The Utilization of Salt water treatment on Reducing Oxalic Acid in Konjac (*Amorphophallus muelleri Blume*) Flour as a Hydrocolloid Source

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ABSTRACT

Konjac flour is a product from konjac tubers which glucomannan as the main composition. Konjac glucomannan has high potential to applied in food, pharmaceutical and chemical industry. Glucomannan is a water-soluble dietary fibers that is strong hydrocolloid and low in calories. In China and Japan konjac glucomannan used as food ingredients which acts as gelling agent, thickener, emulsifier and stabilizer. However, konjac flour as glucomannan source has special challenges related to food safety due to the presence of oxalic acid. In this study, we discover a method to reduce the oxalic acid regarding to produce a safer konjac flour. There were four samples to be analyzed. There were two different methods of immersed processed of konjac chips followed by two kinds of drying method which direct and indirect sun drying method. The konjac chips were immersed in 6% salt water for three days with no change and change the water in each 24 h. The result showed that the different immersed processed and different drying method have significant effect on oxalic acid content of konjac flour. Konjac chips with no immersed treatment has 0.31 ± 0.02^{a} % oxalic acid. Konjac chips immersed in 6% salt water with changed water in each 24h during three days followed by indirect sun drying method has the lowest oxalic acid of 0.20 ± 0.01^{c} % with the highest reducing oxalic acid of 35.5%. Therefore, the immersed processed combined with indirect sun drying method are suggest to reduce the oxalic acid content in konjac flour.

Keywords: *Glucomannan, immersed, konjac flour, salt water, sun drying method, oxalic acid.*

INTRODUCTION

Konjac (*Amorphophallus muelleri Blume*) is a perennial plant and a member of Araceae family. Konjac flour is produced from the mashed processed of konjac tuber. Konjac tuber is usually grown in Asian countries such as China, Japan, Thailand and Indonesia. The main composition of konjac tuber is glucomannan (1). Glucomannan is a hydrocolloid polysaccharide that consisting of mannose and glucose as a source of water-soluble dietary fiber. Glucomannan composed of β-1,4 linked D-mannose, and D-glucose joined though the C-3 of D-mannose and D-glucose, with an approximate degree of branching of 8% (2). Konjac glucomannan has very high water absorbency, which absorbing as much as 100 g of water per g sample. Konjac glucomannan has an ability to stabilize the gel structure and form gel 10 times stronger than corn flour (3,4). In addition, many study reveal the health benefit effect of konjac glucomannan. It has proved to be an effective adjunct to manage hyperglycemia and hypercholesterolemia (5). It may lead to a gradual absorption of dietary sugar, which might reduce the elevation of blood sugar levels. The dietary fiber of konjac glucomannan can bind into bile acids in the gut and carry them out of the body in the feces which requires the body to convert more cholesterol into bile acids. So it regarding to cholesterol reduction (6). Furthermore, konjac glucomannan was widely applied in the food, pharmaceutical and chemical industry due to the high

viscosity and its many benefits. Konjac glucomannan is physically in the form of flour. In China and Japan konjac glucomannan is used as a non-calorie food ingredient (konyaku and shirataki) which acts as gelling agent, thickener, emulsifier and stabilizer (7-9). However, konjac flour has special challenges especially related to food safety. Some of the problems with konjac include the presence of oxalic acid (10).

Oxalic acid is an acid group chemical compound that has the formula $H_2C_2O_4$. Oxalic acid is an organic acid which is relatively stronger than acetic acid. Oxalic acid plays a role in the body's metabolic processes because it can bind minerals such as calcium, magnesium, and iron. Water-soluble oxalic acid combines with calcium to form calcium oxalate (CaC_2O_4) which is insoluble in water. Therefore, consumption of foods containing excessive amounts of oxalic acid can cause precipitation to form calcium oxalate crystals and will reduce the bioavailability of calcium in the body, thereby increasing the risk of kidney stones (11). Therefore, our study aimed to discover a method to reduce the oxalic acid on konjac in order to obtain a safer konjac flour as a glucomannan sources.

MATERIAL AND METHODS

Materials

Konjac as the main materials were purchased from farmers in Bolo village, Kare District, Madiun Regency, East Java, Indonesia (Figure 1). The chemical were kalium permanganate (Sigma-Aldric, USA), distilled water, sulfuric acid (Pudak scientific), chloride acid (Pudak scientific), alcohol 75% and other chemical.

