

Preparation and Characterization of Dextrin Obtained from *Xanthosoma sagittifolium* (L.) Schott Starch with Acid Catalyst and Enzymatic Methods

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Abstract. Taro has the potential as a substitute material for wheat and rice or as diversification into food and raw materials for pharmaceutical industrial. The aim of this study was to prepare and characterize dextrin from *Xanthosoma sagittifolium* starch with acid catalyst and enzymatic methods. Dextrin was made by acid catalyst method using 1 N HCl and enzymatic method using α -amylase enzyme. Dextrin was characterized and tested according to the Indonesian National Standard (SNI) 01-2593-1992. The results showed that the yield from acid catalyst and enzymatic methods were 41.73 % and 67.10 %, respectively. The color test showed that dextrin from acid catalyst method was yellowish whereas the enzymatic method gave white dextrin. The characteristic of 80 mesh fineness for dextrin fabricated by acid and enzymatic methods were 94.7 ± 0.06 % and 93.96 ± 0.02 % respectively. Dextrin obtained from acid catalyst had higher water and ash content than dextrin from enzymatic methods. Dextrin made from enzymatic method had higher solubility in cold water than dextrin from acid catalyst method. Dextrose equivalent for dextrin produced by 13.65 \pm 0.36 and 15.31 \pm 0.46, respectively for acid catalyst and enzymatic methods. Acidity degree of dextrin fabricated from acid catalyst and enzymatic methods were 2.86 \pm 0.23 and 4.39 \pm 0.4. The research shows that the characterization of dextrin by acid catalyst and enzymatic methods meet the quality requirements of Indonesian National Standard (SNI) 01-2593-1992.

Key words: Taro, dextrin, acid catalyst method, enzymatic method

Abstrak. Talas memiliki potensi sebagai bahan pengganti gandum dan beras atau sebagai diversifikasi ke dalam makanan dan bahan baku untuk industri farmasi. Tujuan dari penelitian ini adalah untuk membuat dan mengkarakterisasi dekstrin dalam pati *Xanthosoma sagittifolium* dengan katalis asam dan metode enzimatik. Dekstrin dibuat dengan metode katalis asam menggunakan HCl 1 N dan metode enzimatik menggunakan enzim α -amilase. Dekstrin dikarakterisasi dan diuji menurut Standar Nasional Indonesia (SNI) 01-2593-1992. Hasil penelitian menunjukkan bahwa hasil dari katalis asam dan metode enzimatik adalah 41,73% dan 67,10%,. Uji warna menunjukkan bahwa dekstrin dari metode katalis asam berwarna kekuning-kuningan sedangkan metode enzimatik memberikan dekstrin berwarna putih. Karakteristik kehalusan mesh 80 untuk dekstrin yang dibuat dengan metode asam dan enzimatik masing-masing adalah 94,7% \pm 0,06 dan 93,96% \pm 0,02. Dekstrin yang diperoleh dari katalis asam memiliki kadar air dan abu yang lebih tinggi daripada dekstrin dari metode enzimatik. Dekstrin yang terbuat dari metode

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enzimatik memiliki kelarutan yang lebih tinggi dalam air dingin daripada dekstrin yang diperoleh dari metode katalis asam. Kesetaraan dekstrosa untuk dekstrin yang dihasilkan adalah $13,65 \pm 0,36$ dan $15,31 \pm 0,46$ untuk katalis asam dan metode enzimatik. Tingkat keasaman dekstrin yang dibuat dari katalis asam dan metode enzimatik adalah $2,86 \pm 0,23$ dan $4,39 \pm 0,4$. Penelitian menunjukkan bahwa karakterisasi dekstrin oleh katalis asam dan metode enzimatik memenuhi persyaratan kualitas untuk Standar Nasional Indonesia (SNI) 01-2593-1992.

