ISSN 0970-0153
R. N. 135/AL/84-N. T. I.
NAAS RATING : 4.08

ANNALS OF BIOLOGY

Vol. 36, No. 2 (April 2020)

CONTENTS

Articles

Annals of Biology **36** (2) : 173-176, 2020

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

RATIH KUSUMA WARDANI* AND PRASETYO HANDRIANTO**

Akademi Farmasi Surabaya, Indonesia
**(e-mail : ratihkusumawardani19@gmail.com; Mobile : +62 82233610419; **prasetyohandrianto@gmail.com; Mobile : +62 81248464051)*

ABSTRACT

Porang tubers were one type of tuber that contained a lot of glucomannan. Glucomannan was widely used in the food industry as a food thickener. In the health sector, glucomannan was a good food if consumed by people with hypertension and diabetes. The use of porang tubers as food was still very little. This was due to the high calcium oxalate content. Calcium oxalate could cause itching and burning in the tongue and throat when consumed and could cause interference with the kidneys. Objective of this study was to reduce calcium oxalate levels in porang tubers. Decreasing calcium oxalate levels was 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. Porang tubers, which had been soaked with 15% vinegar, had decreased calcium oxalate level by 68%. From the results of these studies, it could be seen that the immersion treatment with a solution of lime juice and vinegar effectively reduced calcium oxalate levels in porang tubers.

Key words : Tubers, porang, oxalate, vinegar, lime juice

INTRODUCTION

Porang tubers were a type of tuber that was widely cultivated in Indonesia. Porang tubers had a characteristic that was not possessed by other tubers which contain about 65% glucomannan (Koswara, 2013). Glucomannan was one of the polysaccharide compounds that could be used as a source of dietary fiber. Glucomannan had high molecular weight, very soluble in water and high viscosity in solution. Glucomannan was widely used in various sectors. In the food sectors, glucomannan was used as an additive that was safe to use as a food stabilizer, thickening and gelling agents (Tester and Al-Ghazzewi, 2017). In the health sector, glucomannan could increase blood lipid profile and reduce glucose concentration in the body so that glucomannan was very well consumed by people with type 2 diabetes. Glucomannan was also consumed by obese sufferers because glucomannan could reduce blood cholesterol and serum cholesterol significantly (Tester and Al-Ghazzewi, 2017).

Besides high glucomannan, porang tubers also contained calcium oxalate which was harmful to the body. Calcium oxalate crystals could cause itching on the tongue, mouth and throat when consumed. Itching could also be felt on the palms when peeling the porang tubers (Maulina *et al.*, 2012). The content of oxalate or calcium oxalate compounds that were too high in a food could be bad for human health because it could cause kidney stone disease. Calcium oxalate was safe in the body if it did not exceed 1.25 g/day for six consecutive weeks (Wardani and Handrianto, 2019).

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

A. bilimbi juice extract with a concentration of 3, 5 and 7% could reduce calcium oxalate levels in porang tubers. The higher the concentration of *A. bilimbi* juice, the higher was 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, were used to reduce calcium oxalate levels in taro tubers. Citric acid solution and 5% lime juice were optimal concentrations to reduce calcium oxalate levels in taro tubers compared to concentrations of 1 and 10% (Purwaningsih and dan Kuswiyanto, 2016). Kimpul tubers were a type of tuber that contained calcium oxalate. The calcium oxalate content in the tuber could 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 had been soaked with vinegar acid solution had decreased approximately 50-66% (Agustin *et al.*, 2017).

Based on several studies that had been conducted on the reduction of calcium oxalate levels in several types of tubers, researchers wanted to conduct research on the reduction of calcium oxalate levels in porang tubers. Efforts to reduce calcium oxalate levels were 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 used the permanganometric titration method.

MATERIALS AND METHODS

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 were 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.

Concentrations of lime juice solution used in this study were of 3, 5 and 7% v/v. A solution of 3% lime juice was 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% was 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 were of 10, 15 and 20% v/v. A 10% vinegar acid solution was prepared by diluting 40 ml of a 25% vinegar acid solution in 100 ml of solution. Fifteen and 20% vinegar acid solutions were made in the same way with a volume of 60 and 80 ml vinegar acid solution. Initially, the porang tubers were sliced into wet chips with a size of 2 × 2 cm and 0.5 cm thick. Wet porang chips, as much as 50 g, were soaked in 250 ml of lime juice solution with varying concentrations of 0, 3, 5 and 7% v / v. Soaking was done for 3 × 15 min and washed with distilled water. After the soaking process, wet porang chips and porang flour were dried at 60°C for 24 h (Wardani and Handrianto, 2019). Dried porang flour chips were pounded until smooth. The same procedure was also carried out on a vinegar solution with a concentration of 10, 15 and 20%.

