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PHYSICAL CHARACTERISTICS OF KEPOK, TALAS, AND CAVENDISH BANANAS FLOUR

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ABSTRACT

Banana flour is one of the semi-finished products which processed aims to maintain shelf life, provide goods for diver food products, facilitate packaging and transportation. This research aimed to determine and compare the physical characteristics of flour from three banana species, i.e., *Kepok (Musa acuminata x balbisiana)*, *Talas (Musa acuminata* Colla var. Talas), and Cavendish (*Musa acuminata* Colla var. Cavendish). This research is a single factor experiment arranged in a completely randomized design with three (banana species) treatments and five replications. Data were analyzed by ANOVA except for wettability data, and gelatinization profile is processed using the Kruskal-Wallis test. The experimental parameters were swelling power, starch solubility, bulk density, water absorption capacity, oil absorption, and color. The results showed that swelling power and oil absorption of the banana flour from the three banana species are not significantly different ($p > 0.05$) but significantly different ($p < 0.05$) for solubility, bulk density, wettability, water absorption capacity, and color. Gelatinization temperature for *Kepok*, *Talas*, and Cavendish banana flour was 79.45°C, 81.45°C, and 78.20°C, respectively. In this research, we found that the physical properties of *Talas* banana flour are in between the physical properties of *Kepok* and Cavendish banana flour.

Keywords: banana flour, physical characteristics, *Kepok*, *Talas*, Cavendish

INTRODUCTION

Due to the high total solids content (40-70%), bananas can be processed into flour, providing broader utilization in the food industry (Vatanasuchart *et al.*, 2012). In addition, flour from immature bananas is rich in resistant starch (Virulchatapan and Luangsakul, 2020) and minerals (Vilela *et al.*, 2014), so that evaluated as a functional food. In some countries, banana flour is used as a primary food ingredient, such as mixtures for baby food, raw material for making bread, cakes, biscuits, noodles, and flakes (Fida *et al.*, 2020). However, the physical and chemical properties are very diverse due to the species/varieties (Gnagne *et al.*, 2017), the origin of the species (Vatanasuchart *et al.*, 2012), maturity level (Olawuni *et al.*, 2013), and processing method (Histifarina *et al.*, 2012; Singh *et al.*, 2017).

Indonesia has plenty of banana varieties (Poerba *et al.*, 2018), which may play an essential role in food diversification, functional food, and carbohydrate source to ensure food security. A high potential endemic banana from the region of South Kalimantan Province is *Talas* banana (*Musa acuminata* Colla, AAB) (Poerba *et al.*, 2016; Sunaryo *et al.*, 2019). Moreover, the banana also grows well in the region of East Kalimantan.

Based on morphological and agronomical characters, *Talas* banana is in between *Kepok* (*Musa acuminata x balbisiana*, ABB) and Cavendish (*Musa acuminata* Colla var. Cavendish, AA) banana, a plantain and dessert banana type, respectively (Poerba *et al.*, 2016; Sunaryo *et al.*, 2020). In addition, *Talas* banana has a unique taste as dessert banana, has a more extended maturity (20-24 days after the first harvest), and high production level (16-23 ton/ha) (Sunaryo *et al*., 2017).

Kepok banana shows a high level of consumption in the form of processed food, like banana fries, sweet banana soup, or even processed semi-finished goods like flour (Mathew and Negi, 2017; Fida *et al.*, 2020). On the other hand, Cavendish banana is usually consumed as fresh fruit (Poerba *et al.*, 2018). There are still limited reports about the utilization of *Talas* banana. This study explores the physical characteristics of *Talas* banana flour, while *Kepok* and Cavendish banana flour are used to compare.

MATERIALS AND METHODS

Materials

All banana types were provided at the green maturation level. Farmer at Batu Besaung Village, Samarinda Utara sub-district, provided the *Talas* banana. Cavendish and *Kepok* bananas were bought from Super Market at Samarinda Central Plaza and traditional market in Samarinda, respectively. The chemical reagents, i.e., HCl, Na_2CO_3, $C_6H_8O_7$, $CuSO_4$, KI, H_2SO_4, starch, $Na_2S_2O_3$, NaOH, and phenolphthalein provided by Riedel-Haen, Germany.

