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Modification of Casava Starch Properties by Spontaneous Fermentation

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Abstract
The impact of spontaneous fermentation on the physical and chemical characteristics of fluidized cassava starch treated in a sedimentation tank were examined. Tapioka, aci puter, and elot are three types of casava starch products that were made from starch slurry collected at various periods of spontaneous fermentation. By different spontaneous fermentation time, the appearance of granules was significantly changed. Besides, there was different response color to iodine test indicating a different amylopectin chain-length distribution pattern. Among them, there were significant differences in moisture content, swelling power, water absorption ratio, gel formation ability and pH value. These studies showed that spontaneous fermentation might be used to modify casava starch products.

Keywords: casava starch, spontaneous fermentation, modification

1. Introduction

`Cassava is one of the most widely cultivated starch sources in Indonesia. cassava harvested area in Indonesia in 2019 covering an area of 0.63 million hectares with production of 16.35 million tons [1]. In general, cassava has a chemical composition consisting of 60.88-74.48% (dw) moisture content, 19.13-24.49 35% starch (dw), 1.18-2.44% (dw) crude fiber, 0.13-1.21% (dw) fat content and 0.83-2.13% ash content [2]. Starch from cassava is called tapioca and is widely used as food, feed, energy sources, and various purposes as auxiliary materials in various industries.

The process of making tapioca generally consists of peeling, washing, grating, squeezing, or extracting, settling, drying, and milling [3]. Small-scale tapioca producers generally produce several types of tapioca which are produced from different settling times. In the scenario of small scale of casava starch (ITARA Rukun Santosa, Lampung Timur), the starch slurry is gathered and stored in a cement tank. The starch is then covered by the resulting supernatant, which quickly solidifies at the tank's bottom. The starch could be kept at room temperature for a period of time without having the supernatant replaced with tap water. The casava starch named tapioca was collected after sedimentation for 1–3 days, and the rest was collected after 14-30 days, and 4-12 months to yield product called as aci puter and elot, respectively. During the casava starch sedimentation process, a spontaneous fermentation process that is often dominated by lactic acid fermentation may take place [4]. As far as we are aware, the features of these three compounds (tapioca, aci puter, and elot) that promote spontaneous fermentation have not yet been fully characterized.

According to earlier research [5] [6], fermentation has a significant impact on the compositional and structural characteristics of cassava starches. In this work, it was hypothesized

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that when casava starch is held in a tank, spontaneous fermentation causes significant changes in the morphological, structural, and physicochemical aspects of the starch. Thus, the purpose of this research was to determine how the starch granule structures changed during spontaneous fermentation under various storage circumstances and to what extent these changes were related to particular starch quality.

2. Materials and Method

2.1 Materials and Apparatus

The main ingredients used in this study were tapioca, aci puter, and elot obtained from ITARA Rukun Santosa, East Lampung, and Pak Tani commercial tapioca as a control were from store in the market. Other ingredients were distilled water, water, and iodine solution. The tools used in this research were light microscope, oven, desiccator, centrifuge, and pH meter.

2.2. Characterization of Starch Casava Properties

Starch casava properties characterization included the apperanace of starch granule, water content, swelling power, solubility, water absorption ratio, iodine test, gel formation test, and pH.

The appearance of starch granules was observed with a light microscope with 40x magnification. Analysis of water content using the gravimetric method [7]. Swelling power and solubility using the method performed by Torruco-Uco and Betancur-Ancona [8].

The water absorption ratio was tested by weighing 1 gram of tapioca. The suspension was then stirred for 5 minutes and transferred to a centrifuge tube, then centrifuged at 3500 rpm for 30 minutes at 25˚C. The supernatant obtained was measured using a 10 ml measuring cup. The value of water absorption is calculated based on the water absorbed by the material after centrifugation per volume of initial water added. The result is expressed as the percentage of water absorbed by starch in g/g.

Iodine test is done by direct determination of casava starch. The sample was first made a 10% suspension and then was given one drop of iodine solution. Then the sample was observed visually.

