The Novelty of Producing Maltodextrin From The Local Sago of Papua

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ABSTRACT

Sago (sago Metroxylon Rottb) is an abundant starch source in Indonesia but has not been used optimally. On the one hand, Indonesia is still importing modified starch, including starch-based maltodextrin, to meet the needs of industry, especially pharmaceuticals and food. Maltodextrin production from sago starch of Papua is expected to support the development of plant-based starch derivative products in Indonesia. This study produces sago starch-based maltodextrin through hydrolysis using two constant time parameters for 60 minutes, temperature 80^0C, and varied enzyme alpha-amylase into three different loadings of 0.05%, 0.075%, and 0.1%. Some of the acceptable characterizations of Maltodextrin measured were Dextrose Equivalent (DE) and solubility in water corresponding to values of 16.7 and 96.9%, respectively, which were obtained from Sago starch sample hydrolyzed using the highest enzyme loading of 0.1%. Another supporting parameter is the lowest moisture content of 5.46%, generated by the enzyme loading of 0.1% during hydrolysis. This study has good prospects and is achievable to support local food development towards industry in Papua and feasible to missing text.

Keywords: Sago Starch, hydrolysis, α-amylase loading, Maltodextrin, Industry-Papua

Introduction

The production of Maltodextrin from the local Sago of Papua represents a novel and potentially lucrative endeavor. The use of sago starch for hydrolysis in industrial applications, such as maltodextrins and glucose syrups, has been limited by granular resistance to commercial enzymes and high paste content (Karim, A., et al. 2008). Due to this limitation, researchers have been exploring alternative methods to improve the saccharification of sago starch.

Sago (sago Metroxylon Rottb) is one of the starch-producing plants that grew well originally in the eastern part of Indonesia and has recently been planted widely in other parts of this country. It has been reported that the potential Sago in Indonesia accounts for up to 50% of the world population of Sago, corresponding to a productivity of 25 tons/ha annually (Derosya & Kasim, 2017; Bujang, 2014). Especially in the eastern part of the country, Sago is a typical plant material used as the primary food source in certain areas in Papua. Based on data from the Central Bureau of Statistics in Papua (Papua, 2015), the sago plant has a total land area of 12.716 ha, which ranks fourth in land use plantation crops after Chocolate, Coconut, and Palm Oil plants; however, this number has not been used optimally. Moreover, the sago palm trees in Papua are known for their vast natural stands and high genetic variation, making the region a center of sago diversity and, therefore, an ideal location for the production of sago-derived products such as Maltodextrin (Elgadir, M A., et al , 2009).

Meanwhile, to improve the uses of Sago to become more economically and sustainable for several sectors, one of the derivative products that can be produced is named Maltodextrin (Fajriutami, et al, 2015). Bonds essentially tie this derivative product containing units of α-D-glucose -(1,4) glycosidic (Ratnayake and Jacson., 2008., (Sunari, et al., 2016) and widely used as a mixture creamer or cheese, diet such as isotonic drinks. In addition, this product could be a mixture of making cakes or bread in the market. Through the sense of taste/tongue, Maltodextrin has a characteristic sweetness because it is a mixture of glucose, maltose, oligosaccharides, and dextrin. Moreover, despite the benefits that may accomplished from this derivative product, the present work done in this area is still limited due to several factors, such as the readiness of technology and sharing knowledge of the urgency for producing derivative food in Indonesia.

By adopting former technology and research focusing on producing Maltodextrin from other starches feedstocks, Sago from starch is reliable. One of the main concepts determining the success of maltodextrin production is the liquefaction of starch. Starch liquefaction can be completed through partial hydrolysis of starch using acid or enzymes (Sunari, et al. 2016); Abdorreza et al., 2012). Despite the potential to accelerate the acid hydrolysis of the starch liquefaction process, classified acid hydrolysis methods are relatively expensive due to the main ingredient of the acid itself, which is costly. Also, the environmental impact caused by the acid disposal at the end of the starch liquefaction process needs additional handling care. Therefore, the enzyme is a widely used option in the industry to produce Maltodextrin. Specifically, α-amylase used was able to improve the production of Maltodextrin in this work with several characterizations: observed moisture, solubility in water, total reducing sugar, and total carbohydrate content. It is aimed at ensuring that parameters used during the hydrolysis process may have an impact on contributing to better maltodextrin characterization.

Materials and Methods

In this study, sago starch was initially harvested from the Jayapura regency. This feedstock was dissolved into a solution mixer containing sodium acetate buffer pH of 5 and 1000 ppm of $CaCl_2$. The next step was a gelatinization process in which the starch solution was heated at temperature ranges between 80°C for ± 30 minutes on a hotplate stirrer. After that, the temperature was lowered to 60°C, then α-amylase with varying loading concentrations of 0.05%, 0.075%, and 0.1% were added into three different batches. The mixture of each batch was heated to a temperature of 70 ° C for 60 minutes of reaction time. The temperature of the mixture is then adjusted to 30°C.