Two g of sample (porang chips that had 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 h. 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 was 70°C. The solution was then titrated with 0.1N $KMnO_4$ solution, which had been standardized before, until the colour of the solution changed from colourless to pink which did not disappear within a few seconds.

RESULTS AND DISCUSSION

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 could cause the rafid wall to rupture and calcium oxalate crystals to come out of the rafid to the surface. Calcium oxalate crystals that come out would pierce the skin and cause itching on the skin of the hands, mouth, tongue and throat.

Calcium oxalate compound was the oxalate salt which was the most difficult to dissolve in water. Calcium oxalate had water solubility of 0.0067 g/l at 13°C (Wardani and Handrianto, 2019). Washing with water could only dissolve oxalic acid compounds but not with calcium oxalate compounds. Calcium oxalate crystals could be removed by proper washing and soaking several times. Calcium oxalate was not soluble in water but dissolves in dilute acids, so it was better to wash and soak the tubers in an acidic compound so that calcium oxalate compounds could be removed optimally. Lime juice contained organic acids such as citric acid and ascorbic acid (Purwaningsih and dan Kuswiyanto, 2016). Both of these acids could convert water-insoluble calcium oxalate into water-soluble oxalic acid so that it was wasted with immersion water. Calcium oxalate was difficult to dissolve in dilute vinegar, so the concentration of the vinegar acid solution used to soak porang tubers in this study was 10, 15 and 20% (Table 1).

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

Solution	Conc.	Replication	Oxalate acid (% w/w)	Average (% w/w)
Aquadest	-	-	4.9254	4.9254
Vinegar	10%	1	2.1891	2.1356
		2	2.1122	
		3	2.1054	
	15%	1	1.5433	1.6839
		2	1.7818	
		3	1.7266	
	20%	1	1.5537	1.6197
		2	1.6377	
		3	1.6676	

Analysis of calcium oxalate levels in porang tubers was using permanganometry method. Before analysis, the sample was prepared first. Porang tubers that had been soaked, dried first and then pounded into flour. The porang flour was then reacted with 0.3 M HCl solution and heated to boiling for 1 h. The use of HCl solution was aimed at dissolving calcium oxalate. Oxalate ions from calcium oxalate reacted with H^+ ions from HCl to form oxalic acid compounds that were dissolved in water according to the following reaction equation :

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

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

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

Calcium oxalate levels in porang tubers after soaking in vinegar (acetic acid) are shown in Table 1. Vinegar acid solutions 10, 15 and 20% could 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) could 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 Fig. 1.

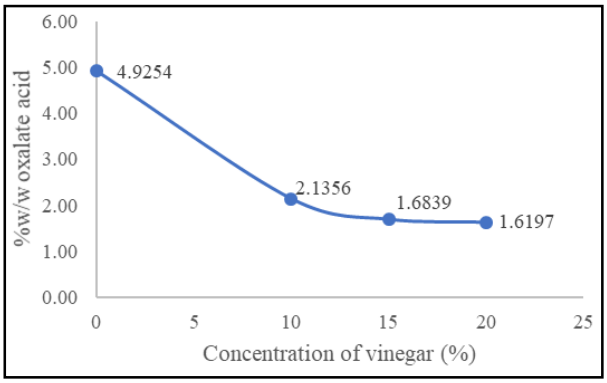

Fig. 1. Graph of decrease in calcium oxalate levels after the process of soaking in vinegar.

Citric acid was a weak organic acid. Citric acid could react with calcium oxalate to form oxalic acid which was soluble in water and calcium citrate which was insoluble in water. Calcium oxalate contained in porang tubers when soaked in lime juice would react with citric acid contained in lime juice. Oxalic acid and calcium citrate that were formed from these reactions would also be wasted with soaking water (Wardani and Handrianto, 2019). A similar reaction also occurred 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

could be seen that lime juice 3, 5 and 7% could reduce calcium oxalate levels in porang tubers by 45, 58 and 47%, respectively. Lime juice 5% could reduce calcium oxalate levels optimally. These results are in accordance with research (Purwaningsih and dan Kuswiyanto, 2016) that the 5% lime juice extract was 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 Fig. 2.

