PHYSICOCHEMICAL CHARACTERISTICS OF CASSAVA STARCH PRODUCED BY ITTARA - A SMALL SCALE TAPIOCA INDUSTRY : *A Case Study at PD Semangat Jaya , Lampung*

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ABSTRACT

Cassava is very potential crop grown on marginal lands. It has great productivity, which in Lampung , most of the cassava roots are used for tapioca production. PD Semangat Jaya is one of small scale tapioca industry at Lampung. This industry still uses traditional technology in processing the starch, and the properties of the starch have never been characterized. Therefore the objective of this study was to evaluate the physico-chemical properties of the starch produced by this industry. Based on its distance for settling during extraction process, the starch was categorized into three grades, Grade I, grade II and grade III. Parameters evaluated were, the starch pH, whiteness, moisture, ash, starch, and amylose contents, and pasting properties. The data obtained from three replications were analyzed analyzed descriptively. The results showed that the pH, whiteness, moisture, ash, starch, and amylose contents of starch grade I were 4.1; 77.1; 7,87%; 0.17%; 79.3%; and 34.96%. Whereas for grade II were 4,25; 75.1; 8,1%; 0,22%; 72.38%; and ; 34.97% . The similar contents for grade III were 4,1; 65.7; 8.04%; 0.27%; 77.08% and 31.47% . These results revealed that chemical contents analyzed were in compliance with SNI. For the pasting properties, it was found that the maximum viscosity for grade I, II and II were 968.5 BU; 831.5 BU; and 688.5 BU. The paste instability (breakdown) for grade I, II, and III were 614.5BU; 512 BU; and 327.5 BU. The setback viscosity for grade I, II, and III were 191 BU; 181 BU; and 91 BU. These indicated that the starch granules in each grade has different structure , different functionality and therefore further study is needed.

Keywords: cassava, ITTARA, Lampung, pasting properties, starch.

INTRODUCTION

Cassava (*Maninot esculenta* Crantz), originated from South America, is a perennial woody shrub with tuberous roots . The world production of was estimated as 262 585 742 tonnes with the top producers being Nigeria, Indonesia, Brazil, and Thailand (FAO, 2014). Cassava's planting and harvesting time is flexible, therefore, is available all year around and thus make it a reliable crop for food security.

Cassava grown in Indonesia, includes Lampung , is mainly for tapioca production. Lampung Province is one of major tapioca production center . The tapioca industries in Lampung area consisted of modern industries as well as small scale traditional industry called ITTARA (Industri Tapioka Rakyat). One of ITTARA survivor is PD Semangat Jaya which is located at Pesawaran District. PD Semangat Jaya , so far, uses a series of traditional technique includes peeling outer skin, washing, rasping, pressing, settling and sun-drying of the starch slurry in tapioca production. However the effects of traditional settling and sun-drying on the physic-chemical properties of the tapioca have never been reported. Therefore, this paper reports some physicochemical properties of the tapioca processed traditionally.

MATERIALS AND METHODS

Materials

Raw material used for thus study was starch grade I, grade II and grade III produced by PD Semangat Jaya. Grade I was starch originated or taken from settling area which has the distance of 0-30 m, grade II was 30-60 m , and grade III was 60-90 m from the fresh starch slurry inlet after being settled for 15 h. Whereas the tapioca with commercial brand was bought from local market.

Chemical composition of tapioca

The chemical compositions were analyzed using methods described in AOAC, (2005) with the number of method description as follows: ash (Method 923.03), moisture (Method No 925.10) and starch (Method No 945.37). The amylase content was determined using method described by Juliano (1971).The pH was measured in triplicate using a pH meter (Jenway 3330, UK). Tapioca whiteness was determined using a Powder Whiteness Tester Model C 100, Kett Electric Laboratory.

Determination of amylose content

The amylose content was determined using amylose-iodine complex procedure as described by Juliano (1971). The value of samples and amylose standard absorbance were obtained at 620 nm using a spectrophotometer (Shimadzu UV-1700, Tokyo). The plot of samples absorbance against pure potato amylose standard curve was used to calculate the amylose content of the samples.

