

Variations of Washing Agent on The Physicochemical And Microbiology Properties of Sago Starch

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Abstract. Food is the world's population's basic need that must be fulfilled in quantity, quality, and continuity. Food availability can be solved by utilizing the potential of natural resources, including using local food sago as a carbohydrate or starch source. In addition, starch production through a washing process could increase product quality. The study aimed to determine the best type of washing agent for good sago starch quality. The design of study used a completely randomized design. Sago starch washing treatment includes water, metabisulphite (500, 1000, 1500, 2000 ppm), and chlorine (500, 1000, 1500, 2000 ppm). Sago starch without washing was used as a control. The weighting and characteristics of sago starch quality results revealed that water was the best washing agent, according to SNI 3729:2008. The results obtained were a normal color, taste, and aroma, 9.92% of moisture content, 0.17% of ash content, 87% of starch content, 0.44% of fiber, 2.99% of acidity level, SO₂, Hg, and As levels were not detected, 0.7 ppm of Pb, 2.34 ppm of Cu, TPC value of 2.93 log cfu/g. E Coli of 0 log cfu/g and molds of 1.57 log cfu/g.

Keywords: chlorine, metabisulphite, sago, water, washing agent

1. Introduction

Food is one of the population's basic needs that must be fulfilled in quantity, quality, and continuity. The food needs are estimated to grow in line with the increasing population. The growth rate of Indonesia's population in 2015-2020 ranges from 1.06%–1.08% per year (1), in 2021 around 1.22% (2), and in 2022 by 1.17% (3). The utilization of potential natural resources, such as local food as a carbohydrate, can be used to maintain food availability. Sago usage as a food source greatly reduces dependency on rice and wheat.

The main component of sago is starch. Sago starch consists of 70 – 80% amylopectin, which is difficult to dissolve in cold water and easy to gelatinize (4). Sago starch can be applied in the food industry (making bread, noodles, cakes, papeda, lime, etc.), the beverage industry (liquid sugar), the packaging industry (biodegradable packaging), the pharmaceutical industry, cosmetics, paper, ethanol, and textiles, also animal feed. High organic content makes it sago pulp can be used for plant media (5), biomass as biogas because it contains lignin and hemicellulose (6) (7), sago starch as a natural raw material edible film (8), starch as a raw material for analog rice (9). Sago starch is a raw material for bamboo microfibril cellulose (10). Modification of sago starch by ozone oxidation affects solubility and swellability (11)

An important component in the development of sago is the production process of sago starch. Generally, the production of sago starch includes cutting and cleavage, grating, squeezing, filtering, settling, and packaging. The water component is needed in the extraction (grating and squeezing) and deposition processes. Therefore, as the primary helper material, water must meet food standards. Washing agents will affect the final product of sago starch. The addition of bleaching agents such as chlorine and metabisulfite can be applied to produce white sago starch.

Sodium metabisulfite can improve starch's nutritional and functional properties (12). Sodium bisulfite can minimize damage and improve sago pith quality and starch quality. However, sodium bisulfite still leaves sulfite levels that meet SNI (13). Chlorine is a harmful bleaching agent that affects

starch products' odor and color (14). This study aims to obtain suitable washing materials so that sago starch meets the established SNI.

2. Research Methods

The research was carried out at the Laboratory of the Central Research and Development Center for Postharvest Agriculture, Bogor. The materials used in the research were sago starch, sodium metabisulfite, and chlorine, as well as materials for chemical analysis. The tools used are scales, pH-meter, stopwatch, autoclave, proximate and starch analyzer, microscope, screw, desiccator, oven, destillator, chromameter, and glassware.

This study consisted of three stages: water analysis, washing sago starch, and selecting the washing method. The analysis of sago starch includes physical characteristics (shape, aroma, color, taste), chemical characteristics (moisture content, ash content, crude fiber, starch, acid level, SO₂ content, metal content), and microbiological characteristics (15). The experimental design used was a factorial completely randomized design with three factors, and each treatment had three replications (16). The best treatment is determined on all parameters with weights according to the level of importance (16). The weighting was done based on the assessment of the panelists who know a lot about sago and its application

3. Results and Discussion

Water is an important component in the sago starch washing process. The results of the analysis of the water used for the sago starch washing process are presented in Table 1.

Table 1. Results of water analysis.