The test of the concentration of starch gel formation was carried out by making a starch suspension with a concentration of 2%-20% in 10 mL of distilled water. The suspension is boiled in a boiling water bath for one hour and then cooled in cold water. The next step is the test tube is put in the refrigerator for 2 hours and the test tube containing the gel is inverted to determine whether the gel has fallen or not [9]. Measurement of pH refers to Dufour et al [10] which begins with making a sample suspension with a concentration of 10%. The material was then given 30 minutes to settle at room temperature. The suspension was centrifuged at 27°C for 10 minutes at a speed of 3000 rpm. After separating the resulting supernatant, the pH was assessed using a pH meter.

2.3 Data Analysis

Six replications of the experiments were run using a randomized complete block design. The data of water content, swelling power, solubility, water absorption ratio, and pH were subjected to one-way ANOVA test and Tukey's honestly significance difference (HSD) at 5% significant level. The data of starch granule, iodine test, and gel formation test were visually reported.

3. Results and Discussion

3.1 The appearance of starch granule.

The casava starch granules of tapioca samples resemble the shape of commercial casava starch granules, which are round, whole and homogeneous. In the “aci puter” sample there were some broken starch granules and the size was not homogeneous. Meanwhile, the "elot" casava starch, granule was in small quantity, has a round granule shape, and many are broken. Moorthy [11] reported that tapioca granules have round and oval shapes with a size of about 5-40 µm.

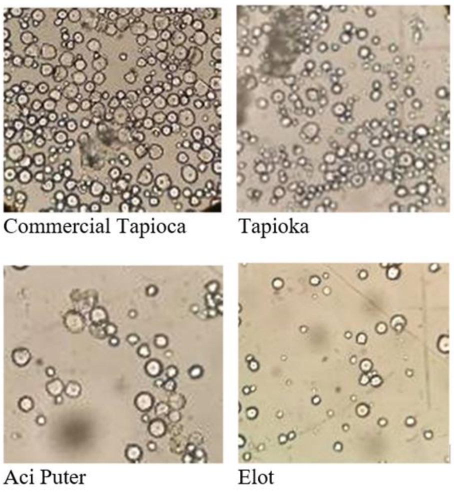

Figure 1. Granule of casava starch

3.2 Iodine Test Observation

Iodine with amylose will combine to form a blue complex [12]. Visual observation based on the iodine test on commercial casava starch and tapioca Itara resulted in a purplish-blue color response, on aci puter it produced a brownish red color and on elot it produced a brown color (figure 2). These results suggested that long fermentation has effect on many loosing amyloses chain. Therefore, its response was no longer blue color when dripped by odine, as presented on Fig. 2.

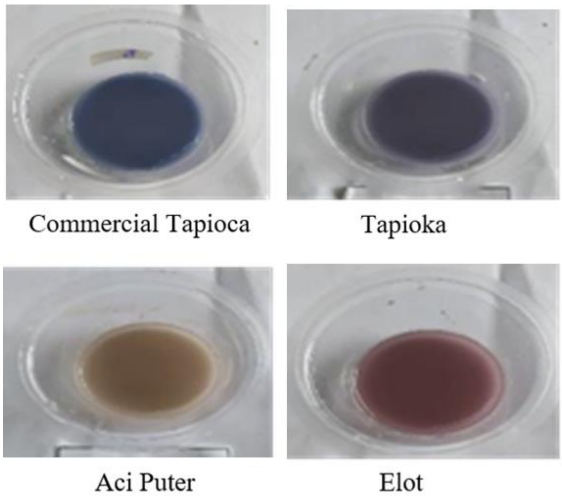

Figure 2. Visual color of iodine test

The two most important polysaccharides that make up starch are amylose and amylopectin. The tapioca starch consists of 17% amylose and 83% amylopectin [13]. Long fermentation has effect on many loosing amyloses chain. Based on the iodine-binding principle, therefore, different amounts of amylose in casava starch product (*tapioka, aci puter, elot*) showed the different intensity of blue complex.

3.3 Physicochemical Properties

The physico-chemical properties of casava starch which include water content, pH, water absorption ratio (WAR), swelling power, and solubility, are presented in Table 1.

Also, the results of the least concentration test for gel formation is presented in Table 2.

