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Extraction and Analysis of Characteristics of Starch from Sago Hampas

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Abstract – Sago hampas is a by-products of the sago processing industry which has not been handled properly and has unique material because it is a strachy lignocelluloses material with a starch content of 50-70%, but it has a weakness because it it tightly bound in the lignocelluloses matrix. This research aimed to determine the appropriate extraction method for sago hampas starch and characteristics of starch from sago hampas.This research used two extraction methods, hydrothermal using autoclave and ultrasonification using ultrasonic bath. The results showed that the best extraction method was using ultrasonification for 60 minutes without temperature treatment with a sago hampas concentration of 4% (w/v), obtained a water content of 6.35%, yield 7.69%, density 0.83 (g/ml), pH 5.59, visicosity 967 BU, solubility 11.13%, swelling power 14.46 g/g, amylose 17.75% and amylopectin 82.25%.

Keywords – Sago Hampas, Ultrasonification, Hydrothermal, Characteristics.

I. Introduction

Sago is a natural resource that has started to experience increased utilization in Indonesia since the late 70s as a result of the national self-sufficiency utilization program. Indonesia has the largest area of sago forest and the largest genetic diversity in the world with data on Indonesia's sago area of about 5.4 million hectares with a potential productivity of sago palm estimated at around 5 million tons per year [1].

Sago has great potential to meet food needs and other industrial needs [2]. According to [3] the sustainable potential for sago production is 5.000.000 tonnes per year, but only 200,000 tonnes are being utilized per year. Based on the 2015 food consumption statistics by the Center for Agricultural and Information Systems, the average growth in the use of sago food continues to increase by an average of 16.16% per year compared to the need for rice food, which is 1.49% per year. The high potential of sago in Indonesia is followed by an increase in sago consumption and production by the community. This increase was also accompanied by an increase in the amount of sago hampas produced.

Sago hampas is a fibrous residue that remains after most of the starch has been washed from the pith of the sago palm. Sago hampas is available quite a lot throughout the year, is cheap and easy to obtain [4] with a ratio of flour to hampas of 1:6 [5]. This shows that the amount of hampas produced from the sago processing industry is higher than the amount of sago starch obtained. Sago hampas is generally not well managed so it can be a source of problems for the environment. However, sago hampas is a unique material because it is a starchy lignocellulosic material. Sago hampas contains 60-70% starch [6]; 51.53% [7] ; 55.33% [8]

based on dry weight. The starch content obtained from these studies shows high enough yields so that it can be used as an ingredient to meet high starch requirements.

According to [9] large amount of starch is still trapped in the lignocellulosic material of sago hampas after microscopic examination. This shows that there is starch that is tightly bound in the sago hampas so that an appropriate extraction process is needed to obtain extracts with maximum starch content. The results of the study [7] showed that the use of distilled water in the hydrothermal process of sago hampas produced the highest starch content, namely 17.9 g/l with 87.24% yield in the extract.

Starch extraction can also be carried out using ultrasonic waves at a frequency (about 18-20 kHz). The application of the ultrasonic intensity technique is able to extract phytochemical compounds such as alkaloids, flavonoids, polysaccharides, proteins and essential oils from various parts of plants and plant seeds [10]. Extraction of sago starch by [11] shows that the highest concentration of sago starch, 71.5%, is obtained at a concentration of 10% (w/w), power 160 W, and time of 7 minutes. This shows that different extraction methods can affect the amount of starch obtained, as well as its characteristics, so it is necessary to choose the right hampas starch extraction method. Sources and different starch extraction methods are thought to affect the yield of starch extraction in terms characteristics starch.

II. Materials and Methods

This research used an exploratory method to determine the appropriate starch extraction method.The materials used in this research were sago hampas obtained from Koto Marapak, Padang Pariaman City, aquades, $Ca(OH)_2$, NaOH, K_2SO_4, 96% ethanol, CH_3COOH, iodine, amylose standard. The equipment used is autoclave, pH meter, ultrasonicbath, brabender, cabinet dryer, oven, blender, centrifuge, hotplate, testube, spectrophotometry, beaker, erlenmeyer, analytical scales, 150 mesh filter cloth, aluminum plate, sieve 80 and 100 mesh.