Furthermore, once the enzyme was deactivated, 0.1N HCl was added to set the solution's pH between 3.7 and 3.9. The resulting mixture of solid and liquid (Maltodextrin) was dried in an oven at 50°C for three days, ground into a specific size, and ready for characterization.

Once this feedstock was taken for research, several standard characterizations were done using the services of two different laboratories: Universitas Cenderawasih and the Center for Agro Industry-Based in Bogor. Standard characterization was compared with the former study in this focus research area.

Results and Discussions

Characterization of Raw Sago

Table 1. Characterization of Raw Sago

Parameters	Units	Results	Methods
pH		3.66	SNI 01-2891-1992 point 16
Water/Moisture content	%	42.0	SNI 01-2891-1992 point 5.1

Dush	%	0.03	SNI 01-2891-1992 point 6.1
Protein (Nx6.25)	%	0.05	SNI 01-2891-1992 point 7.1
Fat	%	0.17	SNI 01-2891-1992 point 8.2
Amylose	%	24.6	SNI 01-4447-1998 point 6.11
Amylopectin	%	33.2	IK 7,2,3

The characterization of Sago Starch is shown in Table 1. The characterization measurements were done using the wet Sago standard. It is suggested from the results that the structure of carbohydrates in Sago starch is a combination of two major components called amylose and amylopectin. The above characterization data can vary depending on the type and location of the Sago plantation. The results are comparable to several previous studies about Sago characterization (Safitri et al., 2012., Marlida et al., 2014., Arfah et al., 2018).

Moisture Content

Moisture content measured from three different enzyme loadings is presented in Figure 1. From the data obtained, the direct effect of varying enzyme loadings was accounted for in the amount of water given in the Maltodextrin produced from Sago. The concept was supported by the theory previously reported by Sit et al. (2014). This group concluded that more water added correlates directly to the reduction of the enzyme activity in the process, while less water makes the enzyme work optimally. When the total volume of hydrolyzing was fixed at 100 ml for all reaction batches, the more enzyme loading was added, the less water was adjusted to one fixed volume.

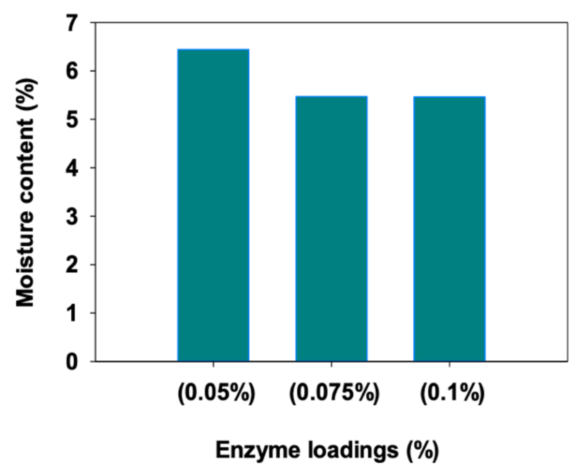

Figure 1. Moisture content profile

On the other hand, during the process, more enzyme loading aimed at higher reaction rates was added throughout the hydrolyzing period. The lowest moisture content corresponded to a value of 5.46 %, while the highest moisture content was observed from the most down enzyme loading of 0.05%. Results obtained from this study are comparable with those of several previous groups (Derosya and Kasim, 2017;

Laga A, et al., 2018). It confirms that the methods used to produce Maltodextrin are trustworthy and can be relied upon.

Carbohydrate and Reducing Sugar

Carbohydrates presented in maltodextrin samples from three different loadings correspond to 92.6 to 94 % values. Meanwhile, total reducing sugar correlated to the amount of enzyme added during hydrolysis. Data obtained confirmed that the lowest enzyme loading added the lowest total reducing sugar produced, and the highest total reducing sugar was measured from optimum enzyme loading in this study, as presented in Figure 2.

