

## The Effect of Pretreatment Process for Taro tuber (*Colocasia esculenta*) Calcium Oxalate Content

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**Abstract**—Cormels of taro (*Colocasia esculentum* (L) Schott) have high economic potential, but unfortunately also contain anti-nutrients, namely calcium oxalate crystals, which must be removed before being utilized for food. Removal of oxalate content in food can be done by physical process, like cooking, or chemical process by changing its oxalate crystals, becoming soluble oxalate compounds. Therefore, the incorporation of chemical and physical methods are expected to be a very efficient way of processing. Thus the objectives of this research are: examining the influence of processing variables into flour taro root standardized, including; baking soda solution concentration 0-10% variation), time of immersion of the cormels (variation 0-10 hours), and the time of boiling (variation 0-60 minutes) taro cormels in a solution of baking soda. The stages of the research are: Proximate analysis of taro tubers; optimization variable concentration vs. time soaking baking soda, boiling time variable optimization. The results of this research indicate that the optimal conditions for the pre-treatment is to soak the root taro in baking soda solution 10% for 2 hours to reduce the levels of calcium oxalate at 40.3% followed by boiling the taro tubers for 60 minutes can reduce calcium levels oxalate at 76.9%.

**Keywords** — baking soda, calcium oxalate, taro tubers

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### I. INTRODUCTION

Indonesia is known as a tropical country that has many varieties of food crops. One type of tuber crops in Indonesia that has been lacking a place but it has a high economic potential is taro root [1]. Taro tubers (*Colocasia esculentum* (L) Schott) has great potential due to carbohydrates. Starch from tubers of taro has a very small grain size, which is between 1-5  $\mu\text{m}$  [2] and have a high amylase content (20-25%), which makes it very easy to digest with the aid of  $\alpha$ -amylase in water saliva into simple sugars. Taro tubers also a good source of protein, vitamin C, thiamine, riboflavin, niacin and minerals [3]. Because some of these advantages that taro tubers can be used as a source of non-gluten meal can be used for food alternative for patients allergic to gluten.

In addition to containing nutrients that are beneficial to the human body, taro tubers also contain anti-nutrients, namely oxalate, proteinase inhibitors, phytate, tannins, alkaloids, steroids and cyanogenic glucosides. Almost all parts of the taro plant contain calcium oxalate crystals that resemble needles should be removed by thorough cooking before eating [4]. Basically, removing oxalate content can be done by physics through boiling, heating, drying, pressing and leaching, or by chemical means most convenient way is to process it with a slightly alkaline solution (with the addition of baking soda). Other materials that can help prevent the formation of calcium oxalate are vitamin C, vitamin B, sodium citrate and potassium citrate. However, these materials are very expensive when compared with the baking soda and taro tuber itself. Therefore, the incorporation of chemical and physical processing methods is expected to be a very efficient way of processing to remove the oxalate content of taro root, so that it is further processing into safer flour food. Thus the objectives of this research are: examining the influence of processing variables into flour taro root standardized, including the following: *baking soda* solution concentration, time of immersion of the cormels, and the time of boiling in a solution of *baking soda*.

### II. MATERIALS AND METHODS

This research is divided into three stages: initial proximate analysis of taro root, optimization of variable immersion time vs. concentration of baking soda and boiling time variable optimization.

## 1. Sample preparation

Varieties of taro *Colocasia esculentum (L) Schott* that obtained from market Peterongan, Semarang is used in this research. While all chemical reagents with pro-analysis quality is obtained from the Laboratory of Chemical Engineering, State University of Semarang. Baking soda that used in this research, obtained from Chemistry Stores "Indrasari" in Semarang.

