

Swelling power and WSI of modified Bangka sago starch

by Nura 9

Submission date: 23-Sep-2019 10:21AM (UTC+0700)

Submission ID: 1177931691

File name: Swelling_Power_and_WSI_of_Modified_Bangka_Sago_Starch.pdf (649.27K)

Word count: 2335

Character count: 11874

Swelling power and WSI of modified Bangka sago starch

Merynda Indriyani Syafutri*, Filli Pratama^{1,2}, Nura Malahayati and Basuni Hamzah

Department of Agricultural Technology, Faculty of Agriculture, Universitas Sriwijaya, South Sumatera, Indonesia

Received 8 December 2016; Revised 27 September 2017

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). A 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.

IPC code; Int. cl. (2015.01)–A61K 9/2059, A61K 47/36

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 high¹. 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 starch³. Heat moisture treatment (HMT) was one method of physically modified to decrease the swelling power and solubility of starch⁴.

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 low¹¹. 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 calculation¹².

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

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

$$\text{Amount of distilled water} = BP_2 - BP_1$$

KA₁ = beginning of starch moisture content

KA₂ = moisture content of starch that was desired

BP₁ = beginning of starch weight

BP₂ = weight of starch after treatment

*Correspondent author

E-mail: misyafutri@yahoo.com, merynda@fp.unsri.ac.id

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 (W_1). The precipitate was left in the test tube weighed (W_s)¹⁵. The calculation of swelling power and water soluble index values were :

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

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

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 index⁴. The swelling power and water soluble index of rice flour also decreased during HMT process¹⁰. 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 (mins)	Number of cycles					
	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

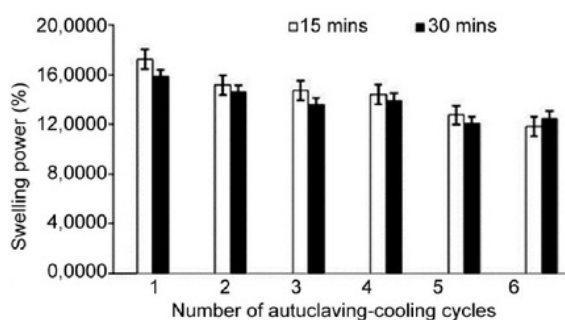


Fig. 1 — Swelling power of modified Bangka sago starch

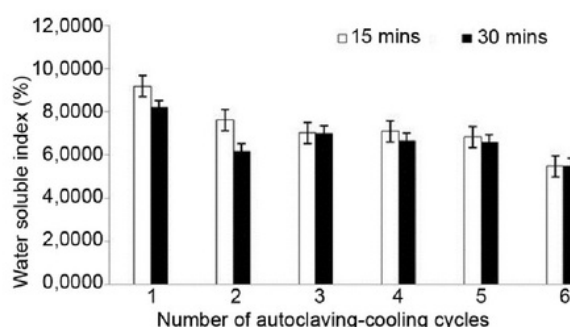


Fig. 2 — Water soluble index of modified Bangka sago starch

different temperature. The increasing of autoclaving temperature caused decreasing of swelling power and solubility of sweet potato starch¹⁶.

The autoclaving process of starch with limited moisture content caused the gelatinization of starch. The starch 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 gelatinization¹⁷. Autoclaving treatment caused disruption of the granular structure of starch¹⁶.

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 content¹⁸. 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 starches²¹.

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.

Acknowledgement

This research was supported by Directorate of Research and Community Service, Ministry of Research, Technology and Higher Education, Indonesia by provided research funding through the Doctoral Dissertation Research Program.

References

- 1 Syafutri M I, Functional and pasta properties of Bangka sago starch, *Sagu: Agric Sci Technol J*, 2015, **14**(1), 1-5.
- 2 Nuwamanya E, Baguma Y, Emmambux N, Taylor J and Patrick R, Physicochemical and functional characteristics of cassava starch in Ugandan varieties and their progenies, *J Plant Breed Crop Sci*, 2010, **2**(1), 1-11.
- 3 Alexis S D and Georges A N, Swelling and solubility of some wild yam species starch granules, *Focusing on Modern Food Industry*, 2013, **2**(3), 118-122.
- 4 Wadchararat C, Thongnam M and Naivakul O, Characterization of pregelatinized and heat moisture treated rice flours, *Kasetsart J (Nat Sci)*, 2006, **40**, 144-153.
- 5 Oluwalabi K O, Oluwalabi B I, Olayinka O O and Lawal A, Effect of heat moisture treatment and annealing on physicochemical properties of red sorghum starch, *Afr Biotechnol*, 2005, **4**(9), 928-933.
- 6 Chung H J, Liu Q and Hoover R, Impact of annealing and heat-moisture treatment on rapidly digestible, slowly digestible and resistant starch levels in native and gelatinized corn, pea and lentil starches, *Carbohydr Polym*, 2009, **75**, 436-447.
- 7 Chung H J, Cho A and Lim S T, Effect of heat moisture treatment for utilization of germinated brown rice in wheat noodle, *Food Sci Technol*, 2012, **47**, 342-347.
- 8 Sunae P, Tran T and Sirivongpaisal P, Effect of heat moisture treatment on structural and thermal properties of rice starches differing in amylose content, *Starch-Stärke*, 2007, **59**(12), 593-599.
- 9 S L and Gao Q Y, Effect of heat moisture treatment on the formation and properties of resistant starches from mung bean (*Phaseolus radiatus*) starches, *World Acad Sci Eng Technol*, 2010, **48**, 812-819.
- 10 Iowhakam K and Naivikul O, Modification of rice flour by heat moisture treatment (HMT) to produce rice noodles, *Kasetsart J*, 2006, **40**(2), 135-143.