Items	Parameter Physic	Unit	Requirements	Result
1	Aroma	-	No aroma	No aroma
2	Flavor	-	Normal	Normal
3	Color	TCU	Max. 15	5
4	Total Dissolved Solids	mg/l	Max. 1000	142
5	Turbidity	NTU	Max. 5	2
6	Air Temperature	°C	3°C	No detected
Chemical				
1	Fe	mg/l	Max. 0,3	<0,016
2	CaCO ₃	mg/l	Max. 500	16
3	Cl	mg/l	Max. 250	13
4	Mn	mg/l	Max. 0,1	0,313
5	pH		6,5 – 8,5	6,07
6	Zn	mg/l	Max. 8	0,022
7	SO ₄	mg/l	Max. 250	1
8	Cu	mg/l	Max. 1	<0,015
9	Cl ₂	mg/l	Max. 5	1,75
10	NH ₄	mg/l	Max. 1,5	0,296
Organic chemistry				
1	As	mg/l	Max. 0,01	No detected
2	Cd	mg/l	Max. 0,003	<0,005
3	NO ₃	mg/l	Max. 50	0,256
4	NO ₂	mg/l	Max. 3	0,008
5	CN	mg/l	Max. 0,07	<0,002
6	Pb	mg/l	Max. 0,01	<0,03
7	Hg	mg/l	Max.0,001	<0,001

The analysis water used for washing sago starch has met the requirements as a production material (17). In this study, sago starch was washed with water, sodium metabisulfite, and chlorine. Sago without washing was used as a control.

3.1. Physical characteristics of sago starch

The physical characteristics of sago starch are presented in Table 2.

Table 2. The physical characteristics of sago starch

Items	Treatments	Form	Aroma	Color	Flavor	Foreign object	Insect	No Starch
1	N1	fine	normal	white	normal	No	No	No
2	N2	fine	normal	white	normal	No	No	No
3	N3	fine	normal	white	normal	No	No	No
4	N4	fine	normal	white	normal	No	No	No
5	K1	fine	normal	white	normal	No	No	No
6	K2	fine	normal	white	normal	No	No	No
7	K3	fine	normal	white	normal	No	No	No
8	K4	fine	normal	white	normal	No	No	No
9	TP	fine	sour	white	normal	Lint, black spots	No	No
10	PA	fine	normal	white	normal	No	No	No

Remarks :

N1, N2, N3, N4 = washing with sodium metabisulfite (500, 1000, 1500, 2000) ppm

K1, K2, K3, K4 = washing with chlorine (500, 1000, 1500, 2000) ppm

TP = no washing

PA = washing with water

Unwashed sago starch has a normal sago flavor and is slightly acidic. The sour aroma of sago starch without washing was due to the dirty water involved and the sewage that comes during soaking. This sour aroma causes the shelf life of sago starch to be shorter and makes it easier to change color.

The starch before washing was slightly dirty due to the presence of fibers involved in the drying process and black spots. Through washing several times, the sewage can be reduced. Meanwhile, insects in the form of stadia and pieces were not found in sago starch without washing or washing. In addition, there were no other types of starch other than sago starch.

3.2. Chemical characteristics of sago starch

The chemical characteristics of sago starch are presented in Table 3.

Table 3. Moisture content, ash, crude fiber, starch, degree of acid and SO₂

Items	Treatments	Moisture content (%)	Ash content (%)	Crude fiber (%)	Starch (%)	Degree of acid	SO ₂ (ppm)
1	N1	8,62 ^a	0,05 ^a	0,46 ^{ab}	87,66 ^b	2,83 ^b	Nd
2	N2	9,76 ^a	0,10 ^a	0,48 ^{ab}	86,53 ^{ab}	2,90 ^b	Nd
3	N3	9,39 ^a	0,11 ^a	0,45 ^a	85,88 ^a	2,66 ^{ab}	Nd
4	N4	8,82 ^a	0,08 ^a	0,49 ^{ab}	87,03 ^{ab}	2,58 ^{ab}	Nd
5	K1	8,96 ^a	0,08 ^a	0,46 ^{ab}	86,65 ^{ab}	2,42 ^{ab}	Nd
6	K2	8,58 ^a	0,13 ^a	0,49 ^{ab}	86,71 ^{ab}	2,50 ^{ab}	Nd
7	K3	8,90 ^a	0,14 ^a	0,50 ^{ab}	87,66 ^b	2,50 ^{ab}	Nd
8	K4	9,47 ^a	0,17 ^{ab}	0,46 ^{ab}	86,58 ^{ab}	2,08 ^a	Nd
9	TP	9,56 ^a	0,26 ^b	0,57 ^b	85,75 ^a	2,08 ^a	Nd
10	PA	9,92 ^a	0,17 ^{ab}	0,44 ^a	87,19 ^{ab}	2,99 ^b	Nd