Initial proximate analysis of taro tubers consisted moisture content analysis, carbohydrate, protein, fat, ash (with AOAC method, 2005) [5] and oxalate content analysis. In the early stages of optimization baking soda concentration and time of immersion, taro tubers are washed, peeled with a kitchen knife and cut all the unwanted parts. Furthermore taro tubers are washed with cold water for 3 minutes to get rid of mucus on the surface and other materials attached to it. After wash water discharged, taro tubers sliced into thick pieces 2 x 2 x 0.5 cm and weighs  $\pm 50$  g with manual slicer. Sliced taro root and then soaked in a solution of baking soda with a concentration of 0-10% with intervals of 2% and the duration of soaking 0-10 hours with a 2 hour intervals, to turn off the enzyme and removes the oxalate. The weight ratio of taro tubers to water or submerged solution was 1:4 [6]. Once drained, taro tubers are ready to be analyzed the oxalate content. After obtaining the optimal concentrations of baking soda and soaking time, then do the boiling time optimization using optimal concentration and time variables in the previous stage. In these optimization phase, the variation time used is 0-60 minute with intervals for 10 minutes. After going through the boiling process, then it is analyzed the oxalate levels.

## 2. Oxalate content

The oxalate content was determined using the method originally employed by Ukpabi and Ejidoh (1989) [7]. The procedure involves three steps : digestion, oxalate precipitation and permanganate [8].

### *Digestion*

At this step, 2 g (db) of flour was suspended in 190 ml of distilled water contained in a 250 ml volumetric flask; 10 ml of 6M HCL was added in the suspension digested at 100°C for 1 hr, followed by cooling, and then made up to 250 ml before filtration.

### *Oxalate precipitation*

Duplicate portions of 125 ml of the filtrate were measured into a beaker and four drops of methyl red indicator added, followed by the addition of concentrated NH<sub>4</sub>OH solution (dropwise) until the test solution changed from its salmon pink color to a faint yellow color (pH 4-4.5). Each portion was then heated to 90°C, cooled and filtered to remove precipitate containing ferrous ion. The filtrate was again heated to 90°C and 10 ml of 5% CaCl<sub>2</sub> solution was added while being stirred constantly. After heating, it was cooled and left overnight at 5°C. The solution was then centrifuged at a speed of 2500 rev/min for 5 min. The supernatant was decanted and the precipitate completely dissolved in 10 ml of 20% (v/v) H<sub>2</sub>SO<sub>4</sub> solution.

### *Permanganate titration*

At this point, the total filtrate resulting from digestion of 2 g of flour was made up to 300 ml. Aliquots of 125 ml of the filtrate were heated until near-boiling, and then titrated against 0.05M standardized KMnO<sub>4</sub> solution to a faint pink color which persisted for 30 s. The calcium oxalate content was calculate using the formula bellow (i.e., (1))

$$\text{oxalate content} = \frac{T \times (V_{me})(DF) \times 10^5}{(ME) \times m_f} \left( \frac{mg}{100g} \right) \quad \dots\dots (1)$$

where T is the titre of KMnO<sub>4</sub> (ml), V<sub>me</sub> is the volume-mass equivalent (i.e. that 1 cm<sup>3</sup> of 0.05M KMnO<sub>4</sub> solution is equivalent to 0.00225 g anhydrous oxalic acid), DF is the dilution factor of titrate, ME is the molar equivalent of KMnO<sub>4</sub> in oxalate (KMnO<sub>4</sub> redox rxn. (5)) and m<sub>f</sub> is the mass of flour used.

## III. RESULT AND DISCUSSION

Results are shown in Table 1 and 2 is the content of oxalate and the percent reduction of oxalate from taro tubers in the treatment phase of immersion in a solution of baking soda. And the treatment phase of boiling in a solution of baking soda as shown in Table 3.

