, and temperature [21]. According to [16]), the high ash content in the powdery material is less preferred because it tends to give a dark colour to the product and influence the stability of the dough.

The Table 1 showed that the lowest fat content in White flour (0.6%), then Purple Kutim (0.75% db) and the last was Sawenter flour (1.15%). The fat content of these sweet potato flour less the same compared to the sweet potato flour in Indonesia, which on average reaches 0.75% [17] and qualified to be supplied to the food industry because of less than 1% db [23]. The Sawenter flour had the higest fat content (1.15%), therefore the less favourable in the process of storage because it is easier rancid. The lower the fat content in flour shows the better quality [18].

The protein content of Sawenter flour was 2.12%, and White 2.38%, both meet the range of an average protein content of sweet potato flour produced in Indonesia at 2.11% -4.46% [17]. While the protein content of Purple Kutim 1.63%, the lowest among the others. Reduced levels of a protein thought to be caused by excessive stripping. This is because the highest protein content of the sweet potato tubers found on the outer portion adjacent to the outer skin [15]. Kutim Purple flour is suitable as a raw material in the manufacture of products that do not require a large development such as crackers. The protein content of these sweet potato flours were relatively low when compared to wheat flour, which around 8.05-12.98% [19], therefore it has a low level of development. Sweet potato flour can be used for certain products that do not require a high level of development.

3.2.Physical Characteristics

3.2.1. Color. Sawenter sweet potato flour has the highest brightness level of 95.63 followed by White with 93.78 and the lowest brightness on Purple Kutim at 73.15. Sawenter sweet potato flour to the value a = -1.97 green colours have a tendency stronger than the White varieties of sweet potato flour, with the value a = -0.40 while the Purple sweet potato flour Kutim with the value a = + 1.92 tend to red.

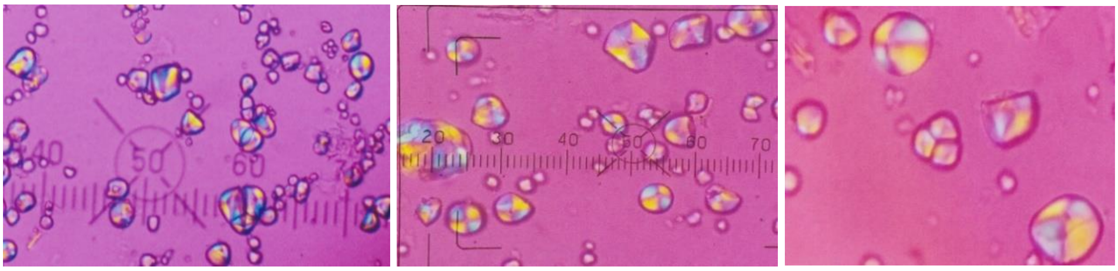
Table 2. The color of local sweet potato varieties of Sawenter, White and Purple Kutim

Color	Varieties		
	Sawenter	White	Purple kutim
L	95.63	93.78	73.15
A	-1.97	-0.40	+11.93
B	+16.52	+6.20	+1.92

Sawenter sweet potato flour with a value of b = + 16.52 has the strongest tendency to yellow than White sweet potato flour with a value of b = +6.20 while the Purple sweet potato flour Kutim with the value b = + 1.92 has the weakest yellow colour. Sawenter granular sweet potato flour, sweet potato flour white and purple sweet potato flour Kutim has a spherical shape and a polygonal measuring 2-12 μm. Based on this explanation and Figure 1, it can be seen that Purple Kutim sweet potato flour tends to have a dark colour, this indicates that the flour contains anthocyanins. According to [5], the purple colour of sweet potatoes is due to the presence of natural dyes called anthocyanins. Anthocyanins are a group of pigments that cause a reddish color, located in water-soluble cell fluids. Purple sweet potato can be used as a healthy processed food to reduce the risk that it can damage cells due to the presence of radical compounds [6].

Figure 1. Local varieties of sweet potato flour are Sawenter, White and Purple Kutim

3.2.2. The shape and size of the granules. Birefringence is the nature of the starch granules reflect polarized light that shows the colors blue and yellow as well showed the presence of maltose cross or cross pattern [26]. Under the microscope with a magnification of 400 X, visible granules Sawenter, White and Purple Kutim flour starch granule size had nearly the same, which were about 2-12 μm with a round shape was round and square granules lot (polygonal). The size of the starch granules associated with gelatinization temperature, starch with small granule sizes having initial gelatinization temperature lower than the starch granule size large [20].