Kata kunci: *Talas, dekstrin, metode katalis asam, metode enzimatik*

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1. Introduction

Indonesia is a tropical country with an abundant of natural resources especially in the local tubers plants [1]. Taro tuber is rich of gum (mucilage) that is utilized as binder and emulsifier. It has small granules that are useful as fillers for polyethylene film which is biologically degradable [2].

Unmodified starch (native starch) has shortcomings in which it needs a long cooking time (high energy required), paste formed is hard and not clear. The properties are being too sticky, non-resistance to acid treatment, low viscosity, solubility and swelling. Those cause native starch to have limited usage in industry. Therefore, technology was developed to modify starch with more stable viscosity at either high or low temperature, gel formed is clearer with softer texture, low stretch strength, high solubility and swelling, granules in starch are easily cracked, and gelatinization is at shorter time and lower temperature [3].

One of modified starch is dextrin. It can be made in two ways, such as dry (filtration) and wet methods. Dry method (filtration) causes color change in starch during the process. Therefore, the dextrin produced has darker color. Hence dry method was used to produce dextrin with the addition of acid of enzymes. Dextrin made with acid catalyst has advantages as the process is easy, material is easy to get and cheap [4]. Whereas dextrin made with enzyme can be done in a non-extreme process (medium temperature and pH closes to normal), with a higher conversion rate and a more specific reaction [2]. Dextrin is polydextrose in pharmaceutical fields that work as diluents for pills and capsules, binder, sugar coating material as plasticizer, adhesive and thickening agent for suspension [5].

Based on the description above, the research was conducted to compare dextrin produced from acid catalysts and enzymatic methods from taro tubers to increase their economic value and utilities. Next, dextrin produced was characterized based on Indonesian National Standard [6].

2. Materials and Methods

Sample was collected using purposive sampling. The sample was taken without comparing the same sample from different area. Sample used was taro tubers (*Xanthosoma sagittifolium* (L.) Schott), from Tanah Karo, Brastagi, North Sumatra.

2.1. Equipments

The equipments used were glasswares, autoclave (Wisd Laboratory Analytical), blender (Miyako), buret (Oberol), evaporating dish, freezer (LG), hot plate stirrer (Thermo Scientific Cimarex), filter paper, melting point (Stuart), *orbital shaker* (Major Science), oven (Dynamica), water heater, reaction tube clamp, pH meter (Eco Tester), 80 mesh sieve, spatula, spot plate, furnace (Stuart), thermometer and digital scale (Boeco Germany).

2.2. Materials

The materials used were taro (*Xanthosoma sagittifolium* (L.) Schott), distilled water, α -amylase enzyme (Sigma All-rich), ethanol absolute p.a, Fehling A solution (Fluka Analytical Sigma-Aldrich), Fehling B solution (Fluka Analytical Sigma-Aldrich), 1 N HCl, 0.1 N iodine, phenolphthalein indicator, lugol solution, 1 N Na_2CO_3 and 0.1 N NaOH.

2.3. Starch Production

Eight kilograms of taro tubers were cleaned with clean water. Next, taro was cut transversely with the size of ± 1 cm then they were put into blender with a ratio of 5L/kg. Sliced taro was blended roughly and was filtered and squeezed. Residue was separated from starch suspension. Then distilled water was added to dregs then squeezed and filtered. The treatment was repeated until clear supernatant was obtained. Starch suspension was left for ± 24 hours in a container until starch was precipitated. After 24 hours, the cloudy solution was removed and 2L/kg distilled water was added. Then it is left for another ± 24 hours again. Next, clear liquid at the upper layer was removed and starch precipitation was dried in room temperature. Dried starch was obtained and softened with a blender and sieved with 80 mesh sieve. Qualitative test for starch was conducted with lugol solution [7].