A. Raw Material Preparation

The raw material used in this research is sago hampas as a by-product of the sago processing industry taken from Nagari Koto Marapak, Kota Pariaman.Wet sago hampas is collected and dried using the sun for two days and followed by drying with a cabinet dryer until the water content is 10-11%. The sago hampas is then sieved to pass an 80 mesh sieving and then packed in clear plastic and stored in an airtight jar.

B. Extraction of Starch

1. Hydrothermal (HT)

Extraction of sago hampas starch was carried out using modification [7]. The sago hampas is dried to a water content of 10-11%, then reduced in size to pass an 80 mesh sieve. 4% (w / v) of hamapas sago mixed with distilled water in 500 ml Erlenmeyer and closed tightly. The hydrothermal process was carried out at a temperature of 115 oC for 15 minutes using an autoclave. The extracted mixture was pH adjusted to 6.5 with $Ca(OH)_2$ 0.5 N and filtered with 150 mesh pores. The filtrate was dried by cabinet drying at 60 ^oC for 48 hours, then reduced in size until it passed a 100 mesh sieving.

2. Ultrasonification (US)

Extraction of sago hampas starch used modification [11]. 4% (w/v) of sago hampas was extracted with distilled water using utrasonicbath for 60 minutes by controlling the temperature below 40 ^oC. The mixture is then filtered with a filter cloth with pores of 150 mesh. The liquid is then deposited for 2 hours until it is separated between the sediment and the liquid. The starch precipitate was dried by cabinet drying at 60 ^oC for 18 hours and reduced in size until it passed a 100 mesh sieving.

III. Results and Discussion

A. Sago Hampas

Sago hampas is the main raw material for starch extraction. It is necessary to test the water content of the hampas from drying out to determine the water content of the sago hampas before storage. Sago hampas should be dried to the right water content to avoid unwanted microbial growth during storage. The results of testing the water content and pH of sago hampas can be seen in Table 1.

Table 1. The results of testing the water content and pH of sago hampas

Analysis	Sago Hampas ± SD
Water content (%)	11.46 ± 0.3185
pH	4.83 ± 0.0942

The results showed that the water content of sago hampas was 11.46% with a pH of 4.83. The water content obtained in this study was almost the same as [12] and [13] namely 11.68%. The water content of the sago hampas obtained was in accordance with [7] where the water content of the sago hampas was adjusted to 10-11%. Drying the sago hampas to the right water content needs to be done so that dry materials can be stored for a longer time and can be protected from damage by microorganisms during storage.

B. Extraction of Sago Hampas Starch

The results showed that different types of extraction methods produced starches with different characteristics. The hydrothermal process causes the sago hampas starch to gelatinize, resulting in a slightly thick liquid with the final product like sheets of glass after cabinet drying. Starch sheets that have been dry when reduced to 100 mesh size with a slightly coarser texture than general starch with a brown starch finish.

The ultrasonic method of sago hampas starch extraction produces starch with an appearance similar to starch in general. The resulting starch has a texture similar to sago starch and other starches. The resulting starch is brownish in color. Pictures of starch extracted from hydrothermal (HT) and ultrasonification (US) methods can be seen in Figure 1.

a b

Figure 1. Sago Hampas Starch

a = Hydrothermal (HT) ; b Ultrasonification(US)

C. Physical Characteristics

Physical characteristics of sago hampas starch were observed to see changes in the physical properties of starch if heat treated or otherwise. Physical properties are changes experienced without forming new substances. The physical characteristics of sago hampas starch can be seen in Table 2.

Table 2. Results of Analysis of Physical Characteristics of Sago Hampas Starch

Analysis	Hydrothermal (HT) ± SD	Ultrasonification (US) ± SD
Yield (%)	21.54 ± 0.2705	7.69 ± 0.0208
Density ((g/ml)	0.80 ± 0.0028	0.83 ± 0.0081
Viscosity (BU)	24.5 ± 2.5	967 ± 0.0000

Solubility (%)	9.95 ± 0.0433	11.13 ± 0.0952
Swelling Power (g/g)	7.86 ± 0.0172	14.46 ± 0.0178

1. Yield

Yield is the ratio between the results obtained and the basic ingredients [14]. The HT extraction method produced rice with a higher yield than the US starch extraction method. The use of hight temperature treatment in this method causes a change in the shape of the starch, which is indicated by the breakdown of the sago hampas starch granules. The use of high heat in this method causes the starch to change shape which is indicated by the breaking of the sago hampas starch granules. The gelatinization produces starch in a large number of sheets so that the final yield of starch with this method is higher than starch in the US method.