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

Solution	Conc.	Replication	Oxalate acid (% w/w)	Average (% w/w)
Aquadest	-	-	4.9254	4.9254
Lime Juice	3%	1	2.7890	2.7026
		2	2.5372	
		3	2.7817	
	5%	1	1.9201	2.0422
		2	2.1350	
		3	2.0715	
	7%	1	2.4715	2.5837
		2	2.7012	
		3	2.5783	

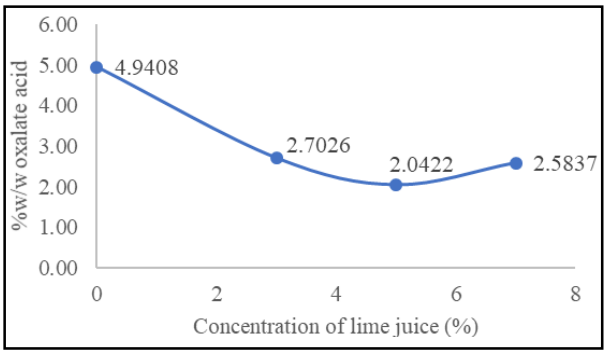

Fig. 2. Graph of decrease in calcium oxalate levels after the process of soaking in lime juice.

CONCLUSION

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

ACKNOWLEDGEMENTS

Our gratitude went to Lembaga Layanan Pendidikan Tinggi (LLDIKTI) wilayah VII and 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.

REFERENCES

Agustin, R., Estiasih, T. and Wardani, A. K. (2017). Penurunan Oksalat Pada Proses Perendaman Umbi Kimpul (*Xanthosoma sagittifolium*) di Berbagai Konsentrasi Asam Asetat. *Jurnal Teknologi Pertanian* **18** : 191-200.

Amalia, R. and Yuliana, R. (2013). Studi Pengaruh Proses Perendaman dan Perebusan Terhadap Kandungan Kalsium Oksalat Pada Umbi Senthe (*Alocasia macrorrhiza* (L.) Schott). *Jurnal Teknologi Kimia dan Industri* **2** : 17-23.

Chotimah, S. and Fajarini, D. T. (2013). Reduksi Kalsium Oksalat Dengan Perebusan Menggunakan Larutan NaCl dan Penepungan Untuk Meningkatkan Kulitas Senthe (*Alocasia Macrorrhiza*) Sebagai Bahan Pangan. *Jurnal Teknologi Kimia dan Industri* **2** : 76-83.

Koswara, S. (2013). Modul : Teknologi Pengolahan Umbi-umbian Bagian 2 : Pengolahan Umbi Porang. Bogor : Southest Asian Food and Agricultural Science and Technology (SEAFAST) Center, Agricultural University, Bogor.

Maulina, F. D. A., Lestari, I. M. and Retnowati, D. S. (2012). Pengurangan Kadar Kalsium Oksalat Pada Umbi Talas Menggunakan $NaHCO_3$: Sebagai Bahan Dasar Tepung. *Jurnal Teknologi Kimia dan Industri* **1** : 277-283.

Mawarni, R. T. and dan Widjanarko. S. B. (2015). Penggilingan Metode Ball Mill Dengan Pemurnian Kimia Terhadap Penurunan Oksalat Tepung Porang. *Jurnal Pangan dan Agroindustri* **3** : 571-581.

Purwaningsih, I. and dan Kuswiyanto (2016). Perbandingan Perendaman Asam Sitrat dan Jeruk Nipis Terhadap Penurunan Kadar Kalsium Oksalat Pada Talas. *Jurnal Vokasi Kesehatan* **2** : 89-93.

Tester, R. and Al-Ghazzewi, F. (2017). Glucomannans and nutrition. *Food Hydrocolloids* **68** : 246-254.

Wardani, R. K. and Handrianto, P. (2019). Pengaruh perendaman Umbi dan Tepung Porang Dalam Sari Buah Belimbing Wuluh Terhadap Sifat Fisik dan Kadar Kalsium Oksalat. *J. Pharmacy and Sci.* **4** : 105-109.

Wardani, R. K. and Handrianto, P. (2019). Reduksi Kalsium Oksalat Pada Umbi Porang Dengan Larutn Asam. Graniti, Surabaya.

Wardani, R. K. and Handrianto, P. (2019). Pengaruh Perendaman Umbi Porang Dalam Larutan Sari Buah Belimbing Wuluh Terhadap Penurunan Kadar Kalsium Oksalat. *Prosiding SENAKI* **40** : 1-9.

Widari, N. S. and Rasmito, A. (2018). Penurunan Kadar Kalsium Oksalat Pada Umbi Porang (*Amorphopallus oncophillus*). *Jurnal Teknik Kimia* **13** : 1-4.