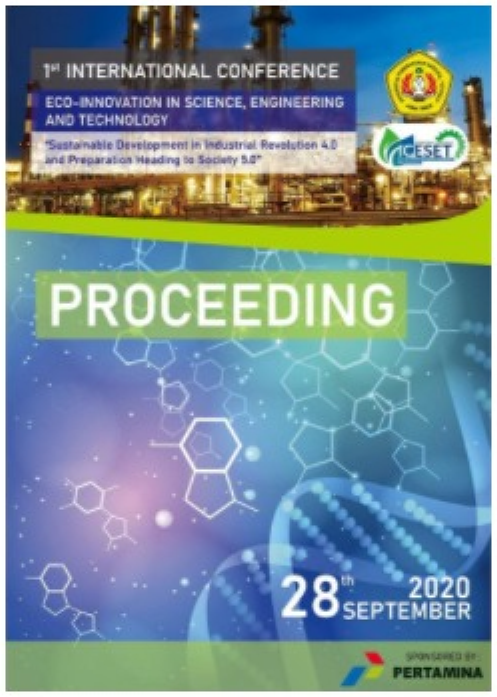

Whereas economic growth is recognized as the most important instrument for the decline in global poverty levels in the past 50 years, not all countries have been equally successful at reducing poverty, and income inequality has risen considerably within and among countries. Moreover, current production processes cannot be sustained within planetary boundaries: resource depletion, climate change, massive increases in waste production and pollution are challenges that have endured. The 2030 Agenda for Sustainable Development calls upon countries to pursue a different kind of growth, one that is socially inclusive and environmentally sustainable.

The driving force of the Fourth Industrial Revolution, or Industry 4.0, will be innovation – experimenting with different ways to make use of a range of emerging physical, digital and biological technologies that transform how we produce, consume, and interact and, ultimately, how it meet the Sustainable Development Goals (SDGs). New technologies include remarkable advances in artificial intelligence, robotics, automation, the Internet of Things, 3D printing and additive manufacturing, nanotechnology, and biotechnology.

Industry 4.0 describes the integration of modern Information and Communication Technologies (ICT) with traditional physical products and processes, which will create new business models and new markets. The major idea of Industry 4.0 is the introduction of internet technologies into industry. Currently, industrial production is facing serious challenges, because information and communication technologies – e.g. the Internet of Things (IoT), Cyber-Physical Systems (CPS), Embedded Systems (ES), Augmented Reality (AR), Machine-to-Machine Communication (M2M), Cloud Computing –are entering the factory. I4.0 is a generic term, a vision that shows where the journey in industrial production is going.

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Conference Paper

The Effect of Soaking Time and Temperature of Acetic Acid Solution to the Decrease of Calcium Oxalate Levels in Porang Tubers

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ABSTRACT

Porang is one of the tubers that grow easily in the plains of Indonesia, one of which is in the Madiun city area, East Java. Porang tubers can be used in various sectors, namely in food processing. Porang tubers are used as the basic material for making food, such as flour. However, porang tubers contain high levels of calcium oxalate. It can cause itchy tongue and throat. This study aimed to determine the effect of temperature and soaking time of porang tubers in 5% acetic acid solution. Soaking the porang tuber sample at 60°C had the greatest decrease percentage in calcium oxalate, which was 53.91%. Soaking the porang tubers for 60 minutes also gave the largest reduction percentage in calcium oxalate, namely 42.54%.

Keywords: Porang tubers, calcium, oxalate, acetic acid

Introduction

Porang (Amorphophallus muelleri Blume) is a tuber plant that grows easily in plains of Indonesia, one of which is in the Madiun city area, East Java. Porang tuber has high glucomannan content. The high levels of glucomannan make porang tubers hold very promising prospects to be utilized suitably. The use of glucomannan in porang tubers is very broad in the fields of industry and food processing. High levels of glucomannan also make porang tubers have a highly functional role for health because they have positive physiological effects, such as reducing blood sugar and inhibiting cholesterol and glucose absorption (Agustin, Estiasih, & Wardani, 2017).