US method of sago hampas starch extraction produces starch with an appearance similar to starch in general, brownish white**.** The yield starch obtained using this method is lower than starch extraction using HT because the starch components are extracted without changing the physical form of the starch. In this extraction method, the starch that is firmly bound in the cellulose matrix of sago hampas will come out as a result of the cavitation produced by the ultrasonic bath. The resulting vibration causes the cell wall in the cellulose matrix of the sago hampas to open so that the sago hampas starch can come out and be extracted. This is in accordance with [15] that the mechanical action of cavitation with high velocity and shear forces causes high penetration of cell dispersals which leads to cell disruption.

2. Density

Density is defined as the ratio between the weight of foodstuff to the volume of the material in a room [16]. Density measurement needs to be done because it is one of the important parameters in determining the type of packaging and storage method for starch products. The test results showed the density values of sago hampas starch using the US method were 0.83 g/ml and 0.80 g/ml for the HT method. The analysis results showed that the density values were almost the same for the two types of starch. The same value is because the particle or mesh size of the two starches is the same, which is 100 mesh, so the weight of the material per volume of the place is not much different. The results of the analysis are in accordance with the statement [17] that the density of the cage is affected by the particle size. The results of the density analysis of sago hampas starch were almost the same as the density values of cassava starch, namely 0.28-0.81 g / ml [18] and mocaf flour, namely 0.71-0.81 g / ml ([19].

3. Viscosity

The viscosity test is carried out by dissolving the starch in water so that the viscosity of the starch can be measured. The results of the starch viscosity test of the HT method showed a visicosity value of 24.5 BU and 967 BU in the extraction method using the US method. The low viscosity value of the starch in the HMT method was due to the previous gelatinization of starch due to the extraction process using a temperature of 115 °C. Gelatinization that occurs in the starch granules during the starch extraction process by this method causes a decrease in the visicosity value of the starch of sago hampas so that the starch cannot gelatinize completely when testing viscosity with amilograph brabender. These results are consistent with [19] where the decrease in viscosity value occurs due to the brittleness of the starch granules due to heating friction. These results are consistent with [20] where the decrease in viscosity value occurs due to the brittleness of the starch granules due to heating friction. The friction heating of the HT starch method has occurred during the starch extraction process using high temperatures at the raw material preparation stage. Meanwhile, the starch visicosity of the US method showed a high value with perfect swelling of the starch granules. The peak visicosity value of sago starch in the US extraction method was higher than the visicosity of sago starch based on the quality standard of malaysya sago starch [21], which is 600 BU, but it has low visicosity for HT starch method.

4. Solubility

Solubility is the weight of starch dissolved and can be measured by drying and weighing the amount of supernatant solution [22]. Solubility Starch is an important component when applied. Starch which dissolves easily is preferred and used in its application. Sago hampas starch extracted by US method had higher solubility values, namely 11.13% and 9.95% in HT starch method. These results indicate that US starch is more soluble than HT starch. The solubility value obtained in this study was lower than the results of the research on the solubility of sago starch from various cutting ages with a value of 21.07-25.91%, but higher than the solubility of natural ihuir sago starch, namely 4.86% with a solubility value of 4, 85% -5.38% in sago starch with heat moisture treatment [23]. While the solubility value of sago starch from several varieties ranged from 1.80 to 2.83%, which had a lower solubility value than this study. This shows that the starch solubility value can be influenced by several factors such as variety, cutting age, starch source and others.

5. Swelling power

Swelling power shows how much the starch can swell as indicated by changes in weight due to water absorption by starch granules. The result of swelling power test showed that the highest value of granule swelling was in the US method starch, which was 14.46 g / g, while for HT starch, it was 7.86 g / g. These results indicate that the starch with the US method absorbs more water so that the swelling of the starch granules is higher. Swelling of the granules by water is influenced by the size of the granules and the amylose content in them. According to [24] swelling power was determined by amylose content and granule size. The higher the amylose content and the larger the granule size, the greater the swelling power. From the results obtained, it can be seen that high swelling in the US method starch is due to the high amylose content of the US method starch, namely 17.75% compared to the HT method starch with an amylose content of 12.57% which can be seen in Table 3.