Table 1. Calcium oxalate content of soaked cocoyam tubers at baking soda solution (mg/100g)

Process	Time (hr)	Concentration of baking soda solution (%)					
		0	2	4	6	8	10
Control (raw)	0	1290.4					
Soaked in baking soda solution	2	1144.8	1134.9	1055.6	911.9	802.8	770.0
	4	1115.1	1075.4	981.2	768.1	723.5	642.6
	6	1080.4	911.9	807.8	708.7	688.9	626.6
	8	1050.6	837.5	753.3	614.5	604.6	573.5
	10	1015.9	743.4	693.8	599.7	569.9	552.3

Table 2. Reduction (%) of calcium oxalate content of soaked cocoyam tubers at baking soda solution (mg/100g)

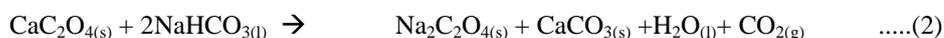
Process	Time (hr)	Concentration of baking soda solution (%)					
		0	2	4	6	8	10
Soaked in baking soda solution	2	11.3	12.1	18.2	29.3	37.8	40.3
	4	13.6	16.7	24.0	40.5	43.9	50.2
	6	16.3	29.3	37.4	45.1	46.6	51.4
	8	18.6	35.1	41.6	52.4	53.1	55.6
	10	21.3	42.4	46.2	53.5	55.8	57.2

Table 3. Calcium oxalate content of boiled cocoyam tubers at baking soda solution (mg/100g)\*

Process	Time (minute)	Oxalate content	Reduction of oxalate (%)
Control (raw)		1290.4	
Boiled at 97°C in baking soda solution 10%	0	770.0*	40.3
	10	646.5	49.9
	20	588.4	54.4
	30	457.6	64.5
	40	385.0	70.2
	50	334.2	74.1
	60	297.8	76.9

\* variables used in the boiling process is taro tubers that soaked in a 10% solution of baking soda for 2 hours

The analysis showed that the levels of calcium oxalate taro tubers are used to reach 1290.41 mg/100 g of material. Levels of calcium oxalate taro tubers in this research was approximately 81.75% higher than the level of calcium oxalate taro tubers from Nigeria reported by Iwuoha and Kalu (1994) [8]. The difference in the levels of secondary metabolites can be caused by several things, including the time of harvesting, bulbs age, condition of soil, agro-climatic and geographic distribution [9] [10]. In variable that taro tubers soaking in pure water (Table 2) can only be reduced to 21.3% of oxalate in 10 hours immersion. The reduction during steeping must be due to leaching, because some oxalate fractions are water-soluble (e.g at room temperature) [8]. But it is less effective than the variable soaked with a solution of baking soda. Greatest reduction of oxalate for soaking in baking soda variables (Table 2) is at a concentration of 10% baking soda for 10 hours can reduce oxalate at 57.2%. This relates to the possibility of chemical degradation that occurs during the immersion process in the baking soda solution which follows the reaction below (i.e., (2))



Oxalate contained in taro addition will dissolve into the solution but also reduced in the presence of CO<sub>2</sub> that is formed so that the reduction oxalate process will be faster. The authors chose concentrations of baking soda soaking is 10% for 2 hours immersion as the optimal condition for consideration of efficiency

and lower cost. This optimal conditions are used on boiling variable. Greatest reduction of oxalate indicated by boiling for 60 minutes, which can reduce as much as 76.9% oxalic oxalate as shown at Table 3. On the whole, the results from boiling are indicative that calcium oxalate has a hydrothermal lability. The observed marked reduction caused by boiling may be due to the dual effects of leaching and thermal degradation. They are similar to results from aqueous boiling of cocoyams by Osisioqu et al. (1974) [11] who reported that when boiled for 15 min there was a considerable reduction in irritant effect (in the present work it can be observed after 10-20 min boiling) and when boiled for 1 h the irritant effect was lost [8].

#### IV. CONCLUSION

Soaking and boiling affected the calcium oxalate in taro tubers, especially with the addition of baking soda in the soaking solution and boiling solution. In the immersion process in which chemical degradation of calcium oxalate transformed into dissolved phase. In the process of boiling thermal degradation occurs. Merger between soaking and boiling process will deliver more effective results in the removal of oxalates in taro.

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