Banana flour processing

Bananas were selected from dirt and damage. The bananas were washed using running water, then treated by soaking in a salt solution for ± 20 minutes to facilitate the peeling process. The bananas were peeled and sliced into 0.5 mm slices, then soaked in $Na_2S_2O_5$ solution for ±20 minutes. The soaked banana slices were drained and then dried in an oven at 50°C for ±18 hours. The dried slices of banana were floured and screened by an 80-mesh sieve

Physical characteristics analysis

Bulk density

The bulk density of banana flour was determined by the method suggested by Singh *et al.* (2017) with a bit of modification. Ten grams of flour were poured into a 100 mL volumetric cylinder. The bottom of the cylinder was tapped several times to obtain a constant volume. The bulk density was presented as the weight of flour (g) divided by its volume (cm^3).

Wettability

Wettability (wetting time) is defined as flour's time from when the flour is added to the water until all the flour is wetted thoroughly. The wettability was determined by the method suggested by Olawuni *et al.* (2013). Banana flour of 0.4 g was put into 40 mL of distilled water in a measuring cup (inner dia 4 cm x height 11 cm). The dispersion was carried out at room temperature without stirring, and the wetting time was recorded using a stopwatch.

Swelling power and water solubility

Swelling power is the flour's ability to expand (mL) after heating at a specific temperature and time. The swelling power was determined according to Onyango *et al.* (2013) with some modifications. First, a sample of 0.1 grams of the dry base in a scaled centrifuge tube was added with 10 mL of distilled water. The sample was vortexed until the mixture was homogeneous, then heated in a water bath at 60°C by stirring occasionally. After 30 min the sample was cooled in ice water for 1 minute then let at room temperature for 5 minutes. Finally, the sample was centrifuged at 3500 rpm for 15 minutes. The swelling power was calculated as the weight of starch gel divided by the weight of dry starch.

Water solubility index was obtained by pouring the resulting supernatant from the above assay of swelling power into a cup to decant and dry to constant weight at 110°C. The water solubility index was presented as the percent of dried weight of decanted supernatant based on the weight of the sample.

Water absorption capacity

Water absorption capacity was determined using the method suggested by Singh *et al.* (2017). First, one gram of banana flour was poured into 10 mL distilled water in a centrifuge tube. Then the mixer was vortexed for 30 seconds until the mixture was homogeneous. The sample was then allowed to stand at room temperature for 30 minutes and centrifuged at 3500 rpm for 30 minutes. Next, the supernatant was decanted, then the water absorption capacity was expressed as a weight percentage of water absorbed by 1 g of flour.

Oil absorption capacity

Oil absorption capacity was measured using the method suggested by Singh *et al.* (2017) with a minor modification. One gram of banana flour was mixed into 10 mL of oil and stirred using a vortex mixer for 30 seconds. Next, the mixture was put in a 10 mL conical centrifuge tube and placed in a 30°C water bath for 30 minutes. The mixture was vortexed again and then centrifuged at 3000 rpm for 20 minutes, and the free oil was decanted. The oil absorption capacity was expressed as the percentage of oil absorbed by the banana flour.

Gelatinization profile

Gelatinization profile was obtained from the sample having one cycle of heating and cooling information on initial, final, setback, breakdown, and peak viscosity. The gelatinization profile of the bananas flour was determined using the Rapid Visco Analyzer Instrument TecMaster Newport Scientific Pty Ltd., Warriewood-Australia. Sample (3.3 g on 14 g moisture per 100 g of flour) was suspended in 25 mL of distilled water. The suspension was heated to a temperature of 50°C and maintained for 1 minute. The rotational speed of the paddle started at 960 rpm and slowed down to 160 rpm in 20 min, then kept the speed during the rest of the assay. The heat was further increased until it reached a temperature of 95°C with a heating speed of 6°C per minute and maintained at this temperature for 5 minutes. After that, it was cooled to 50°C with a cooling speed of 6°C per minute, then maintained at that temperature for 5 minutes.

