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Submission date: 12-Nov-2020 05:10PM (UTC+0700)
Submission ID: 1476652222
File name: cek_similarity_jurnal_internasional_bereputasi.docx (52.75K)
Word count: 2366
Character count: 11764

The Effect of Soaking Porang Tubers in Acid Solution on Decreasing Calcium Oxalate Levels

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Abstract. Porang tubers are one type of tuber that contains a lot of glucomannan. Glucomannan is widely used in the food industry as a food thickener. In the health sector, glucomannan is a good food if consumed by people with hypertension and diabetes. The use of porang tubers as food is still very little. This is due to the high calcium oxalate content. Calcium oxalate can cause itching and burning in the tongue and throat when consumed and can cause interference with the kidneys. This study objective is to reduce calcium oxalate levels in porang tubers. Decreasing calcium oxalate levels is done by soaking porang tubers in the chips form with a solution of lime juice and vinegar with a variety of solution concentrations. Soaking porang tubers in the 5% lime juice solution showed optimal results which were able to reduce calcium oxalate levels by 58%. Using 15% vinegar showed better results compared to 5% lime juice solution. Porang tubers which have been soaked with 15% vinegar has decreased calcium oxalate level by 68%. From the results of these studies, it can be seen that the immersion treatment with a solution of lime juice and vinegar effectively reduces calcium oxalate levels in porang tubers.
Keywords : tubers, porang, oxalate, vinegar, lime juice.

INTRODUCTION

Porang tubers are a type of tuber that is widely cultivated in Indonesia. Porang tubers have a characteristic that is not possessed by other tubers which contain about 65% glucomannan (Koswara, 2013). Glucomannan is one of the polysaccharide compounds that can be used as a source of dietary fiber. Glucomannan has high molecular weight, very soluble in water, high viscosity in solution (McCarty, 2002). Glucomannan is widely used in various sectors. In the food sectors, glucomannan is used as an additive that is safe to use as a food stabilizer, thickening and gelling agents (Parry, 2010; Saha and Bhattacharya, 2010). In the health sector, glucomannan can increase blood lipid profile and reduce glucose concentration in the body so that glucomannan is very well consumed by people with type 2 diabetes (Chen, et al., 2003; Vuksan, et al., 2001). Glucomannan is also good consumed by obese sufferers because glucomannan can reduce blood cholesterol and serum cholesterol significantly (Martino, et al., 2005).

Beside of contain high glucomannan, porang tubers also contain calcium oxalate which is harmful to the body. Calcium oxalate crystals can cause itching on the tongue, mouth and throat when consumed. Itching can also be felt on the palms when peeling the porang tubers (Maulina, et al., 2012). The content of oxalate or calcium oxalate compounds that are too high in a food can be bad for human health because it can cause kidney stone disease. Calcium oxalate is safe in the body if it does not exceed 1,25 grams/day for 6 consecutive weeks (Knudsen, et al., 2005).

The content of calcium oxalate in the tubers can be reduced by mechanical and chemical means. The mechanical method can be done by ball mill and stamp mill methods (Mawarni and Widjanarko, 2015; Sutrisno, 2011)). The chemical method can be done by soaking tubers in a solution of acid and salt. Salt solution that is commonly used is NaCl or commonly known as table salt (Amalia and Yuliana, 2013; Widari and Rasmito, 2018; Syamsiah, 2011; Chotimah and Fajarini, 2013). Acid solutions that can be used to reduce levels of calcium oxalate in the tuber include citric acid solution, lime juice, *Averrhoa bilimbi* juice, and vinegar (Purwaningsih and Kuswiyanto, 2016; Agustin, et al., 2017).

Averrhoa bilimbi juice extract with a concentration of 3, 5 and 7% can reduce calcium oxalate levels in porang tubers. The higher the concentration of *Averrhoa bilimbi* juice, the higher decrease in calcium oxalate levels in porang tubers (Wardani and Handrianto, 2019). Citric acid solution and lime juice with concentrations of 1, 5 and 10% respectively have been used to reduce calcium oxalate levels in taro tubers. Citric acid solution and 5% lime juice are optimal concentrations to reduce calcium oxalate levels in taro tubers compared to concentrations of 1 and 10% (Purwaningsih and Kuswiyanto, 2016). Kimpul Tubers are a type of tuber that contains calcium oxalate. The calcium oxalate content in the tuber can be reduced by immersing it in a vinegar acid solution with a concentration of 10, 15 and 20%. Calcium oxalate levels in the tubers which have been soaked with vinegar acid solution has decreased approximately 50 – 66% (Agustin, et al., 2017).
Based on several studies that have been conducted on the reduction of calcium oxalate levels in several types of tubers, researchers want to conduct research on the reduction of calcium oxalate levels in porang tubers. Efforts to reduce calcium oxalate levels are done by soaking porang tubers in a solution of lime juice (with concentrations of 3, 5 and 7%) and vinegar acid solutions (with concentrations of 10, 15 and 20%). Analysis of calcium oxalate levels using the permanganometric titration method.

