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Swelling power and WSI of modified Bangka sago starch

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This study used factorial completely randomized design, which used two factors. The first factor was autoclaving time (15 and 30 minutes) and the second factor was a number of cycles (1, 2, 3, 4, 5, and 6 cycles). Each combination of the factors was repeated three times. Statistical analysis showed that autoclaving time had a significant effect on water soluble index, whereas number of cycles had significant effects on swelling power and water soluble index. Modified Bangka sago starch that was treated for 15 minutes on autoclaving time had higher swelling power and water soluble index values than Bangka sago starch that treated with 30 minutes on autoclaving time. The result showed that increasing number of autoclaving-cooling cycle caused decreasing of swelling power and water soluble index values.

Keywords: Autoclaving, Bangka sago starch, Heat moisture treatment, Modified, Swelling power, Water soluble index.

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Introduction

Bangka sago starch is one of sago starch types that had the potential to be developed as a carbohydrates food source. Using of Bangka sago starch was still limited because Bangka sago starch had some weaknesses. Food products made from Bangka sago starch would harden faster. It was caused by swelling power (20.00 to 22.00 %) and water soluble index (23.75 to 25.10 %) of Bangka sago starch that was still high[1]. It showed the hydrophilic properties of sago starch. The properties of the sago starch needed to be modified to get a lower swelling power that resembles the swelling power of tapioca (10.12 to 15.01 %)[2].

Swelling power was one of the functional properties of starch that was related to the quality of food products. The swelling power reflected the hydration capacity of the starch. One way to lower the swelling power value of sago starch was physically modified starch[3]. Heat moisture treatment (HMT) was one method of physically modified to decrease the swelling power and solubility of starch[4].

Starch modification with HMT method was done by using the oven (100 to 120 °C) for 2 to 18 hours, with a moisture content of starch between 15 to 35 %[5-10]. Modified starch with HMT method required quite a long time and could affect the colour of starch produced, so it needed to be combined with another method like autoclaving-cooling. A study on the modification of rice, cassava and pinhao starches with HMT method using an autoclave had been conducted. The results showed that viscosity and the swelling power values of starch were low[11]. The objective of this research was to determine the effect of the combination of heat moisture treatment and autoclaving -cooling on swelling power and water soluble index of Bangka sago starch.

Materials and Methods

Sago materials

Bangka sago starch obtained from sago craftsmen in Sungailiat, Bangka Belitung Province, Indonesia.

Combination of HMT and autoclaving-cooling method

Modification of Bangka sago starch used a combination of heat moisture treatment (HMT) and autoclaving-cooling. The method started by determining the amount of distilled water that would be sprayed to reach the desired moisture content of starch (30 %). Amount of distilled water that was sprayed was determined by the following calculation[12].

$$(100\ \% - KA_1) \times BP_1 = (100\ \% - KA_2) \times BP_2$$

$$(100\ \% - X) \times 200\ g = (100\ \% - 30\ \%) \times BP_2$$

Amount of distilled water= $BP_2 - BP_1$

KA_1= beginning of starch moisture content
KA_2= moisture content of starch that was desired
BP_1= beginning of starch weight
BP_2= weight of starch after treatment

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Sago starch known for its moisture content was put in a Beaker glass, and then distilled water was sprayed. Beaker glass covered with a plastic and kept for 24 hours in refrigerator (15 °C). After that, it was put into the autoclave (121 °C) for 15 and 30 minutes, then it took at room temperature. Bangka sago starch was stored at 4 °C for 24 hours (1 cycle)[13,14].

Measurement of swelling power and water soluble index

Modified Bangka sago starch was weighed (100 mg) and placed in a screw-cap test tube (known as an empty weight). Distilled water (10 mL) added to test tube. Modified Bangka sago starch and distilled water were mixed using vortex mixer for 10 seconds. Then, it was incubated in a water bath (85 °C) for 30 minutes while stirring occasionally. Then, it was cooled in ice water to room temperature. The solution was centrifuged at 2000 rpm for 30 minutes. The supernatant liquid was transferred into a cup that had been weighed and then it was heated in an oven to a constant weight (W1). The precipitate was left in the test tube weighed (Ws)[15]. The calculation of swelling power and water soluble index values were :

$$\mathrm{SP} = \frac{W_s}{[0.1 \times (100\% - \mathrm{WSI})]}\ (\mathrm{g/g})$$

where $\mathrm{WSI} = W_1/0.1 \times 100\%$.

Statistical analysis

This study used a factorial completely randomized design with two factors. The first factor was autoclaving times (15 and 30 minutes) and the second factor was a number of cycles (1, 2, 3, 4, 5, and 6 cycles). Each combination of the factors was repeated three times. The data obtained were evaluated using analysis of variance (ANOVA), and the significant different treatments were further analysed for a mean test at the 5 % level.

Results and Discussion

The swelling power of modified Bangka sago starch values ranged from 11.81 to 17.24 % (Table 1). The highest value (7.24 %) of modified Bangka sago starch was found in W_1S_1 (15 minutes of autoclaving time; 1 cycle), while the lowest value (11.81 %) of modified Bangka sago starch was found in W_1S_6 (15 mins of autoclaving time; 6 cycles). The analysis of variance showed that a number of cycle factor had a significant effect on swelling power of modified Bangka sago starch, while autoclaving time factor and interaction of autoclaving time and number of the cycle had no significant effect on swelling power.