Apart from having a high glucomannan content, porang tubers also contain other compounds, namely calcium oxalate. High levels of calcium oxalate in porang tubers can cause itchy mouth, cause irritation, and trigger the development of kidney stones (Ulfa & Nafi'ah, 2018). To avoid the risk, due to high calcium oxalate levels, it is necessary to reduce calcium oxalate levels. Treatments that can be done to reduce calcium oxalate levels in porang tubers are soaking, washing, and heating ((Agustin, Estiasih, & Wardani, 2017; Purwaningsih & Kuswiyanto, 2016). Soaking can be conducted in an acetic acid solution. Acetic acid is a solution that has a magnificent ability to reduce calcium oxalate. A decrease of calcium oxalate in tubers can occur due to changes in the pH of soaking water, which changes water-insoluble calcium oxalate to oxalic acid compounds that are soluble in water. Acetic acid with a concentration of 20% could reduce calcium oxalate levels in porang flour by up to 90.27%. However, a considerably high concentration of acetic acid could cause acetic acid to stick to the sample even though the sample had been washed twice (Wardani & Handrianto, 2019). Heating and soaking time are important factors that affect the decrease in calcium oxalate levels. In a study conducted by Widari and Rasmito (2018), soaking in a NaCl solution at 80°C was able to reduce calcium oxalate by 90.9%. In a study conducted by Amalia and Yuliana (2013), the results showed that the highest reduction in calcium oxalate levels was found in the longest soaking time, namely the variation of 60 minutes with a decrease of 42.54%. Based on this background, the researcher wanted to know the effect of soaking time and temperature of the acetic acid solution, as a soaking solution, on calcium oxalate levels.

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Research Method

The materials used in this study were porang tubers (Amorphophallus muelleri Blume), 5% acetic acid solution, pro analysis concentrated HCl acid, pro analysis $KMnO_4$, pro analysis concentrated H_2SO_4, pro analysis sodium oxalate ($Na_2C_2O_4$), and distilled water.

The porang tubers were cut into square chips sized 2 x 2 cm, with a thickness of 0.5 cm. 50 grams of porang chips were then soaked in 250 ml of 5% acetic acid solution for 15 minutes. After the soaking process, the porang chips were washed with distilled water twice. The treatment was also performed with a soaking time of 30, 45, and 60 minutes. Porang chips with the same mass as in the previous procedure were immersed in 250 ml of acetic acid solution at 40, 50, and 60°C for 15 minutes. Washing using distilled water was also done after soaking the porang chips. After the porang chips were washed with distilled water, the porang chips were dried at 60°C for 24 hours. After they were dry, the porang chips were ground into porang flour.

The analysis of the remaining levels of calcium oxalate in porang chips was done by dissolving two grams of porang flour in a mixture between 190 ml of water and 10 ml of 6M HCl. Then it was heated in a water bath at 100°C for an hour and filtered. The obtained filtrate was then diluted twice. Finally, the analysis of calcium oxalate levels was conducted with the permanganometry method (Wardani and Handrianto, 2019).

Results and Discussion

The sample used in this study was the porang tubers obtained from the Giringan Kepel Village, Kare District, Madiun Regency. Porang tubers were peeled, washed, then sliced into wet porang chips sized 2 x 2 cm with a thickness of 0.5 cm. The process was done to increase the surface area of the porang tubers during soaking. If the surface area of the porang tubers is broader, the more calcium oxalate in the porang tubers will be dissolved in acetic acid. Two reasons that porang chips were cut with a thickness of 0.5 cm were that if the thickness of the slices was smaller than 0.5 cm, it caused the tubers to stick to the drying bed, while if the thickness of the slices was more than 1 cm, the drying process would take longer and triggered the growth of fungus on the porang chips (Koswara, 2013).