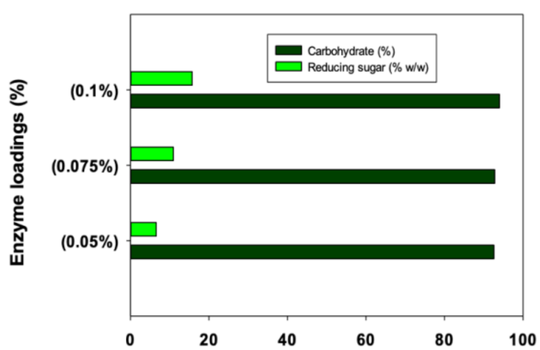

Figure 2. Carbohydrate and total reducing sugar

The highest total reducing sugar produced was 15.7 %, obtained from enzyme loading of 0.1%. In comparison, the lowest reducing sugar produced came from the most downloading of 0.05%, corresponding to a value of 6.57 %. Reducing sugar and maltodextrin DE values on products affects the quality grade of the product maltodextrin. From reducing sugar obtained, Dextrose Equivalent (DE) calculated were 7.09, 11.74, and 16.7, respectively, from lower concentration up to the highest one in the range of suggested DE required for Maltodextrin, which is 20 <. DE-generated difference values are related to the physical and biological functional properties of Maltodextrin, thus affecting its intended use for several purposes. The results of reducing sugars and DE values from this work were higher than the study reported by Derosya and Kasim, 2017 and moderately exact, as presented by another group that used the same type of enzyme (Sunari, et al. 2016). Moreover, results in this study used only 60 minutes of the hydrolyzing period with a mild temperature of 80 ^{0}C. When higher temperatures apply to the maximum enzyme activity temperature of 90 ^{0}C, it assumes that more reducing sugar will be produced, resulting in a higher DE value in the system.

Solubility in water

Solubility in the water is another critical success factor in producing Maltodextrin (Bhupinder et al., 2002). Therefore, standard observation was made of the texture of maltodextrin, as shown in Figure 3.

Figure 3. Three different enzyme loadings – Maltodextrin samples

From three different samples, the highest enzyme loading produced the smaller size of Maltodextrin with the finest textures. Meanwhile, the textures produced were correlated with the solubility of maltodextrin in the water, as presented in Figure 4. The finest texture of the highest loading could perform better solubility in the water, corresponding to a value of 96.9 %. At the same time, the solubility of two other samples was measured to be 85.5 % and less than 0.075%, 0.05%, and 93.1 % for samples, respectively. Another study reported that the solubility of Maltodextrin from corn starch in cold water was 61% to 86.79 % (Marta et al., 2017). Meanwhile, cassava reached maximum solubility in cold water, corresponding to a value of 90.09% (Husniati, 2009).

Other Characterization of Maltodextrin from Sago

Other than several important parameters reported above, other measurements were also performed to quantify Maltodextrin characterization, as shown in Table 2 below. Data obtained showed that the pHs of maltodextrin samples were close to the pH in Table 1, similar to the protein and fat of the original Sago presented. This finding summarizes that this derivative product still owns the characterization of Sago feedstock and moderately becomes one source for the consumable product (Laga A., et al, 2018).

Conclusion

Maltodextrin can be produced from Sago starch of Papua by combining several parameters during hydrolysis, such as temperature, reaction time, and enzyme loading. From the data obtained with a variation of three different enzyme loadings while two other parameters of time and temperature hydrolysis were fixed constant, some notably good characteristics of Maltodextrin, such as DE has reached 16.7 and the solubility in cold water, which is relatively high at 96.9% was gained.

Therefore, further research is needed to increase the production scale and other variations in ancillary parameters.

References

Elgadir, M A., Bakar, J., Zaidul, I., Rahman, R A., Abbas, K A., Hashim, D M., & Karim, R. (2009). *Thermal Behavior of Selected Starches in the Presence of Other Food Ingredients Studied by Differential Scanning Calorimetry (DSC)–Review. https://scite.ai/reports/10.1111/j.1541-4337.2009.00078.x*.

Husniati, H. (2009). Studi Karakterisasi Sifat Fungsi Maltodekstrin Dari Pati Singkong. *Indonesian Journal of Industrial Research*, *3*(2).

Karim, A., Tie, A P., Manan, D., & Zaidul, I. (2008). *June 1). Starch from the Sago (Metroxylon sagu) Palm Tree—Properties, Prospects, and Challenges as a New Industrial Source for Food and Other Uses. https://scite.ai/reports/10.1111/j.1541-4337.2008.00042.x*.

Laga A., Langkong J., Muhpidah, Fitri, &, & Wakiah, N. (2018). *Pengembangan Olahan Tomat Enrekang dalam Bentuk Kurma Tomat (Karakteristik Kurma Tomat). Jurnal Dinamika Pengabdian,. 4*, 72-78.

Sunari Sunari, Syaiful Bahri, H. Y. (2016). Produksi Maltodekstrin Dari Tepung Sagu Menggunakan Enzim α-Amilase. *Kovalen*, *2*(3), 33–38.

W S Ratnayake, D. S. J. (2008). Thermal behavior of resistant starches RS 2, RS 3, and RS 4. *Journal of food science*.