The water soluble index of modified Bangka sago starch values ranged from 5.48 to 9.20 % (Table 1). The highest value (9.20 %) of modified Bangka sago starch was found in W_1S_1 (15 minutes of autoclaving time; 1 cycle), while the lowest value (5.48 %) of modified Bangka sago starch was found in W_2S_6 (30 minutes of autoclaving time; 6 cycles). The analysis of variance showed that autoclaving time factor and number of cycle factor had a significant effect on water soluble index of modified Bangka sago starch, while the interaction of autoclaving time and number of the cycle had no significant effect on water soluble index.

The results showed that swelling power and water soluble index of modified Bangka sago starch decreased with increasing of a number of cycles (Fig. 1 and 2). Fig. 2 also showed that longer in autoclaving time resulted in a lower water soluble index of modified Bangka sago starch. This study used a combination of two physical methods. The first method was heat moisture treatment (HMT). HMT method for this study used limited moisture content (30 %). Modified starch using HMT method could decrease swelling power and water soluble index[4]. The swelling power and water soluble index of rice flour also decreased during HMT process[10]. The second method was autoclaving-cooling which used an autoclave for the heating process. The swelling power and solubility of sweet potato starch decreased during the autoclaving process with

Table 1 — Swelling power and water soluble index values of modified Bangka sago starch

Autoclaving times	Number of cycles					
(mins)	1	2	3	4	5	6
Swelling power						
15	17,24	15,13	14,71	14,37	12,73	11,81
30	15,82	14,56	13,56	13,90	12,05	12,46
Water soluble index						
15	9,20	7,63	7,03	7,11	6,84	5,49
30	8,18	6,16	7,01	6,65	6,59	5,48

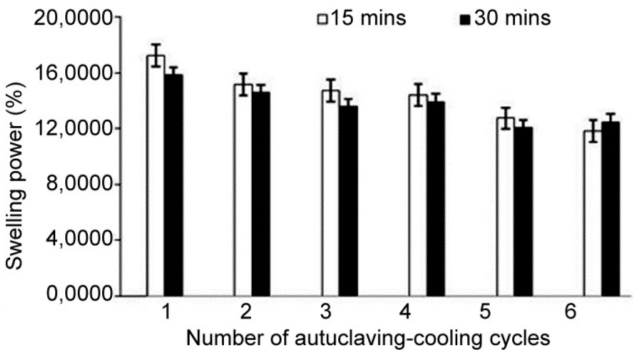

Fig. 1 — Swelling power of modified Bangka sago starch

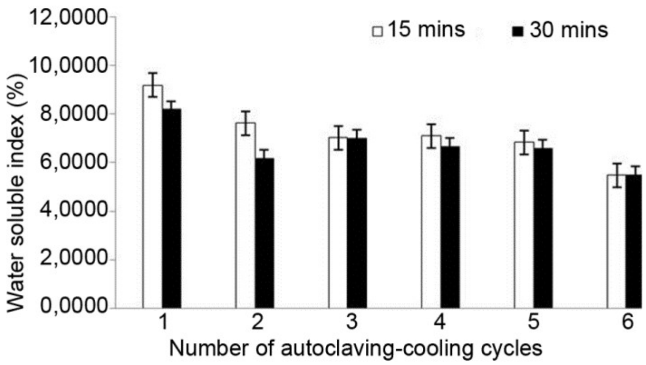

Fig. 2 — Water soluble index of modified Bangka sago starch

different temperature. The increasing of autoclaving temperature caused decreasing of swelling power and solubility of sweet potato starch[16].

The autoclaving process of starch with limited moisture content caused the gelatinization of starch. The strach granules swelled up and broken. Some changes in starch like starch granules became hydrated and swell, granule structure collapses due to melting of crystallites and breaking of hydrogen bonds referred that starch undergoes gelatinization[17]. Autoclaving treatment caused disruption of the granular structure of starch[16].

Starch gelatinization also caused a chain of amylose and amylopectin broken. Structure of amylose and amylopectin undergo modification. Longer in heating process in HMT process could increase amylose content[18]. Because of limited moisture content, amylose was not out of the granule structure. But, the bond of amylose and amylopectin still occurred. The cooling process caused a fraction of amylose had retrogradation or recrystallization. It caused modification of starch. The polymer chains of amylose formed a double helical structure through hydrogen bonding and were irreversible[19,20]. The increasing of starch crystallinity after starch modification had restricted water adsorption within starch matrices. It caused reduction of the swelling power of modified starches[21].

Conclusion

The swelling power and water soluble index values of modified Bangka sago starch were 11.81 to 17.24 % and 5.48 to 9.20 % respectively. Autoclaving time factor had a significant effect on water soluble index, whereas a number of cycle factor had significant effects on swelling power and water soluble index. The increasing of a number of autoclaving-cooling cycles caused a decrease of swelling power and water soluble index values.

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