The porang chips were soaked in a 5% acetic acid solution. Acetic acid is a solution that has a substantial ability to reduce calcium oxalate. A change in the pH of soaking water was able to change water-insoluble calcium oxalate into oxalic acid compounds that were soluble in water and disposed of together with the soaking solution (Agustin et al., 2017), according to the following equation.

$$CaC_2O_4 + CH_3COOH \rightarrow H_2C_2O_4 + CH_3COO^- + Ca^{2+} \quad (1)$$

The soaking process was performed on wet porang chips with variations in soaking time and temperature of the soaking solution. The soaking temperature variations used were room temperature, 40, 50, and 60°C, and the time variations used were 15, 30, 45, and 60 minutes. During the soaking process, a slippery gel layer formed on the porang chips. As the soaking time progressed, more gel was formed. Furthermore, porang chips soaked at high temperatures created more of a slippery gel layer than porang chips soaked at room temperature. The gel was formed because the porang tubers contained high levels of glucomannan (around 65%). Glucomannan had characteristics that easily bind to water and form a gel (Zhu, 2018). The gelatinization process mainly occurs at high temperatures. It was advisable to soak at a temperature of 34-38°C to prevent the gelatinization process (Widari and Rasmito, 2018).

After the soaking process, the porang chips were then dried in an oven at 60°C for 24 hours. The drying process was conducted at 60°C because the optimal temperature for the drying process was 60-65°C. The drying process performed at 70°C was able to cause the sticking of one tuber to another, which was caused by the melting of the tubers at that temperature (Arifin, 2001). After the drying process, the porang chips were then ground into flour for analysis. Analysis of calcium oxalate levels was carried out using the permanganometry method. Before the titration was completed, the porang flour sample was prepared through the first heating step. Porang flour was dissolved in HCl solution and heated for 1 hour. This stage aimed to dissolve the remaining oxalate ions in the sample. The remaining oxalate ion in the flour sample was able to dissolve in a diluted hydrochloric acid solution, as shown below.

$$CaC_2O_4 + HCl \rightarrow CaCl + H_2C_2O_4 \quad (2)$$

The filtrate, obtained from the heating process, was diluted and titrated with KMnO4 0.1 N. The data from the analysis of calcium oxalate levels in porang tubers after soaking at different solution temperatures were shown in Table 1 and Table 2. Those tables showed the results of the analysis of calcium oxalate levels in porang tubers after soaking with the soaking time variations.

Table 1. The Analysis Results of Calcium Oxalate Levels (Soaking Temperature Variations)

Soaking Temperature	Soaking Replication	% $^b/_b$ Calcium oxalate	Average level	Calcium oxalate level decrease percentage
Without soaking	1	2.6030	2.6030	-
Room temperature	1	2.0638	2.0788	20.14%
	2	2.1084		
	3	2.0641		
40°C	1	1.9335	1.9334	25.72%
	2	1.9333		
	3	1.9335		
50°C	1	1.6425	1.6752	35.64%
	2	1.6915		
	3	1.6917		
60°C	1	1.2220	1.1996	53.91%
	2	1.1885		
	3	1.1885		

Table 2. The Analysis Results of Calcium Oxalate Levels (Soaking Time Variations)

Soaking Time	Soaking Replication	% $^b/_b$ Calcium oxalate	Average level	Calcium oxalate level decrease percentage
Without soaking	1	2.6030	2.6030	-
15 minutes	1	2.1967	2.1084	18.91%
	2	2.1085		
	3	2.0201		
30 minutes	1	1.9617	1.8460	29.01%
	2	1.8259		
	3	1.7505		
45 minutes	1	1.7556	1.6683	35.84%
	2	1.6574		
	3	1.5918		
60 minutes	1	1.5387	1.4941	42.54%
	2	1.1885		
	3	1.1885		

From the data obtained, it could be seen that the calcium oxalate level in the control (without soaking) was 2.6030% w/w. Calcium oxalate levels in the sample gradually decreased after being given soaking treatment, both with the effect of soaking temperature and soaking time. Samples soaked with soaking time variations resulted in the greatest reduction in calcium oxalate levels at 60 minutes of soaking (42.54%) from the initial level, with the remaining levels of 1.4941% w/w. The decrease of calcium oxalate levels occurred because the longer the soaking time, the water pressure on the cell walls would increase, and then pushed out and disposed of the calcium oxalate crystals along with the soaking water.