Color measurement

The color was determined by a portable colorimeter (chroma meter CR-400, Konica Minolta, Germany).

Data Analysis

Data were analyzed by ANOVA continued by Tukey for the normally distributed data and Kruskal-Wallis test continued by Dunn's test for the not normally distributed data.

RESULTS AND DISCUSSION

Some of the physical properties of flour from the three bananas are significantly different ($p < 0.05$), i.e., bulk density, wettability, water solubility, and water absorption capacity. However, other physical property parameters, i.e., oil absorption capacity, swelling power, gelatinization temperature, and color, as well as the chemical properties (water content and total sugar), are not significantly different ($p > 0.05$) (Table 1.).

The bulk density and water solubility index of *Kepok* and *Talas* banana are insignificantly different, but both are significantly different from Cavendish banana. On the other hand, the water absorption capacity of *Talas* and Cavendish bananas is insignificantly different, but both are significantly different from *Kepok* bananas. Similar phenomena were recorded for some physical properties, which show an insignificant difference ($p > 0.05$).

Table 1. Physical properties of flour from three banana types

Properties component	*Kepok*	*Talas*	Cavendish
Bulk density (g/mL)	0.67 ± 0.04[a]	0.63 ± 0.03[a]	0.45 ± 0.02[b]
Wettability (seconds)	3.38 ± 0.10[a]	2.37 ± 0.93[b]	0.37 ± 0.15[c]
Swelling power (g/g)	5.30 ± 1.62	4.84 ± 0.62	4.52 ± 1.15
Water solubility (% db)	11.11 ± 0.00[b]	11.11 ± 0.00[b]	33.33 ± 11.11[a]
Water absorption capacity (g/g)	7.56 ± 0.18[b]	7.49 ± 0.07[a]	7.43 ± 0.12[a]
Oil absorption capacity (%)	56.00 ± 11.40	50.00 ± 7.07	62.00 ± 13.03
Gelatinization temperature (°C)	79.45 ± 0.58	81.45 ± 0.39	78.20 ± 1.76
Color*			
L	84.70 ± 0.31	79.37 ± 1.62	64.54 ± 0.01
a	4.78 ± 0.69	5.00 ± 1.15	5.72 ± 0.00
b	6.92 ± 1.54	10.68 ± 4.04	10.01 ± 0.84

Note: Data (mean ± SD) were calculated from five replications, except the gelatinization profile and color using only two replications. Data were analyzed by ANOVA continued by Tukey test, except wettability, gelatinization temperature, and color, which used Kruskal-Wallis test continued by Dunn's test. Data within the same row followed by different letters show a significant difference ($p < 0.05$).

The value of the physical properties of *Talas* banana is in between of *Kepok* and Cavendish banana, except gelatinization temperature and color value of" b," which are higher than *Kepok* and Cavendish banana. On the other hand, the oil absorption capacity of *Talas* banana is lower than *Kepok* and Cavendish. The gelatinization profile of the three bananas flour is presented in Figure 1. and their performance is shown in Figure 2.

Talas banana flour has a bulk density of 0.63, which is between the bulk density of *Kepok* and Cavendish banana, i.e., 0.67 and 0.45, respectively. This experiment shows that other physical properties of the *Talas* banana flour are in between the *Kepok* and Cavendish, like wettability, swelling power, water solubility, and water absorption capacity. This phenomenon may regard to the phenotypic-related between the three banana types. Sunaryo *et al.* (2017) reported that *Talas* banana is in between Kepok and Cavendish based on morphological and agronomical characters. *Talas* banana belongs to the genome group of AAB (Sunaryo *et al.*, 2019), while *Kepok* and Cavendish banana belongs to ABB (Poerba *et al.*, 2018) and AAA (Pereira and Maraschin, 2015), respectively. In addition (Sunaryo *et al.*, 2020) reported that *Talas* and *Kepok* banana has a SimQual coefficient of 0.68.