Remarks :

N1, N2, N3, N4 = washing with sodium metabisulfite (500, 1000, 1500, 2000) ppm

K1, K2, K3, K4 = washing with chlorine (500, 1000, 1500, 2000) ppm

TP = no washing
PA = washing with water
Nd = Not detected

The data presented in Table 3 showed that water content (8.58 – 9.92%), ash content (0.05 – 0.26%), fiber content (0.44 – 0.57%), and starch content (85.75 – 87.66%). The water content meets the maximum standard of 13%, the maximum fiber content of 0.5%, and the minimum starch content of 65% (15). Based on analysis of variance showed that the washing treatment had no significant effect on moisture content, ash content, fiber, and starch. The washing treatment for ash content was not significantly different from without washing, but different with washing treatment using 1500 ppm sodium metabisulfite and 500 ppm chlorine washing.

According to Flach (17), the fiber content of sago starch is about 0.5%, and according to Djoeffie (1996), the content of sago starch fiber is 0.46 % (18). Sago starch has a high carbohydrate (starch) content but few other nutrients. This is due to in one hundred grams of dry sago contains an average of 94 grams of carbohydrates (17), and according to Saripudin (2006), sago starch contains 87.78% carbohydrates

The degree of acidity of sago starch ranges from 2.08 to 2.99. The acid degree value with treatment does not exceed the standard limit set (SNI 3729:2008), which is a maximum of 4. Based on analysis of variance, washing of sago starch has no significant effect on acidity. The washing treatment was not significantly different from without washing, except for washing with 500 ppm sodium (N1), 1000 ppm (N2), and washing with water (PA). SO₂ content was not found in sago starch for all washing treatments. When sago was washed using water repeatedly, sulfite was not found in the sago from washing using sodium metabisulfite. The SO₂ content in sago starch is not expected because it can cause adverse effects on health. This is in accordance with the study that the SO₂ content was not detected in sago starch, both washing and without washing.

The metal content of sago starch based on SNI includes the content of Pb, Cu, Hg, and As. The metal content of sago starch can be presented in table 4.

Table 4. The metal content of sago starch

Items	Treatments	Pb (ppm)	Cu (ppm)	Hg (ppm)	As (ppm)
1	N1	0,88 ^a	3,14 ^a	Nd	Nd
2	N2	0,80 ^a	2,60 ^a	Nd	Nd
3	N3	0,84 ^a	3,12 ^a	Nd	Nd
4	N4	0,82 ^a	1,78 ^a	Nd	Nd
5	K1	0,60 ^a	2,30 ^a	Nd	Nd
6	K2	0,40 ^a	2,35 ^a	Nd	Nd
7	K3	0,92 ^a	1,56 ^a	Nd	Nd
8	K4	0,93 ^a	2,74 ^a	Nd	Nd
9	TP	0,92 ^a	2,51 ^a	Nd	Nd
10	PA	0,70 ^a	0,70 ^a	2,34 ^a	2,34 ^a

Remarks :

N1, N2, N3, N4 = washing with sodium metabisulfite (500, 1000, 1500,2000) ppm

K1, K2, K3, K4 = washing with chlorine (500, 1000, 1500,2000) ppm

TP = no washing

PA = washing with water

Nd : Not detected

The metal content of sago starch included Pb (0.40 - 0.93 ppm) and Cu (1.56 – 3.14 ppm), while Hg and As were not detected. The content of Pb and Cu was below the SNI threshold, while Hg and As were not detected. Based on an analysis of variance showed that washing had no significant effect on Pb and Cu content. Hazardous metals Hg and As were not detected because there was no environmental

pollution of the raw materials or the food processing environment. The metal content of sago starch is in accordance with SNI standards, so it is safe for derivative products of sago starch processing.

3.3. Microbiology characteristics of sago starch

Microbes, especially bacteria, molds, and yeasts, can cause food spoilage. The parameter of damage to sago starch based on SNI 3729: 2008 is if the number of microbes (TPC) is more than 10^6 cfu/g and the amount of mold is more than 10^4 cfu/g. The sago starch of all treatments was still below the established standard. Based on the analysis of variance, the washing treatment significantly affected the number of microbes in sago starch. The washing treatment was significantly different from the non-washing treatment. However, between washing treatments, it had no significant effect. Washing with water was not significantly different from washing with chlorine and sodium metabisulfite. Therefore, the process of making sago noodles simply used washing with water.