- 11 Hein B, Pinto V Z, Vanier N L, Zavareze E R, Colussi R, *et al.*, Effect of single and dual heat moisture treatment on properties of rice, cassava and pinhao starches, *Carbohydr Polym*, 2012, **98**(2), 1578-1584.
- 12 Fitriani S, Rahmayuni and Putra I E, Making artificial rice from sago starch HMT (*heat moisture treatment*) with addition of mung bean flour (*Vigna radiata*), *Sagu, Agric Sci Technol J*, 2011, **10**(2), 31-35.
- 13 Shin S, Byun J, Park K H and Moon T W, Effect to partial acid hydrolysis and heat moisture treatment on formation of resistant tuber starch, *Cereal Chem*, 2004, **81**(2), 194-198.
- 14 Syafutri M I, Pratama F, Malahayati N and Hamzah B, Profiles of modified sago starch by heat moisture treatment and autoclaving-cooling, *Int J Sci Res*, 2017, **6**(6), 2111-2114.
- 15 Senanayake S, Gunaratne A, Ranaweera K K D S and Bamunuarachchi A, Effect of heat moisture treatment condotions on swelling power and water soluble index of different cultivars of sweet potato (*Ipomea batatas* (L.) Lam) starch, *ISRN Agr*, 2013, **2013** 1-4.
- 16 Babu A S and Parimalavalli R, Effect of autoclaving on functional, chemical, pasting and morphological properties of sweet potato starch, *J Root Crops*, 2013, **39**(1), 78-83.
- 17 Wang S, Li C, Copeland L, Niu Q and Wang S, Starch retrogradation: A comprehensive Review, *Compr Rev Food Food Saf*, 2015, **14**, 568-585.
- 18 Sun Q, Wang T, Xiong L and Zhao Y, The effect of heat moisture treatment on physicochemical properties of early *Indica rice*, *Food Chem*, 2013, **141**(2), 853-857.
- 19 Kusnandar F, Hastuti H P and Syamsir E, Resistant starch of sago from acid hydrolysis and autoclaving-cooling processes, *Jurnal Teknologi dan Industri Pangan*, 2015, **26**(1), 52-62.
- 20 Sajlata M G, Singhal R S and Kulkarni P R, Resistant starch review, *Compr Rev Food Sci Food Saf*, 2006, **5**, 1-17.
- 21 Balasubramanian S, Sharma R, Kauri J and Bhardwaj N, Isolation, modification and characterization of finger millet (*Eleusine coracana*) starch, *J Food Sci Eng*, 2011, **1**, 339-347.

Swelling power and WSI of modified Bangka sago starch

ORIGINALITY REPORT

25%

SIMILARITY INDEX

21%

INTERNET SOURCES

25%

PUBLICATIONS

19%

STUDENT PAPERS

PRIMARY SOURCES

1

www.myfoodresearch.com

Internet Source

3%

2

www.mdpi.com

Internet Source

3%

3

www.tandfonline.com

Internet Source

3%

4

www.cogentoa.com

Internet Source

2%

5

Iuliana Aprodu, Ina Vasilean, Cristian Muntenită, Livia Patrascu. "Impact of broad beans addition on rheological and thermal properties of wheat flour based sourdoughs", Food Chemistry, 2019

Publication

1%

6

Hamit Koksel. "Effect of Acid Modification and Heat Treatments on Resistant Starch Formation and Functional Properties of Corn Starch", International Journal of Food Properties, 10/2007

Publication

1%

7	Valmor Ziegler, Cristiano Dietrich Ferreira, Jennifer da Silva, Elessandra da Rosa Zavareze et al. "Heat-moisture treatment of oat grains and its effects on lipase activity and starch properties", Starch - Stärke, 2018 Publication	1%
8	Dede R. Adawiyah, Tomoko Sasaki, Kaoru Kohyama. "Characterization of arenga starch in comparison with sago starch", Carbohydrate Polymers, 2013 Publication	1%
9	Ismailoglu, Sadiye Ozden, and Arzu Basman. "Physicochemical properties of infrared heat-moisture treated wheat starch : Physicochemical properties of infrared heat-moisture...", Starch - Stärke, 2015. Publication	1%
10	res.mdpi.com Internet Source	1%
11	nopr.niscair.res.in Internet Source	1%
12	www.dhan.org Internet Source	1%
13	doaj.org Internet Source	1%

14	www.arpnjournals.org Internet Source	1 %
15	journal.ugm.ac.id Internet Source	1 %
16	Baljeet S. Yadav, Priti Guleria, Ritika B. Yadav. "Hydrothermal modification of Indian water chestnut starch: Influence of heat-moisture treatment and annealing on the physicochemical, gelatinization and pasting characteristics", LWT - Food Science and Technology, 2013 Publication	1 %
17	Submitted to University of Venda Student Paper	1 %
18	Bahareh Fathi, Mehran Aalami, Mahdi Kashaninejad, Alireza Sadeghi Mahoonak. "Utilization of Heat-Moisture Treated Proso Millet Flour in Production of Gluten-Free Pound Cake", Journal of Food Quality, 2016 Publication	1 %
19	link.springer.com Internet Source	1 %
20	Submitted to Massey University Student Paper	1 %
21	Rolf Stute. "Hydrothermal Modification of	1 %

Starches: The Difference between Annealing and Heat/Moisture -Treatment", Starch - Stärke, 1992

Publication

Exclude quotes On

Exclude matches < 1%

Exclude bibliography Off