However, the relationship between physical properties and phenotypic characteristics may need further study using a homogenous research methodology like flour preparation and physical properties assay. Singham *et al.* (2014) reported a different result with this experiment that flour from green matured Cavendish banana has bulk density over the bulk density resulting from this research (0.45), i.e., 0.67, which derived from the 60-mesh sieved flour. The banana flour produced in this research used 80-mesh sieve. The difference in flour characteristics may result in different measurements results in physical properties.

Rohmah (2012) reported a higher bulk density (0.77) of *Kapas* banana flour screened by 120-mesh sieve. *Kapas* banana belongs to the same AAA group genome as Cavendish banana (Poerba *et al.*, 2018). Table 2. resume the physical properties of banana flour, including banana starch and resistant starch from previous studies.

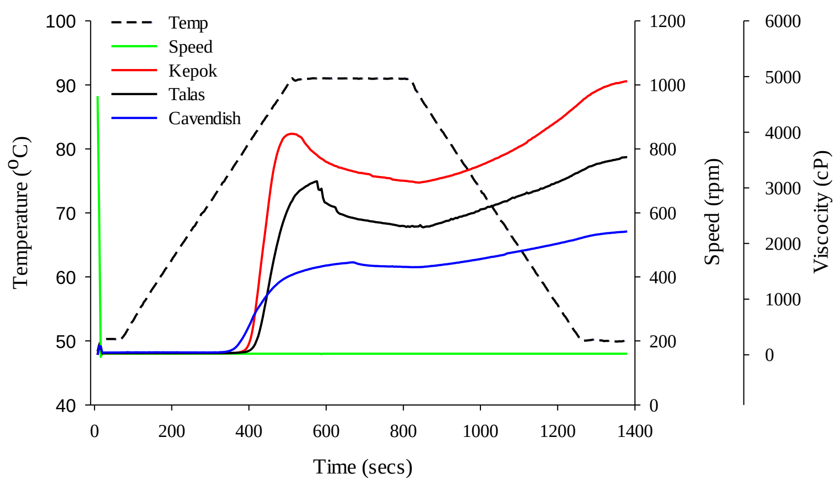

Figure 1. Gelatinization profile of *Kepok*, *Talas* and Cavendish bananas flour

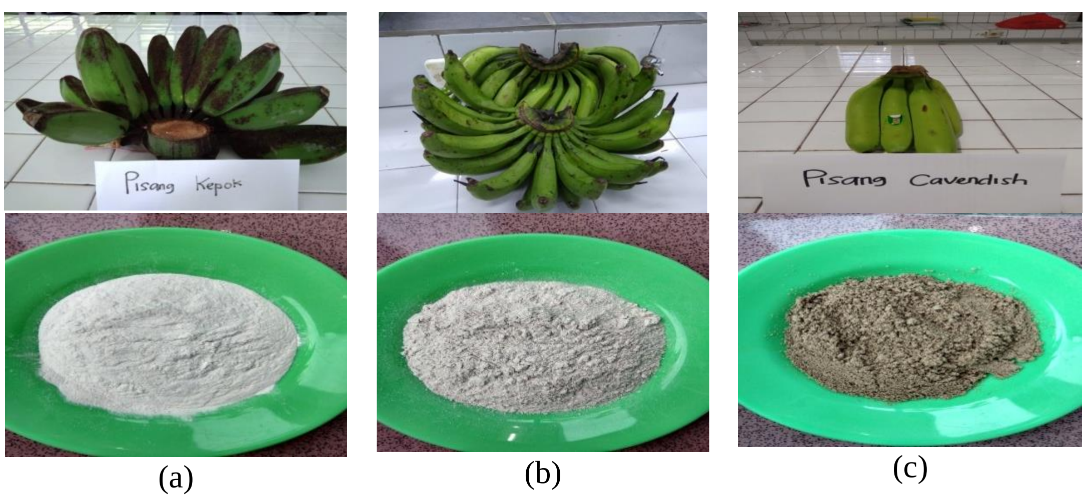

Figure 2. Banana hand and the banana flour from (a) *Kepok*, (b) *Talas*, and (c) Cavendish banana.