MATERIALS AND METHODS

Materials

Materials used in this study included porang tubers, lime fruit, 25% vinegar acid solution, oxalic acid, potassium permanganate, distilled water, concentrated hydrochloric acid (HCl) and concentrated sulfuric acid (H_2SO_4). Lime fruit and 25% vinegar acid solution are used as a marinade solution. Oxalic acid, potassium permanganate, distilled water, concentrated hydrochloric acid and concentrated sulfuric acid were used in the process of analyzing calcium oxalate levels.

Productions of acid solutions

Concentrations of lime juice solution used in this study are of 3, 5 and 7% v/v. A solution of 3% lime juice is made by mixing 3 mL of lime juice with distilled water to a total volume of 100 mL solution. Lime juice solution of 5 and 7% is made in the same way with the volume of lime juice as much as 5 and 7 mL.

concentrations of Vinegar acid solution used in this study are of 10, 15 and 20% v/v. A 10% vinegar acid solution is prepared by diluting 40 mL of a 25% vinegar acid solution in 100 mL of solution. 15 and 20% vinegar acid solutions are made in the same way with a volume of 60 and 80 mL vinegar acid solution.

Process of Immersion Porang Tubers in Acid Solution

Initially, the porang tuberss were sliced into wet chips with a size of 2 × 2 cm and 0.5 cm thick. Wet porang chips, as much as 50 grams, soaked in 250 mL of lime juice solution with variations concentrations of 0, 3, 5 and 7% v / v. Soaking is done for 3 × 15 minutes and washed with distilled water. After the soaking process, wet porang chips and porang flour are dried at 60 ^{0}C for 24 hours (Wardani and Handrianto, 2019). Chips and porang flour that has been dried and then pounded until smooth. The same procedure is also carried out on a vinegar solution with a concentration of 10, 15 and 20%.

The Process of Analysis of Oxalate Levels on Porang Bulbs

Two grams of sample (porang chips that have been crushed in the previous stage) were reacted with 200 mL of 0,3 M HCl solution and heated in a water bath to boil for 1 hour. The filtrate obtained was then added with distilled water to a volume of 250 mL. The filtrate was then diluted twice for further analysis of calcium oxalate levels using the permanganometric titration method (Wardani and Handrianto, 2019).

At the time of titration, the sample solution used was 50 mL. The sample solution was added 10 mL of 4N H_2SO_4 solution and heated until solution temperature is 70 ^{0}C. The solution is then titrated with 0,1N $KMnO_4$ solution, which has been standardized before,

until the color of the solution changes from colorless to pink which does not disappear within a few seconds.

RESULT AND DISCUSSION

Porang tubers soaking process

Oxalate compounds in plants are stored in plant cell fluids in the form of either oxalic acid or calcium oxalate. The presence of oxalate compounds in these tubers causes itching in the palms of the hands when peeling them and itching in the mouth, tongue and throat when consuming them (Maulina, et al., 2012). That is because the prick by the calcium oxalate crystal needles is wrapped in a transparent capsule filled with liquid. The transparent capsule is called rafid. If the tuber is peeled or cut, it can causes the rafid wall to rupture and calcium oxalate crystals to come out of the rafid to the surface. Calcium oxalate crystals that come out will pierce the skin and cause itching on the skin of the hands, mouth, tongue and throat.

Calcium oxalate compound is the oxalate salt which is the most difficult to dissolve in water. Calcium oxalate has water solubility of 0.0067 g / L at 13 ^{0}C (Svehla, 1990). Washing with water can only dissolve oxalic acid compounds but not with calcium oxalate compounds. Calcium oxalate crystals can be removed by proper washing and soaking several times. Calcium oxalate is not soluble in water but dissolves in dilute acids, so it is better to wash and soak the tubers in an acidic compound so that calcium oxalate compounds can be removed optimally

Lime juice contains organic acids such as citric acid and ascorbic acid (Purwaningsih and Kuswiyanto, 2016). Both of these acids can convert water-insoluble calcium oxalate into water-soluble oxalic acid so that it is wasted with immersion water. Calcium oxalate is difficult to dissolve in dilute vinegar, so the concentration of the vinegar acid solution used to soak porang tubers in this study is 10, 15 and 20%.

Analysis of calcium oxalate levels in porang tubers

Analysis of calcium oxalate levels in porang tubers using permanganometry method. Before analysis, the sample is prepared first. Porang tubers that have been soaked, dried first and then pounded into flour. The porang flour is then reacted with 0,3 M HCl solution and heated to boiling for 1 hour. The use of HCl solution aims to dissolve calcium oxalate. Oxalate ions from calcium oxalate react with H^+ ions from HCl to form oxalic acid compounds that dissolve in water according to the following reaction equation.

$$CaC_2O_4 + HCl \rightarrow CaCl_2 + H_2C_2O_4$$

Result of filtration by heating contains oxalic acid compounds and these compounds will be analyzed by permanganometry method. From the reaction equation above, it can be seen that the number of moles of oxalic acid is equivalent to the number of moles of calcium oxalate so that the calcium oxalate level is equivalent to the level of oxalic acid in the filtrate.