The swelling power value obtained in this study was higher than the swelling power value of sago starch from various cutting ages, namely in the range 0.202-0.278 g / g. The high swelling value from the results of this study is presumed because the starch extraction process uses heat and vibration which can affect the particle size and shape of the starch granules. The extraction method indirectly affects the swelling power value of sago hampas starch. The swelling power value of the US starch method is almost similar to the sago starch from several sources of sago varieties, with a swelling power value range of 11.92 g/g-13.32 g/g.

D. Chemical Characteristics

Starch is a carbohydrate component in plants with different characteristics for each type of starch. The different characteristics are influenced by the starch source and the extraction method starch. The chemical characteristics of sago hampas starch can be seen in Table 3 below.

Table 3. Results of Chemical Characteristics Analysis of Sago Hampas Starch

Analysis	Hydrothermal (HT) ± SD	Ultrasonification (US) ± SD
Water content (%)	8.26 ± 0.07767	6.35 ± 0.0463
Amylose (%)	12.57 ± 0.0156	17.75 ± 0.0192
Amylopectin (%)	87.43 ± 0.0196	82.25 ± 0.0192
pH	6.03 ± 0.0471	5.59 ± 0.0047

1. Water Content

Table 3 shows that the water content of the sago hampas starch in both extraction methods met the SNI 01-3729-1995 standards, namely below 13% with a water content of 8.26% in the starch in the HT method and 6.35% for the starch in the US method. The water content of starch is influenced by the length of time for drying in each extraction method. US method starch requires a shorter drying time, namely 18 hours, while the HT method starch requires a longer drying time, namely 48 hours. The results showed that the water content of the HT method was higher due to the extraction process of starch gelatinization so that the dried material had a high water content with a longer drying time. The water content of sago hampas starch obtained in this study was lower than that of sago starch dried by conventional methods, namely 13.69% and 13.42% for solar-powered cross flow fluidized bed drying [25].

2. Amilosa dan Amilopektin

Amylose standard curve was measured to determine the amylose and amylopectin levels of sago hampas starch. Measurement of the standard amylose curve yields a value of y = 0.649x-0.003 with R2 = 0.999. Amylose standard curve can be seen in Figure 2.

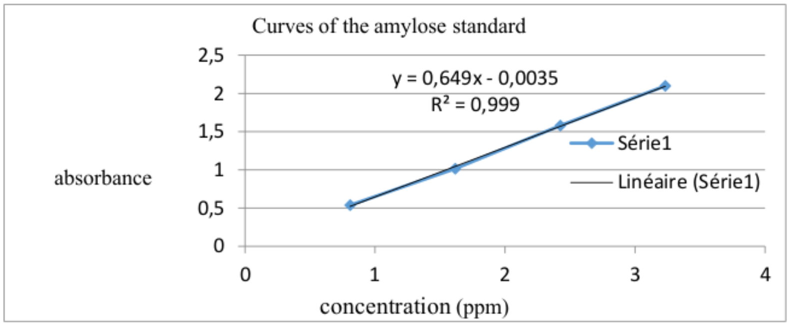

Figure 2. Curves of the amylose standard

The results showed that the amylose and amylopectin content of sago hampas starch from the two extraction methods was in accordance with [26] with amylose content ranging from 15-20% and amylopectin 70-85%. The amylose content of sago hampas starch was lower than sago starch according to [26] namely 35.13-38.65%, [27] at 27.64%, [28] at 24-30%; [29 and [30] amounted to 22-31.7%; [28] ranged from 24-27% and [27] at 27.64%. The lower yield is thought to be due to the starch which comes from the by-product of the sago processing industry, where sago hampas is a fibrous residue. The amylose and amylopectin content of starch obtained were also lower than other types of starch where according [31] to the amylose content of corn, potato and wheat starch around 20-30% with amylopectin around 70-80%.

3. pH

The pH of the two types of sago hampas starch extraction methods was not much different, namely 6.03 in the HT method and 5.59 for the US method of starch. The pH value of the two starches obtained experienced a decrease in pH from the starting material of sago hampas namely 4.83 to neutral pH.

IV. Conclusion

This research was designed to obtain the appropriate method of sago hampas starch extraction. The results showed different characteristics of the two extraction methods.The best extraction of sago hampas starch used the ultrasonification method with a water content of 6.35%, yield 7.69%, density 0.83 (g/ml), pH 5.59, visicosity 967 BU, 11.13% solubility, swelling power 14.46 g/g, amylose 17.75% and amylopectin 82.25%.

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