Table 5. Total Plate Count, *Escherichia coli* and molds in sago starch (log cfu/g)

Items	Treatments	TPC (log cfu/gr)	Mold (log cfu/gr)	<i>E. coli</i> (log cfu/gr)
1	N1	3,34 ^{cd}	1,90 ^{ab}	0
2	N2	3,25 ^{bcd}	1,90 ^{ab}	0
3	N3	3,04 ^{abc}	1,67 ^a	0
4	N4	3,11 ^{abcd}	1,84 ^{ab}	0
5	K1	3,18 ^{abcd}	1,75 ^{ab}	0
6	K2	2,98 ^{ab}	2,15 ^{bc}	0
7	K3	3,15 ^{abcd}	1,87 ^{ab}	0
8	K4	3,28 ^{bcd}	1,90 ^{ab}	0
9	TP	3,39 ^d	2,44 ^c	0
10	PA	2,93 ^a	1,57 ^a	0

Remarks :

N1, N2, N3, N4 = washing with sodium metabisulfite (500, 1000, 1500,2000) ppm

K1, K2, K3, K4 = washing with chlorine (500, 1000, 1500,2000) ppm

TP = no washing, PA = washing with water

Escherichia coli is a microbe that is more critical than TPC and molds because the parameter of food spoilage in the presence of *E. coli* is a maximum of 10 cfu/g. Sago starch with washing and without washing treatment did not find *E. Coli*. This can be caused by good sanitation handling and drying at a temperature of 50 - 60°C for 8 hours. While *E. coli* has a maximum growth temperature of 37°C, above these temperatures, the bacteria will be inactive.

3.4. Water requirements and sago starch washing yield

The water requirements needed in the sago starch washing process are presented in Table 6.

Table 6. Water requirements and sago starch washing yield

Items	Treatments	Sago starch (g)	Water (mL)	Yield of sago starch (g)	Yield (%)
1	N1	500	3500	480	96,0
2	N2	500	3500	477	95,4
3	N3	500	4000	470	94,0
4	N4	500	4000	465	93,0
5	K1	500	3500	475	95,0
6	K2	500	3500	473	94,6
7	K3	500	4000	460	92,0
8	K4	500	4500	455	91,0
9	TP	500	0	500	100,0
10	PA	500	2000	490	98,0

Remarks :

N1, N2, N3, N4 = washing with sodium metabisulfite (500, 1000, 1500,2000) ppm

K1, K2, K3, K4 = washing with chlorine (500, 1000, 1500,2000) ppm

TP = no washing

PA = washing with water

3.5. The best selection of sago starch washing

Based on the physical, chemical, and microbiological characteristics, it was shown that sago starch needs to be washed. The treatment of washing sago starch with water, sodium metabisulfite, and chlorine did not show any significant difference in the results of the physical, chemical, and microbiological analyses. To determine the best treatment, a weighting method was carried out on the physical, chemical, and microbiological characteristics based on the importance of washing the quality of sago starch. In addition, weighting was carried out on the yield, cost of water usage, and washing materials. Yield, cost of water usage, and washing materials significantly affect the total cost of noodle production. The quality and cost of washing sago starch were graded according to their importance, namely 1 (very unimportant), 2 (not important), 3 (quite important), 4 (important), and 5 (very important). The characteristics weight of the sago starch washing treatment can be seen in table 7.

Table 7. Determination of the quality characteristics of sago starch

Items	Characteristics	Value	Weight
1	Aroma	4	0,048
2	Color	4	0,048
3	Flavor	4	0,048
4	Form	2	0,024
5	Foreign Object	3	0,036
6	Insect	3	0,036
7	Fine	4	0,048
8	Moisture content	4	0,048
9	Ash content	2	0,024
10	Crude fibre	2	0,024
11	Starch	4	0,048
12	Degree of acid	4	0,048
13	Pb	4	0,048
14	Cu	4	0,048
15	Hg	3	0,036
16	As	3	0,036
17	TPC	5	0,060
18	E coli	5	0,060
19	Mold	5	0,060
20	Yield	5	0,060
21	Cost water	5	0,060
22	Cost material	5	0,060
Total		84	1

Remarks :

1 = very unimportant, 2 = not important, 3 = quite important, 4 = important, 5 = very important

After weighting the quality and cost of washing sago starch, it was continued with an assessment of the physical, chemical, microbiological, and cost according to the research results. The value of quality characteristics and the cost of washing sago starch is presented in Table 8.