Analysis of oxalic acid levels can actually be done also by the alkalimetry method but in this study it cannot be done. That is because the heating stage involves a solution of HCl. It is feared that the HCl compound is still contained in the filtrate and can react with NaOH, as a secondary standard solution in the alkalimetry method. This makes the measured acid levels not only oxalic acid levels but also hydrochloric acid levels.

Table 1. Calcium oxalate levels in porang tubers after soaking in vinegar

solution	Conc	replication	%w/w oxalate acid	average %w/w
aquadest	-	-	4,9254	4,9254
vinegar	10%	1	2,1891	2,1356

		2	2,1122	
		3	2,1054	
		1	1,5433	
	15%	2	1,7818	1,6839
		3	1,7266	
		1	1,5537	
	20%	2	1,6377	1,6197
		3	1,6676	

Calcium oxalate levels in porang tubers after soaking in vinegar (acetic acid) are shown in Table 1. Vinegar acid solutions 10, 15 and 20% can reduce calcium oxalate levels in porang tubers by 57, 66 and 67%. These results are consistent with Agustin's research (2017) that 20% vinegar (acetic acid) can reduce calcium oxalate levels in the tubers by 66%. A graph of decreased calcium oxalate levels in porang tubers after being soaked in a vinegar acid solution is shown in Figure 1.

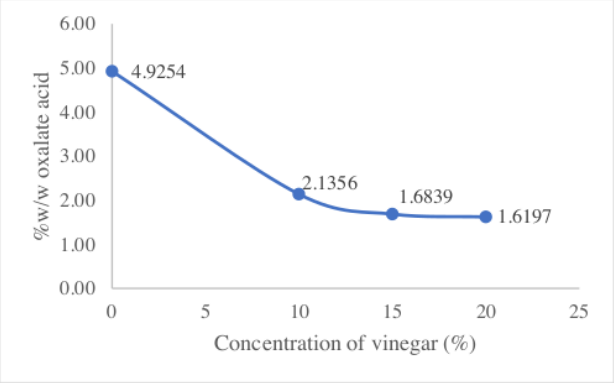

Figure 1. Graph of decrease in calcium oxalate levels after the process of soaking in vinegar

Table 2. Calcium oxalate levels in porang tubers after soaking in lime juice

acid solution	Conc	replication	%w/w oxalate acid	average %w/w
aquadest	-	-	4,9254	4,9254
		1	2,7890	
	3%	2	2,5372	2,7026
		3	2,7817	
		1	1,9201	
lime juice	5%	2	2,1350	2,0422
		3	2,0715	
		1	2,4715	
	7%	2	2,7012	2,5837
		3	2,5783	

Citric acid is a weak organic acid. Citric acid can react with calcium oxalate to form oxalic acid which is soluble in water and calcium citrate which is insoluble in water. Calcium oxalate contained in porang tubers when soaked in lime juice will react with citric acid contained in lime juice. Oxalic acid and calcium citrate that are formed from these reactions will also be wasted with soaking water (Svehla, 1990). A similar reaction

also occurs between ascorbic acid in lime juice and calcium oxalate in porang tubers. The reaction was proven by the decrease in calcium oxalate levels in porang tubers after being soaked with lime juice. From table 2, it can be seen that lime juice 3, 5 and 7% can reduce calcium oxalate levels in porang tubers by 45, 58 and 47%, respectively. Lime juice 5% can reduce calcium oxalate levels optimally. These results are in accordance with research Purwaningsih and Kuswiyanto (2016) that the 5% lime juice extract is the most optimal in reducing levels of calcium oxalate in taro tubers. A graph of decreased calcium oxalate levels in porang tubers after being immersed in lime juice is shown in Figure 2.

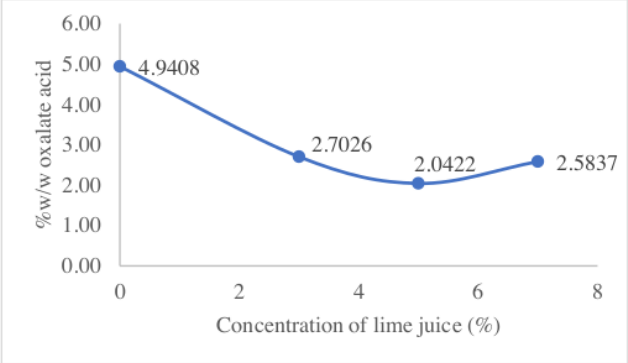

Figure 2. Graph of decrease in calcium oxalate levels after the process of soaking in lime juice

CONCLUSION

Acid solution, in this research that is vinegar and lime juice, has an effect on decreasing the level of calcium oxalate in porang tubers. Vinegar acid 20% can reduce calcium oxalate levels in porang tubers by 66% and lime juice 5% can reduce calcium oxalate levels in porang tubers by 58%.

Acknowledgments

Our gratitude goes to Lembaga Layanan Pendidikan Tinggi (LLDIKTI) wilayah VII dan Direktorat Riset dan Pengabdian Kepada Masyarakat, Direktorat Jenderal Penguatan Riset dan Pengembangan, Kementerian Riset, Teknologi dan Pendidikan Tinggi (Kemenristekdikti) who financed Penelitian Dosen Pemula (PDP) in 2019.

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