Determination of pasting properties

The pasting properties of tapioca samples were determined using Brabender Micro Viscoamylograph (Brabender OHG, Duisburg, Germany). Ten grams (dry basis) of flour samples was suspended in 100 ml of distilled water to obtain 10% suspension w/w. Then the suspension was transferred into the bowl of Brabender, heated from 35°C to 95°C at a rate of 1.5°C/min and kept for 20 min at 95°C. Then it was cooled down to 50°C at a rate of 1.5°C/min and held at 50°C for 20 min. Parameters measured were beginning of gelatinization, peak viscosity, temperature at maximum viscosity, breakdown and setback viscosity.

Statistical analysis

The data of starch proximate, amylose content and pasting properties were taken from 3 replications, and reported in average with standard deviation.

RESULTS AND DISCUSSION

The results of physical content and chemical compositions of the tapioca was summarized in Table 1, and discussed as follows:

pH Value

The pH of the tapioca was between 4.11 and 4.43. The commercial brand tapioca had the highest pH among other samples. This could be caused partly by the different the settling technique used by the manufacturer. ITTARA uses 15 h to settling the starch slurry and then it was sun-dried, whereas the commercial brand uses a vertical dryer machine . The length of settling time affected the pH. The longer the settling, the lower the pH. This phenomena could be caused by the growth of lactic acid bacteria . The growth of lactic acid bacteria (LAB) are dominant during all stages of cassava fermentation and contribute to the development of characteristic properties such as taste, aroma, visual appearance, texture, shelf life and safety. Spontaeous fermentation is also important because it removes considerable amounts of cyanide and produces antimicrobial compounds including organic acids, hydrogen peroxide, and other active low molecular weight metabolites and bacteriocins (Adams and Nicolaides, 1987; Holzapfel, 2002).

Whiteness

The desired starches for commercial purposes should be high value for whiteness. The whiteness of grade 1 grade 2 grade 3 and commercial brand starches was slightly different. They were between 65.7-77.1, whereas the commercial brand starch, as a reference, was 93.3. Different distance of settling tank resulted in small difference in whiteness. The longer the distance resulted in less whiteness value of the starch. This was probably due to the longer the distance had caused higher amount of pigments, polyphenol oxidase and phenolic compounds attached to the starch granule during reaching the settling area. These compounds are easily undergo denaturalization or browning during starch isolation and drying process, lead to inferior starch color (Chen, 2003).

Moisture and Ash Content

The moisture content of the starches were 7.87 % (grade I) to 8.04% (grade III), while this content for commercial brand was 9.05%. These moisture contents were slightly different but meet the National Standard Industry. The ash content of grade I, II, and III starches were 0.17%, 0.22% , and 027%. This results indicated that the longer the distance of settling area from the slurry inlet , the higher the ash content. This phenomena is probably caused by the contribution of low density materials, mainly non -starch polysaccharides materials , together with starch flowing and settling into the further settling areas. The higher ash content indicates less purity of the starch (Thao and Noomhorm, 2011).

Starch and Amylose content

Starch contents of grade I,II, and III were between 72.38% and 79.3%, whereas that of commercial brand was 90%. These values meet the National Standard Industry. The lower content of grade II and grade III was probably attributed to impurities originated from non-starch polysaccharides bound to starch granules.

Amylose contents of grade I,II, and III were between 31.47% and 34.97%, whereas that of commercial brand was 25.87%. The variation in amylase content was attributed to difference of distance of settling areas. Settling area up to 60 m did not affect the amylase content, but further distance (60 m – 90 m) caused decreased in amylase content, while that of commercial brand was much lower (25.87%). These amylose contents were slightly higher compared to those of reported by Richard et al.(2001) which was between 13.6%-23.8%, Moorthy at al.(2002) which ranged from 22.6% to 26.2%.

Tabel 1. Physical characteristics and chemical content of tapioca PD Semangat Jaya and commercial brand

Physical and Chemical Composition	Tapioca			
	Grade I	Grade II	Grade III	Commercial brand
pH	4.11±0.11	4.25±0.17	4.11±0.11	4,43±0,04
Whiteness	77.1± 0.1	75.1±0,15	65.7±0,2	93.3±0,1
Moisture	7.87±0.4	8.11±0.15	8.04±0.01	9.05%±0.1
Ash	0.17%±0,01	0.22%±0,002	0.27%±0,01	0.30%±0.02
Starch	79.3±5.00	72.38±12.05	77.08±7.05	90%±4.05
amylose	34.96±0.53	34.97±0.35	31.47±0.40	25.87%±0.65

All values are mean of three replications followed by standard deviation

Pasting properties

The pasting properties of the starch produced by ITTARA and commercial brand are summarized in Table 2.