The most considerable reduction in calcium oxalate levels in the sample was obtained at 60°C, which decreased by 53.91%. The decrease of calcium oxalate levels was caused by the result of the soaking temperature. The heating process essentially was able to destroy the cell walls and cause the oxalate to escape, which then dissolves in the solvent (Albhin & Savage, 2000). Soaking treatment followed by the heating process gave optimal results. Apart from the osmosis phenomena that occurred during the soaking process, the relatively increased solubility of calcium oxalate at high temperatures was also a supporting factor for the decrease of calcium oxalate levels.

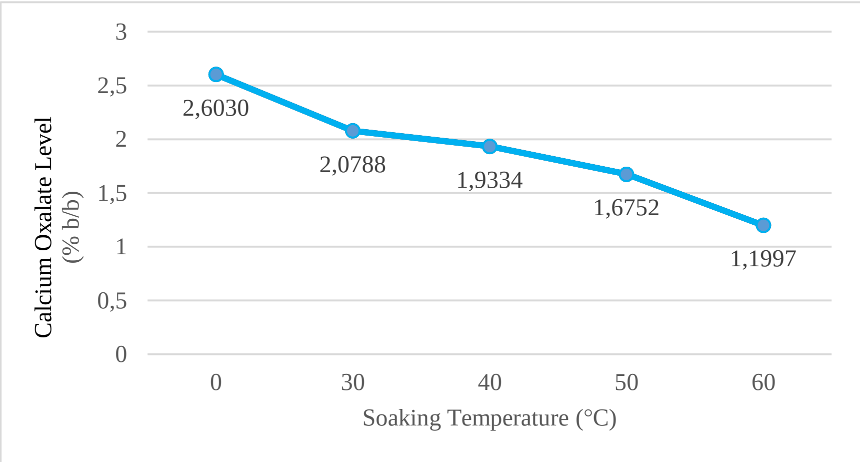

Figure 1. Calcium Oxalate Reduction Curve (Soaking Temperature Variations)

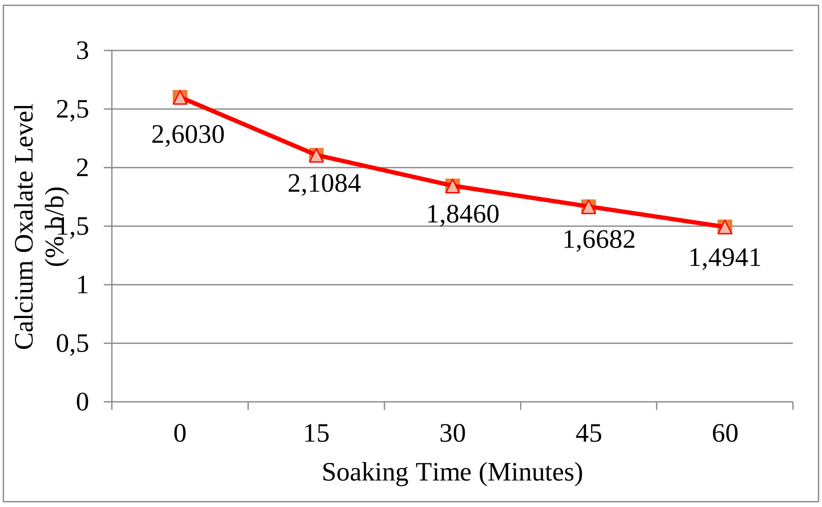

Figure 2. Calcium Oxalate Reduction Curve (Soaking Time Variations)

From Table 1 and Table 2, it could be seen that the treatment of soaking porang tubers in a acetic acid solution followed by heating was able to reduce the calcium oxalate levels properly. Heating process could destroy cell walls and cause oxalates to break down and dissolve in water (Amalia & Yuliana, 2013). Besides, the temperature of the solution was also a factor in increasing the solubility of calcium oxalate in water. The higher the temperature of the soaking solution, the more dissolved calcium oxalate would become and would be disposed of together with the soaking solution.

Conclusion

The duration of soaking time and the temperature of the acetic acid solution affected the decrease of calcium oxalate levels in porang tubers. The largest decrease of calcium oxalate levels occurred in samples soaked in 5% acetic acid solution with a soaking temperature of 60°C, which was 53.91%. The higher the immersion temperature, the more calcium oxalate would be dissolved and disposed of together with the soaking solution.

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