Figure 1. Konjac tuber from farmers in Bolo village, Kare District, Madiun Regency

Preparation of konjac flours

Konjac flour was prepared in several steps by peeled off the konjac tuber, washed, cut off into small pieces, and immersed the konjac chip in 6% saline solution for three days. During three days, there were different treatment which the saline water was no changed and changed every 24 hours. Then, after three days the konjac chip was dried using two kinds of method, namely direct sun drying and indirect sun drying method. The dried konjac chip then was grounded and sieved through a 40 mesh using sieve shakers. So, there were four samples to be analyzed:

Table 1. The sample preparation of konjac flour product

Samples	Treatment
N1	Konjac chips were immersed in 6% salt water for three days, then dried with direct sun drying method
N2	Konjac chips were immersed in 6% salt water for three days, then dried with indirect sun drying method
C1	Konjac chips were immersed in 6% salt water for three days with the saline water changed in each 24 hours), then dried with direct sun drying method
C2	Konjac chips were immersed in 6% salt water for three days with the saline water changed in each 24 hours), then dried with indirect sun drying method

Determination of Water Content

The crucible was dried in an oven at 105°C for 15 minutes, and then cooled in a desiccator for 10 minutes. The crucible is weighed using an analytical balance (A). A sample of 2 grams is put into the crucible, then the crucible and the sample weighed used an analytical balance (W). The sample was dried in an oven at a temperature of 105°C for 16 hours. Next, the sample was cooled in a desiccator for

±20 minutes, and then weighed (Y). After that, the cup containing the sample was dried again in the oven for 15-30 minutes, then weighed again. The drying was repeated until a constant weight was obtained (difference in weight 0.0003 grams) (12). The water content was calculating using the formula below:

$$Water\ content\ (\%) = \frac{W - Y}{W - A} x\ 100\%$$

Determination of Ash Content

The crucible was burned in a furnace (550 °C) for 15 minutes, then store in a desiccator, and weighed (A). A sample of 2 grams (W) was weighed in the crucible, then the crucible containing the sample is burned until a gray ash. Ashing was carried out at 600 °C for 4 hours. Then, coolling crucible containing the sample in the desiccator, and weighed with an analytical balance (X) (12). The ash content was calculating using the formula below:

$$Ash\ content\ (\%) = \frac{X - A}{W} x\ 100\%$$

Determination of Oxalic Acid

Oxalic acid in konjac flour was evaluated based on methods describe by Widjanarko et al (13). Konjac flour as much as 1 g dissolved in 190 mL water which has been mixed with 10 mL of 6 M hydrochloric acid. The mixture is then heated at 100°C for 1 hour. The mixture was added with 250 mL of distilled water and filtered using filter paper. The filtrate is the filtrate that is ready for analysis The filtrate obtained in the sample preparation process previously was taken as much as 50 mL and added with 10 mL of 4 N H_2SO_4. The solution heated to a temperature of 70°C. The solution is titrated with 0.05 M potassium permanganate. The titration was stopped when the solution turns pink.

RESULT

The effect of salt water pre-treatment on konjac flour

The result on Table 2, shows the chemical properties of the konjac flour treatment. The combination of water change treatment on immersed konjac chips in 6% salt water during 3 days showed that there is no significant effect on the water content of konjac flour which was dried using the direct or indirect sun drying method. The water content of konjac flour from direct sun drying method which N1 and C1 were 11.44 ± 0.20% and 11.20 ± 0.26%, respectively. While the water content of konjac flour from indirect sun drying which N2 and C2 were 11.85 ± 0.18% and 11.98 ± 0.30%, respectively. The water content was caried out to determine the water content of the konjac flour products. Another study revealed that water content of konjac flour is 6.15% ± 0.50 (14).

Table 2. The effect of salt water treatment on chemical properties of konjac flour

Parameter	Konjac chips immersed in 6% salt water for three days			
	No changing water		The water was changed every 24 h	
	N1	N2	C1	C2
Water content (%)	11.44 ± 0.20 a	11.85 ± 0.18 a	11.20 ± 0.26 a	11.98 ± 0.30 a
Ash content (%)	1.65 ± 0.05 b	1.44 ± 0.32 d	1.52 ± 0.18 c	1.78 ± 0.14 a

1) Direct sun drying method
2) Indirect sun drying method

The combination of water change treatment in konjac chip immersion on 6% salt water had significant effect on the ash content of konjac flour which was dried using the direct or indirect sun drying method. The ash content of konjac flour used direct sun drying method which N1 and C1 were 1.65 ± 0.05% and 1.52 ± 0.18%, respectively. The ash content of konjac flour used indirect sun drying

method which N2 and C2 were 1.46 ± 0.32% and 1.78 ± 0.14%, respectively. Ash content is the residual mineral left after combustion at a temperature of 500 - 800 °C (15). Therefore, the significant effect of ash content on the konjac flour might due to the influence of mineral salt water during the immersed processed of konjac. The results of the ash content are similar to the other study result of the ash content of konjac flour which is 1.80% (8) and 0.49% (16).