Table 8. Value of quality characteristics and cost of washing sago starch

Items	Karakteristik	Perlakuan									
		N1	N2	N3	N4	K1	K2	K3	K4	TP	PA
1	Aroma	1	1	1	1	1	1	1	1	2	1
2	Color	1	1	1	1	1	1	1	1	1	1
3	Flavor	1	1	1	1	1	1	1	1	1	1
4	Form	1	1	1	1	1	1	1	1	1	1
5	Foreign Object	1	1	1	1	1	1	1	1	2	1
6	Insect	1	1	1	1	1	1	1	1	1	1
7	Fine	2	7	8	10	3	4	6	9	1	5
8	Moisture content	9	2	5	8	6	10	7	4	3	1
9	Ash content	10	7	6	9	8	5	4	2	1	3
10	Crude fibre	6	5	9	4	8	3	2	7	1	10
11	Starch	9	3	2	7	5	6	10	4	1	8
12	Degree of acid	3	2	4	5	7	6	6	8	9	1
13	Pb	4	7	5	6	9	10	2	1	3	8
14	Cu	1	4	2	9	8	6	10	3	3	7
15	Hg	1	1	1	1	1	1	1	1	1	1
16	As	1	1	1	1	1	1	1	1	1	1
17	TPC	2	4	8	7	5	9	6	3	1	10
18	E coli	1	1	1	1	1	1	1	1	1	1
19	Mold	4	3	8	6	7	2	5	3	1	9
20	Yield	8	7	4	3	6	5	2	1	10	9
21	Cost water	3	3	2	2	3	3	2	1	5	4
22	Cost material	4	3	2	1	8	7	6	5	10	9

The results of the weighting and characteristics were used to determine the quality ranking and washing costs of sago starch. The determination of the ranking of these parameters is presented in Table 9.

Table 9. Determination of the ranking of quality characteristics of sago starch.

[illegible]

6	Insect	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036
7	Fine	0,095	0,333	0,381	0,476	0,143	0,190	0,286	0,429	0,048	0,238
8	Moisture										
8	content	0,429	0,095	0,238	0,381	0,286	0,476	0,333	0,190	0,143	0,048
9	Ash content	0,238	0,167	0,143	0,214	0,190	0,119	0,095	0,048	0,024	0,071
10	Crude fibre	0,143	0,119	0,214	0,095	0,190	0,071	0,048	0,167	0,024	0,238
11	Starch	0,429	0,143	0,095	0,333	0,238	0,286	0,476	0,190	0,048	0,381
12	Degree of acid	0,143	0,095	0,190	0,238	0,333	0,286	0,286	0,381	0,429	0,048
13	Pb	0,190	0,333	0,238	0,286	0,429	0,476	0,095	0,048	0,143	0,381
14	Cu	0,048	0,190	0,095	0,429	0,381	0,286	0,476	0,143	0,143	0,333
15	Hg	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036
16	As	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036	0,036
17	TPC	0,119	0,238	0,476	0,417	0,298	0,536	0,357	0,179	0,060	0,595
18	E coli	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060
19	Mold	0,238	0,179	0,476	0,357	0,417	0,119	0,298	0,179	0,060	0,536
20	Yield	0,476	0,417	0,238	0,179	0,357	0,298	0,119	0,060	0,595	0,536
21	Cost water	0,179	0,179	0,119	0,119	0,179	0,179	0,119	0,060	0,298	0,238
22	Cost material	0,238	0,179	0,119	0,060	0,476	0,417	0,357	0,298	0,595	0,536
Value		3,333	3,036	3,393	3,952	4,286	4,107	3,714	2,738	3,060	4,548
Rating		7	8	6	4	2	3	5	9	8	1

Based on the determination of the quality ranking and the cost of washing sago starch showed that washing using water was the best treatment. Further, washing sago using water was applied for the production process of sago noodles.

4. Conclusion

Washing sago flour with water has better quality and cost value than sodium metabisulfite and chlorine. The characteristics of sago starch quality revealed that water was the best washing agent, according to SNI 3729:2008. The results obtained were a normal color, taste, and aroma, 99.1% of fineness, 9.9% of moisture content, 0.17% of ash content, 87% of starch content, 0.44% of fiber, 2.99% of acidity level, SO₂, Hg, and As levels were not detected, 0.7 ppm of Pb, 2.34 ppm of Cu, TPC value of 2.93 log cfu/g. E Coli of 0 log cfu/g and molds of 1.57 log cfu/g.

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