2.4. Dextrin Preparation

2.4.1. Acid Catalyst Method

Distilled water was added to 300 gram of taro tubers starch until it reached the volume of 1.5 L to make a 20% starch suspension. Then 150 ml of acid catalyst (1N HCl) was added and stirred until the mixture was homogenized. Starch suspension was heated in an autoclave for 10 minutes at 110°C. Hydrolysis reaction was stopped by adding in 217 ml of 1 N Na_2CO_3 until pH 7 was reached. It was then left to cool at room temperature. Next, 300 ml of ethanol absolute p.a (1:1) was added and stirred. Dextrin was kept in freezer for ± 12 hours to form 2 layers. After

that it was filtered and the precipitate was collected and dried in oven at 80°C for 3 hours. Rough dextrin was produced and it was powdered using a blender and sieved using 80 mesh sieve. Qualitative analysis with lugol solution was conducted. The final product obtained was dextrin powder.

2.4.1. Enzymatic Method

Distilled water was added to 50 gram of starch until it reached the volume of 250 ml to make a 20% starch suspension. Next, the mixture pH was checked (pH=6.8). Starch suspension was heated on a hot plate stirrer at 95°C and stirred until clear gel (gelatinous) was formed. Next, the temperature was decreased to 40°C and 0.025 g / 50 g starch of α -amylase enzyme was added (liquefaction). Hydrolysis with continuous stirring was conducted for 24 hours with qualitative analysis using lugol solution for every 3 hours. Enzyme was broken down by allowing dextrin to boil and it is dried in oven at 80°C for 7 hours. Then dextrin was powdered in a blender and sieved with 80 mesh sieve. The final product obtained was dextrin powder [7].

2.5. Dextrin Characteristic Test

Dextrin characteristic tests included color, qualitative test with lugol solution, fineness of 80 mesh, water and ash content, solubility in cold water, dextrose equivalent (DE) value, melting point and the degree of acidity [6].

3. Results and Discussion

3.1. Yield

Before dextrin was fabricated, the concentration of taro tubers starch was formulated using the calculation as follow:

Table 1. Preparation of dextrin with acid catalyst method

Variable	F1	F2	F3	F4
Starch concentration (%)	20	20	20	20
1 N HCl (ml)	15	15	10	10
Temperature (°C)	110	110	110	110
Time (min)	10	10	10	10
1 N Na ₂ CO ₃ (ml)	28.7	25.5	14.5	18.3
Ethanol (ml)	-	100	100	100
Dryer	Oven	Hot plate	Oven	Hot plate
Result	Sticky dextrin	Wet dextrin	Yellowish dextrin powder	Brown dextrin powder

Base on the results obtained, F3 method was the best preparation with 1N HCl because dextrin obtained was in powder form with yellowish color and the yield of dextrin was 41.73%.

Table 2. Preparation of dextrin with enzymatic method

Variable	F1	F2	F3
Starch concentration (%)	30	20	15
Temperature (°C)	95	95	95
α -amilase enzyme (g)	0.03	0.01	0.0075
Result	No dextrin formed	White dextrin powder	White dextrin powder
Dextrin (g)	-	13.4208	5.2450

Base on dextrin fabrication using enzymatic method (α -amylase enzyme), the best method was F2 with 20% of starch concentration because the yield of dextrin obtained was 67.10%.

3.2. Characterization of Dextrin

Base on the research conducted, dextrin was fabricated using two methods. They were acid catalyst method (1 N HCl) and enzymatic method (α -amylase enzyme). The dextrin obtained was characterized based on the Indonesian National Standard number 01-2593-1992. The result can be seen in Table 3,

Table 3. Characterization of dextrin

No.	Quality Variable	SNI 01-2593-1992	Taro Dextrin	
			Acid Catalyst (1N HCl)	Enzymatic (α -amilase)
1.	Color	White to yellowish	Yellowish	White
2.	Color with lugol solution	Brownish purple	Brownish purple	Brownish purple
3.	Color with Iodine	-	Reddish brown	Reddish brown
4.	Fineness of 80 mesh (%)	Min 90 (pass)	94.7 \pm 0.06	93.96 \pm 0.02
5.	Water content (%)	Max 11	8.79 \pm 0.15	7.62 \pm 0.23
6.	Ash content (%)	Max 0.5	0.45 \pm 0.02	0.42 \pm 0.04
9.	Solubility in cold water (%)	Min 97	57.47 \pm 0.25	63.09 \pm 0.1
8.	Dextrose equivalent	-	13.65 \pm 0.36	15.31 \pm 0.46
9.	Melting point (°C)	-	185 \pm 0.57	182 \pm 0.57
10.	Acid degree (0,1 ml NaOH N/100 g)	Max 5	2.86 \pm 0.23	4.39 \pm 0.4