Table 3. The effect of salt water treatment on reducing oxalic acid of konjac flour

Parameter	No immersed in salt water	Konjac chips immersed in 6% salt water for three days			
		No changing water		The water was changed every 24 h	
		N1	N2	C1	C2
Oxalic acid (%)	0.31 ± 0.02 a	0.29 ± 0.02 ab	0.24 ± 0.02 b	0.26 ± 0.01 b	0.20 ± 0.01 c
Reducing oxalic acid (%)	-	9.1	23.1	16.7	35.5

1) Direct sun drying method
2) Indirect sun drying method

The result on Table 3, shows the oxalic acid content of konjac flour treatment. The salt water change treatment during the immersion of konjac chips affected the oxalic acid content of konjac flour. The water changing treatment during the immersed might lower the oxalic acid content of konjac flour. The oxalic acid content on konjac flour of C1 and C2 were 0.26 ± 0.01^{b} % and 0.20 ± 0.01^{c} %, respectively, which lower than N1 and N2 of 0.29 ± 0.02^{ab} and 0.24 ± 0.02^{b}, respectively. Furthermore, the decreasing of oxalic acid of N1, C1, N2 and C2 compared to the samples no immersed treatment (control) were 9.1%, 16.7%, 23.1%, and 35.5%, respectively

The effect of different drying method on konjac flour properties

The different drying method on konjac flour affected a significant different on oxalic acid of konjac flour. Based on Figure 2, the oxalic acid of konjac flour dried used indirect sun drying method has a lower value than used direct sun drying method. The oxalic acid content on konjac flour used indirect sun drying method which N2 and C2 were 0.24 ± 0.02% and 0.20 ± 0.01%, respectively, while direct sun drying method which N1 and C1 were 0.29 ± 0.02% and 0.26 ± 0.01%, respectively. The sundrying method has often been used in drying konjac chips. In other study, the used of greenhouse drying method was effective in producing low oxalic acid of konjac compared used sundrying method. Based on Dwiyono (2019), the oxalic acid of konjac chips used sundrying method and greenhouse drying method were 2.92% and 0.84% (17).

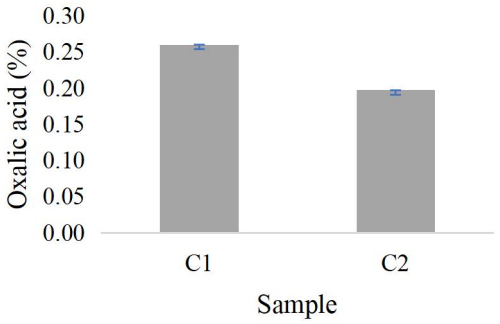

Figure 2. The oxalic acid content on konjac flour in different drying method

DISCUSSION

Konjac flour is a product from konjac tubers with a longer shelf life. Konjac flour has a structure and function similar to pectin because it has high glucomannan content of 64.98% (18). Glucomannan is a water-soluble dietary fiber that is strong hydrocolloid and low in calories. The physical property of glucomannan is able to swell in water up to 138-200% (19). Therefore, konjac flour

has high potential to developed and utilized in the food industry. Konjac flour is processed through several stages, namely cutting, drying, refining and sifting. In this study, there were a pre-treatment before drying process of konjac chips which is the immersion of konjac chip using 6% salt water for 3 days. Then the composition analyzed of konjac flour were water content, ash content and oxalic acid content.

Based on the result, the treatment of salt water changing for each 24 h during the immersed process of konjac chips in 3 days resulted a lower value of oxalic acid. On the other hand, the oxalic acid of konjac chips dried used indirect sun drying method resulted a lower value compared than konjac chips dried used direct sun drying method. The highest oxalic acid value resulted in konjac flour with no immersed salt water pre-treatment which is 0.31 ± 0.02^{a} %. Anggraeni (2014) analyzed that konjac flour has an oxalic acid content of 1.44% (8). Kurniawati (2010) analyzed that konjac flour has an oxalic acid content of 2.11% (16). Kusumawadhani (2007) analyzed that konjac flour has an oxalic acid content of 5.65% (20). While the lowest oxalic acid value resulted in konjac flour treated by changing salt water in each 24 h during immersed processed of its konjac chip followed dried used indirect sun drying method which 0.20 ± 0.01^{c} %.

There have been many studies conducted to reduce oxalic acid level in konjac flour such as dissolve it with a certain solvent. The mineral of sodium chloride in salt water has ability to penetrate the cell wall of idioblast, where the oxalate is accumulated, and removed the oxalate from the cell then dissolved it in acidic environment. Oxalic acid has soluble in water thus it can be remove by washing (21).

CONCLUSION

Based on studies, pre-treatment of konjac chips immersed in salt water can reduce the oxalic acid content of konjac flour. This immersed process might be combined with the indirect sun drying method to further reduce the oxalic acid content. Based on this study, it was concluded that the treatment of changed water for each 24 h during the immersion of konjac chips in 6% saline water followed by direct sun drying method might reduce the oxalic acid as 16.7%. While the treatment of changed water for each 24 h during the immersion of konjac chips in 6% saline water followed by direct sun drying method might reduce the oxalic acid as 35.5% compared to konjac flour with no saline water treatment. Therefore, saline water pretreatment combine with indirect sun drying methods are suggest to reduce the oxalic acid content in konjac flour.

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