Sawenter White Purple Kutim

Figure 2. The shape and size of the local sweet potato flour granules.

3.3. *Thermal profile Gelatinization*

Gelatinization temperature for all three sweet potato flour ranges from 78.50 -79.75^{O}C so that the possibility of heat requirement similar to the gelatinization process. Gelatinisasi starch temperature varies between 60-80^{o}C [27] or 50-80^{o}C [28]. White flour has the highest maximum viscosity of 1157 cP at a temperature of about 99^{O}C. The difference maximum viscosity value and the temperature of gelatinization peak shows that such materials require different energy for the development of granular. It is caused by differences in the degree of association on the part relating to amorphous amylose content and a fat component may limit the development of starch granules. White sweet potato flour has the highest breakdown viscosity of 494 cP viscosity which is a reduction in the maximum toward the lowest viscosity when the suspension is heated at a temperature of 95 °C for approximately 5 minutes. White sweet potato flour has the highest Setback viscosity of 309cP viscosity compared with Purple sweet potato flour Setback Kutim Sawenter 296 cP and 116cP. The setback is re-association of starch molecules when subjected to cooling. Value setback showed a tendency to starch in retro-gradation. White sweet potato flour has the highest final 972 cP viscosity than the final viscosity of sweet potato flour others.

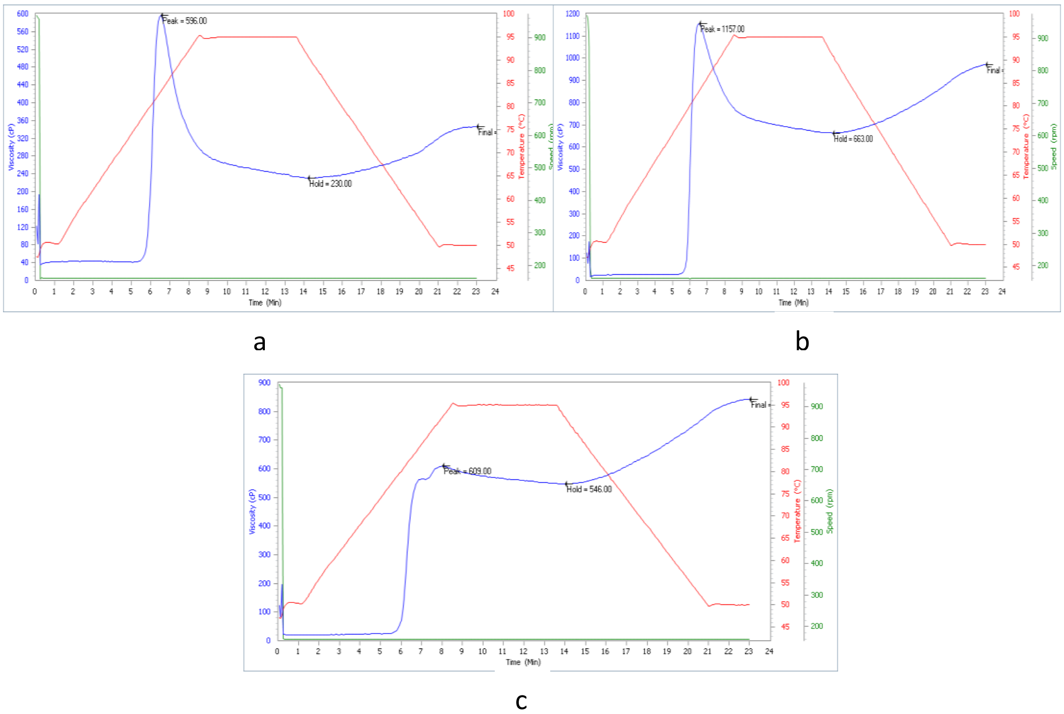


Figure 3. Thermal profile gelatinization of a) Sawenter flour; b) White flour; c) Purple Kutim flour

4. Conclusion

There are significant differences between Sawenter sweet potato flour, White and Purple Kutim on yield, moisture content, ash, protein, fat, dietary. Color analysis results on the value of L, a, b and thermal profiles gelatinization also shows the difference between the three flour. This suggests that sweet potato flour from three local varieties different in the physicochemical characteristic of that application in food processing is not the same. It can be recommended to use White flour and Purple Kutim flour as a mixture of raw materials in making bread, especially brownies because they have high final viscosity. The protein content in local sweet potato flour is relatively low, therefore it can be applied to products that don't require a high level of development such as brownies and biscuits.

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