Table 1. Physico-chemical properties of fermented casava starch

Samples	Water Content (%)	Water absorption ratio (g/g)	Swelling power (g/g)	Solubility (%)	pH
Commercial	9.86±0.31^{d}	1.72±0.023^{d}	8.48±0.07^{b}	1.17±0.06^{d}	5.53±0.04^{a}
Tapioka	12.56±0.35^{b}	1.77±0.064^{c}	8.53±0.09^{b}	1.72±0.02^{c}	4.62±0.08^{b}
Aci puter	16.17±0.39^{a}	1.92±0.029^{b}	11.06±0.10^{c}	7.48±0.07^{b}	6.32±0.12^{c}
Elot	12.43±0.61^{bc}	2.02±0.071^{a}	7.68±0.08^{a}	1.37±0.08^{a}	4.24±0.06^{d}

Table 2. Gel Gelation Test

Casava Starch	Concentration									
	2 %	4 %	6 %	8 %	10 %	12 %	14 %	16 %	18 %	20 %
Commercial	+	+	+	+	+	+	+	+	+	+
Tapioka	+	+	+	+	+	+	+	+	+	+
Aci puter	+	+	+	+	+	+	+	+	+	+
Elot	-	-	-	-	-	-	-	-	-	-

+ not fall down, - fall down

The means followed by the same letter in a column do not differ significantly (HSD test; p> 0.05). The water content of the three types of tapioca ranged from 12.43-16.17% higher than the water content of commercial casava starch (9.86%). The soaking and fermenting process the three casava starches causes the amount of water bound by the granules to increase. This could be due to a loosening chain in the starch granules as a result of fermentation. In relation to the standard of water content of tapioca starch (SNI 2011), only casava starch products (tapioka) with a moisture content of 12.56% meet SNI (less than 14%), while elot and aci puter do not meet these requirements.

Like the effect on increasing of water content, the shorter starch chains that more easily absorbed water also significantly affects the water absorption ratio (WAR) and swelling power. The product with the highest soaking time (elot) had a higher WAR (2.02%) than aci puter (1.92%), and tapioca (1.77%). Meanwhile, commercial starch WRA as a comparison is 1.71%. Likewise, *aci puter* had the highest swelling power (11.06 g/g) compare with that of *tapioka* (8.53 g/g) and commercial casava (8.48 g/g).

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According to Claver et al [14], hydrogen bonding sites can hold more water molecules when the temperature is elevated and active starch disrupts intermolecular bonds. Water absorbed by each starch granule causes it to swell, increasing the swelling power [8]. However, the *elot* product has the lowest swelling power value, this is presumably because many of the starch granules have been damaged as a result of undergoing the fermentation process for too long, so they are unable to withstand the expansion of the granules.

In terms of the solubility value of starch, it appears that the highest solubility value lies in elot, namely 11.37%, then aci puter (7.48%) and tapioca (1.72%). Cassava starch with increased fermentation time had a higher solubility value. The length of fermentation for elat products reaches 3-6 months so that many granules are damaged and released (Figure 1). In line with the statement of Liu et al [15], starch with granules that have been damaged (eroded) has high solubility properties.

The results of pH measurements showed that the three casava starch products included acid starch with the lowest pH value (4.24) was found in the elot product. Meanwhile, the pH of commercial casava starch is around 5.53. The fermentation process causes the pH value of starch to decrease. In the casava fermentation process, metabolism occurs from the activity of microorganisms, especially lactic acid bacteria which produce organic acids [16], thereby lowering the pH.

3.4 Gelation Capacity

Data of gelation capacity are presented in Table 2. The gelation capacity of all sample except elot was 2%. The poor gelation value of the elot product suggests that it could not be a dependable gel forming agent. Starch gels were previously referred to as composites comprised of gelatinized granules contained in an amylose matrix [17]. Thus, in this study, vary amylose and amylopectin in *tapioka*, *elot* and *aci puter* played role in their gelation capacity.

4. Conclusion

The different times of spontaneous fermentation may change the appearance of the granule significantly. There are significant differences in moisture content, swelling, water absorption rate, gelation capacity and pH value. These studies show that transformation of cassava starch product can use spontaneous fermentation. This finding is usefull for casava production plan in small indusrty.

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