Color test with lugol solution showed brownish purple which indicating reducing sugar whereby the polysaccharide chain was broken down to a simple monomer such as oligosaccharide and glucose. It increase the amount of reduction sugar and gave the purple brownish color when lugol solution is added [4].

The determination of particle size with 80 mesh sieve showed almost the same result to all resulted dextrin. The smaller the modified starch, the better the quality of dextrin because modified starch will be easy to be processed [4].

Water content analysis for acid catalyst method gave a higher water content than dextrin made from enzymatic method. A good quality dextrin has a low water content. High water content causes microorganism to grow and reduce the quality. Dextrin with lower water content is easy to be kept and applied [4].

Ash content related to the mineral contained in the raw material, taro. Ash is inorganic matter from the remaining from the combustion of organic matter [8]. The analysis of ash content in dextrin produced from acid catalyst and enzymatic methods had met the requirement of dextrin.

Solubility test in cold water for dextrin made from acid catalyst was lower than dextrin made from enzymatic methods. Starch modification with acid catalyst was happened from the termination of α -(1,4) glycosidic bonds in starch by water with the help of 1 N HCl catalyst. While in enzymatic method (α -amylase enzyme) there is a random termination of α -(1,4) glycosidic bonds or at the middle of polymer chains [2]. The higher the concentration of acid and enzymes used, the faster the hydrolysis process was which meant more sugar was produced [4].

DE value for dextrin fabricated by acid catalyst was lower than dextrin fabricated by enzymatic method (α -amylase enzyme). The differences in DE value were caused by α -amylase enzyme as endoenzyme that is able to break α -(1,4) bond randomly or at the bonds between polymer chains. α -amylase enzyme had specific work in taro tubers starch hydrolysis resulting simple monomer which increase of reducing sugar. Whereas acid catalyst worked randomly in taro hydrolysis. The factors affecting hydrolysis process are starch and acid concentration, enzymes activity and hydrolysis duration. High DE material generally gets brown, hygroscopic, sweet and soluble in water while material with low DE is used as viscosity control, binder or as material for film coating [9].

Dextrin melting point is 178°C. The difference in the melting point was due to the variance in the total of dextrose equivalent (reducing sugar) as dextrin fabricated was not a pure excipient to serve pharmaceutical needs [5].

Acidity degree in dextrin fabricated from acid catalyst was lower than dextrin fabricated from enzymatic method. It was due to the dextrin preparation with enzymatic (α -amylase enzyme) method was done on lower pH, 6.8. On the other hand, there was a neutralization by Na_2CO_3 in acid catalyst method to get pH 7 which explains the lower acidity degree. pH specification for dextrin is 2 - 8 [5]. Acidity degree tells how high the acid content in the material is. The higher the acid, the lower the pH. Acidity degree is greatly affected by acid neutralization technique used [4].

4. Conclusion

Dextrin from taro tubers starch (*Xanthosoma sagittifolium* (L.) Schott) with acid catalyst (1 N HCl) and enzymatic (α -amylase enzyme) methods fulfill the criteria of Indonesian National Standard (SNI) 01-2593-1992. There are differences in characteristic of dextrin produced from taro tubers starch (*Xanthosoma sagittifolium* (L.) Schott) by acid catalyst and enzymatic methods such as yield, colour, fineness of 80 mesh, water and ash content, solubility in cold water, dextrose equivalent, melting point and acidity degree.

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