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The Effect of Pregelatinization Temperature to the Physicochemical Properties of Black Potato Starch

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Abstract: ***Coleus tuberosus (black potato) is one of Indonesian local tuber. Black potatoes have been consumed only as boiled or mixed with vegetables. Black potatoes have a low glycemic index and in raw conditions have a 10% resistant starch and a lot of nutrition contents. Black potato starch is potential to be developed into various carbohydrate-base products. Unfortunately, the physicochemical characteristics of raw starch from local tuber usually need to be improved. Pregelatinization intend to enhance the physicochemical characteristic of black potato starch. The aim of this research is to determine the effect of different temperature of pregelatinization into the physicochemical characteristic of black potato starch. The result of this research displayed that pregelatinization in 15 minutes of 45^0 C is the suggested condition for pregelatinization of black potato starch. Henceforth, increasing temperature will decline the number of amylose content, water absoption, and swelling properties of black potato starch.***

Keywords: *Coleus tuberosus*, pregelatinization, temperature, domestic processing

1. Introduction

Pregelatinization is a method to treat starch based flour through heat and moisture treatment below its pregelatinization temperature. Starch above pregelatinization is tend to be more crystalline, change in structure and tend to lose it's swelling capacity. Native starch usualy need to be improved before being used in processing. Pregelatinization can modify the physicochemical properties of starch without changing the molecular structure. Pregelatinization may use alkaline or acid but also possibly does not involve chemical reagents at all [1]. Pregelatinization is done by heat and moisture through boiling, drum drying, spray drying, or cabinet drying with insufficient heat for gelatinization [2].
Pregelatinized starch can be used in wide range of products. Pregelatinized starch can be used as thickening agent, stabilizing the mixture, or coating for various products. Likewise, pregelatinization can be used to prolong the shelf life of starch based material. Conventional pregelatinized starch are made from corn, tapioca, and potato. The granules have a definite size and better functional properties than raw starch [3]. It has a good swelling properties in cold water and frequent solubility. The properties is applicable for instant products. Beside, the swelling capacity of the granule lead to better digestibility of a starch.

Black potato (*Coleus tuberosus)* is Indonesian native tuber that is only consumed by local regions. Previous studies indicated that raw black potato contains 10% resistant starch and a lot bioactive compound [4]. It has potential to diversified into a lot of products. Current processing is only by boiling or mixed with vegetables. But the physicochemical properties of the product for further processing still need to be improved. Pregelatinization intend to enhance it's functional characteristics to wider the use of black potato

2. Methods

Materials
Black potatoes (*Coleus tuberosus)* were acquired from Jaten Village, Jogorogo, Ngawi, East Java, Indonesia. The tubers harvested in dry season in size of 2-3 cms diameter.

Flour preparation
Black potato was washed, peeled and sliced in ± 1 mm. sliced black potato then dried 60 °C for 7 hours in cabinet drier. Dried chips then milled and shieved 80 mesh.

Pregelatinization
Black potato flour was treated with moisture 300 g/1000 ml. The mixture then heated 40, 45, 50, 55, and 60 °C for 15 minutes with continuous mixing. The samples then dried 60 °C for 7 hours in cabinet drier. The dried flour then milled and shieved 80 mesh.

Physicochemical characteristics determination
The amylose content was determined according to AOAC [5]. The water absorption index and swelling properties was done according to Honestin [6].

3. Results and Discussion

Amylose content is considered to be one of the major factors in determining starch quality, was greatly affected by low temperature treatment (40−45 °C) (Table 1). The amounts of amylose dispersed before complete granular disruption were higher at low temperatures, indicating a greater role of amylose in the gelatinization process during its initial stages. The high amounts of amylose dispersed after the complete granular disruption, at high temperatures, might be due to the increased physical dispersion of starch polymers [7]. Increasing temperature in heating starch reduced the levels of amylose. Higher temperature expected cause the lower molecular weight of amylose. This amylose suffered depolimerization on higher temperature so that amylose has lower molecular weight [8].

Table 1: Amylose content of black potato starch after 15 minutes pregelatinization

Temperature (C)	Amylose content (%)
40	43.97
42	46.63
45	48.30
47	59.97
50	30.96
55	28.30
60	24.96

Swelling power influenced by an ability molecule starch to bind water through the establishment of hydrogen bonds. After gelatinization, hydrogen ties between molecules starch were off and replaced by hydrogen bonds with water, so that starch granules swell maximally. The swelling process caused by many water that absorbed into starch granules and expand to increase swelling power [9].

Table 2: Swelling properties of black potato starch after 15 minutes pregelatinization

Temperature (C)	Swelling properties (g/g)
40	1.0688
42	1.3824
45	1.0309
47	1.7907
50	1.0698
55	1.0159
60	1.0526

The swelling properties of black potato starch are shown in Table 2. Swelling power from black potatoes is vary from 1.01 – 1.79 (g/g), while swelling power from cassava starch was vary from 42-71(g/g) [16]. Swelling properties of black potato starch decreased as pregelatinization temperature increased. Other observation [17] showed that swelling power of starches is usually very low at reduced temperature, and this was supported on swelling power from yam [18].

The higher pregelatinization temperature could effect the starch contents and would not swell until it reached the gelatinization temperature. These datas are also attributed to the pregelatinization process that changed the granule to be much strong and resist swelling at high temperature [10] which is indicates that starch is highly resistant to swelling and rupture. Process in 40 and 45^{o}C temperature leading to increased starch crystallinity because of the changes in starch granule, so that this temperature is needed to reach maximum expansion and break down of the starch granule. But at higher temperature, the decline of swelling properties caused by increasing crystallinity of the starch so that confine the water flows through the starch, and diminished its capability to swell [11]. Another research proposed that the decrease in swelling powers and the increase in gelatinization temperature were caused by transformation of amorphous amylose into a helical form, increase in interactions between amylose chains, and alteration in the interaction between crystallites and the amorphous matrix during annealing [15].

Table 3: Water absorption of black potato starch after 15 minutes pregelatinization

Temperature (C)	Water Absorption (g)
40	2.4855
42	2.7905
45	3.2183
47	3.0573
50	2.6623
55	2.7643
60	2.5919

Heat temperature allowed the amylose molecules located in the bulk amorphous regions to interact with the branched segments of amylopectin in the crystalline regions [12]. As the starch granules swell to form a gel by heating in water, the amorphous region became hydrated [15]. When black potato starch is heated in range of temperature, the granules absorb water and swell. The data indicates that starch granules absorbed more water and swelled more in 45°C. Water absorption on starch affected by its swelling power, rising swelling power will lead higher water absorption [13]. The same data expressed greater swelling power shows harmonious with higher solubility [14]. Increasing in water absorption capacity indicates that the amorphous region may expand slightly and some hydrogen bonds between the amorphous and crystalline regions could be broken [16].

4. Conclusion

Pregelatinization intend to enhance the physicochemical characteristic of black potato starch. The method of pregelatinization in this paper is using simple methods that can be applied home. The results clearly showed that pregelatinization in 15 minutes above 45^{0} C will decrease the number of amylose content, and water absorbtion. And for swelling properties, above 47 will decline the number. Further research is needed to characterize the physicochemical properties of black potato starch.

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