Beside the physical characteristics of the Talas banana flour, preliminary research for the chemical characteristics was conducted. The water content and total sugar of the *Talas* banana were not significantly different ($p > 0.05$). However, the water content of flour from *Talas* banana is in between *Kepok* and Cavendish. On the other hand, *Talas* banana flour has the lowest total sugar.

The water content of the *Kepok*, *Talas*, and Cavendish bananas are 8.50, 8.98, and 9.57%, respectively. In addition, the total sugar is 21.66, 21.62, and 21.74%, respectively.

Table 2. Physical characteristics of plantain and dessert bananas flour

Banana types, Country (group genome)	BD (g/mL)	WT (secs)	SP (g/g)	WS (%)	WAC (g/g)	OAC (g/g)	PT (°C)	Refe-rences
Plantain								
Mysore, Brazil (AAB)*			3.1[a]	1.1[a]	1.19	1.18	79.1	1
Kepok, Indonesia-Central Java (AAB)			6.84	23.51	2.11		63.77	2
Awak, China-Guangdong (ABB)**			98.04[d]	3.56[d]	1.274[d]			3
Green Horn, Nigeria	0.71[c]	1.81[c]	1.66[c]		1.70[c]	2.84[c]	64.33[c]	4
Bluggoe, China-Guangdong (ABB)**			93.55[d]	1.19[d]	1.205[d]			3
Orishele, Côte d'Ivoire					0.874			5
Corne 1, Côte d'Ivoire					0.683			5
French 2, Côte d'Ivoire					0.851			5
Dessert								
Kluai Hom Thonh, Thailand (AAA)			3.5	7.59			81.72	6
Cavendish, Equador (AAA)					3.39	1.61	83	7
Cavendish, China-Guangdong (AAA)**	1.131[d]		87.76	1.69[d]				3
Cavendish, India-Allahabad (AAA)	0.67		3.57	0.99	5.7			8
Kapas, Indonesia-East Kalimantan (AAA)	0.77	26.58			8.97	7.37		9
Mas, China-Guangdong (AA)**			90.44[d]	8.68[d]	1.418[d]			3

Note: BD = bulk density, WT = wettability, SP = swelling power, WS = water solubility, WAC = water absorption capacity, OAC = oil absorption capacity, GT = gelatinization temperature. *) banana starch; **) resistant starch; a) assayed at pH 7; b) assayed at 60°C; c) sun-dried flour from the banana with 9th week maturity time; d) assayed at 70°C. 1) (Fontes *et al.*, 2017); 2) (Buwono *et al.*, 2018); 3) (Wang *et al.*, 2017); 4) (Olawuni *et al.*, 2013); 5) (Gnagne *et al.*, 2017); 6) (Virulchatapan and Luangsakul, 2020); 7) (Campuzano *et al.*, 2018); 8) (Singham *et al.*, 2014); 9) (Rohmah, 2012).

The flour produced in this experiment fulfills type B of the National Indonesian Standard for banana flour (SNI 01-3841-1995), i.e., maximal 12% of water content. The type A standard should have a maximal 6% of water content (BSN, 1995). Campuzano *et al.* (2018) reported total sugar of Cavendish banana flour is 6.33, 12.93, and 51.89% at the ripening stage of 1, 2, and 3, respectively.

CONCLUSION

Flour from kepok, talas, and cavendish banana show significant differences for several parameters of physical properties, namely, solubility, bulk density, wettability, and color. Some of the physical properties parameters of *Talas* banana flour are between *Kepok* and Cavendish, such as swelling power, bulk density, wettability, and water absorption capacity. But *Talas* banana flour has a higher gelatinization temperature than the two. Meanwhile, talas banana flour shows the lowest oil absorption. Therefore, the talas banana can be used as raw material for infant porridge and bread flour.

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