The start of gelatinization temperature for grade I,II and III starches ranged from 72.9°C (grade I starch) to 74.9 °C (grade III starch), while this temperature for commercial brand only was about 67.7°C. These results were higher than the results reported by Richard et al.(1991) and Moorthy et al.(1992) in which reported that temperature of cassava starches varied from 60.11°C to 72.6°C . The differences in the start of gelatinization temperature were affected by changes in interior structure of starches which can occur in both amorphous and crystallize regions (Katayama et al., 2002) or by starch granule size (Chen, 2003).

The maximum viscosity of all ITARA tapioca ranged from 668.5 BU for grade III starch to 968.5 BU for grade I starch, and that of grade II starch was in the middle of that range 831.5 BU , whereas commercial brand tapioca was the highest 1356 BU. The breakdown viscosities for grade I, II, III and commercial brand were 614.5 BU, 512 BU, 327 BU, and 646 BU . While those of setback viscosities were 191 BU, 181 BU, 91 BU, and 655 BU.

Collado and Corke (1997) reported that peak viscosity have negative correlation with amylose content because the amylose restricted the starch granules swelling, resulting in low peak viscosity. This seems to be true for commercial brand tapioca but in line with the results for ITARA tapioca . The differences in peak viscosity may be due to differences in phosphorous content (Chen, 2003) , differences in size and shape of starch granules (Rahman, 2000) or difference in size and branching chain length of amylopectin (Mua and Jacson, 1997; Mua and Jacson 1998).

Starches with higher in phosphorous content exhibited a higher peak viscosity due to increasing hydration of starch by weakening the degree of bonding within the ncrystalline region(Sandhu et al., 2010). The low peak viscosity in grade III was partlt due to lower content of amylose, thus higher amylopectin content primarily very long brach amylipectin. Jane et al. (1999) reported that very long branch chains of amylopectin resembled amylose to form helical complexes with lipids and interlink with other branch chains to hold the integrity of starch granules during heating and shearing, resulting in low peak viscosity.

In term of shear and high temperature stability, the results indicated that grade III starch withstands shear and high temperature much better due to very low breakdown value, which was about 327.5 BU, compared to that other starches, ranging from 614,5 BU (grade I) to 327.5 BU (grade II). Whereas commercial brand starch was the most susceptible to shear and high temperature.

Setback viscosity can be used to predict the tendency of retrogradation. Higher setback value indicates higher rate of retrogradation. Setback values of grade I , II, and III were 191 BU, 181 BU, and 91 BU, thus the higher the amylose content , the higher retrogradation rate . However this phenomena was not observed in the commercial brand tapioca , probably the starch granules have been subjected to some modifications to alter their native properties.

Rahman (2000) and Bhattacharya et al.(1999) reported that starches with higher amylose content exhibited higher setback value, more hardness and less stickiness. Therefore, the setback was considered as another important criterion for starch selection for many food industries.

Tabel 2. Pasting properties of tapioca PD Semangat Jaya dan commercial brand

Point	Fase Pemanasan	Tapioca			
		Grade I	Grade II	Grade III	Commercial brand
A	Start of gelatinization temperature (°C)	72.9±0.14	73.4±0,28	74.9 ±0.28	67.7±1.4
B	Maximum viscosity (BU)	968.5± 0.71	831.5±6.36	668.5±43.3	1356±2.8
C	Start of holding periode at 90° , 20 min (BU)	670.5±19.1	621±7.07	632± 87.68	842±56.5
D	Start of cooling periode (BU)	353±5.66	317.5±0.71	338.5±51.62	708±14.1
E	End of cooling periode (BU)	549.5±14.85	504±9.9	435±25.46	1381±12.7
B-D	Breakdown (Paste instability) (BU)	614.5±6,36	512±7.1	327.5±94.05	646±9.89
E-D	Setback (Retrogradation) (BU)	191±8.48	181±9.9	91±26.87	655±7.07

All values are mean of three replications followed by standard deviation

CONCLUSION

Chemical contents of ITTARA tapioca analyzed were in compliance with SNI. But less white in color compared to that of commercial brand. The starch was less viscous, less stable, and tends to retrograde more as the distance of the settling areas were further . Overall, these results indicated that the starch granules in each grade has different structure , different functionality.

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