Decreasing Oxalate Levels in Kimpul Tubers (Xanthosoma sagittifolium) by Physical and Chemical Methods

I Sulaiman¹*, C Annisa¹, Y M Lubis¹, Z F Rozali¹, S Noviasari¹, K Eriani² and C W Asrizal³

¹Department of Agricultural Product Technology, Faculty of Agriculture, Universitas Syiah Kuala
²Departemen of Biology, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala
³Department of Medical, Faculty of Medicine, Universitas Syiah Kuala

*E-mail: ismail.sulaiman@unsyiah.ac.id

Abstract. Kimpul tubers have anti-nutritional substances in the form of calcium oxalate (CaC2O4) which when consumed will cause itching sensations in the skin, mouth, throat and digestive tract. Calcium oxalate content in kimpul tubers is 1,740 mg / 100 g. The safe limit for consuming oxalate for adults is 0.60 - 1.25 g per day for 6 consecutive weeks. In this research, a combination of physical and chemical methods will be carried out with taro varieties, namely Umbi Kimpul (Aceh Besar). Physical treatment (boiling and steaming) and followed by immersion treatment with chemicals (6% sodium bicarbonate, 20% acetic acid and 10% sodium chloride) are thought to affect the decrease in calcium oxalate in taro. The lowest oxalate content of kimpul tuber flour was obtained, namely 13.62 mg / 100 g of the material from the boiling treatment by soaking in 20% CH₃COOH. While the steaming treatment with the lowest levels of calcium oxalate in kimpul tuber flour, namely 22.28 mg / 100 g after soaking in 6% NaHCO₃. The two values obtained from the test results were lower than the calcium oxalate content of fresh kimpul tubers, which was 42.35 mg / 100 g.

1. Introduction
Basic human needs cannot be separated from food. The need for food continues to increase in line with the increasing population in the world. The quantity and quality of various types of food will continue to be increased in production as intended to meet the food needs of the community. One of the ways to meet the needs and availability of food is by increasing the cultivation and utilization of agricultural products such as tubers [1].

Taro is one of the tubers belonging to the Araceae family with various genera such as Colocasia, Cyrtosperma and Xanthosoma. Taro plants grow in wet areas with an altitude of 0 - 1,400 m above sea level [2]. The diversity of taro plant species in various regions is influenced by environmental factors and human activity factors [3]. The Asia and Oceania region has widely recognized the use of taro as a food ingredient [4].

In most parts of Indonesia taro is used as an additional food, for example fresh tubers are processed into taro chips [4]. However, in some areas such as Papua, Maluku, Sangir Talaud Islands and Mentawai Islands, taro is used as a staple food. Not only in Indonesia, taro is also used as a staple food in a small
number of foreign countries such as New Guinea, Solomon, New Hebrides, New Caledonia, Fiji, Samoa, West Indies, West Africa and Hawaii. The diversity of taro cultivars found in Indonesia includes Belitung / kimpul, eel, bentul, burkok, dempel, sticky rice, lahun anak, Lampung Hitam, Lampung Putin, Paris, Roti and Silk. The large variety of taro cultivars has made Indonesia one of the centers for the distribution of taro in the world. Taro cultivation in Indonesia, with data recorded in FAO, is an area of 1.4 million hectares, which produces 8.3 million tons / year in the world [2].

The taro part, especially kimpul tubers, can be consumed in such a way as being eaten raw, boiled, steamed, fried or processed into “poi” in Hawaii, cakes or bread in the Philippines and Brazil, and made into fermented drinks in Columbia [2]. Kimpul tubers that are used as processed products with raw material for taro flour, especially in Indonesia, are still very few because they are difficult to find and not yet widely available on the market. In fact, many processed products can be made using taro flour as an initial raw material [4].

Bulbs kimpul / Taro Belitung (Xanthosoma sagittifolium) acts as an alternative staple food in some areas in Indonesia. How to eat kimpul tubers by roasting, steaming, boiling or frying [5]. In 2013, kimpul production from 7 regions in Indonesia reached 825 tonnes obtained from 55 ha [6]. The edible weight of kimpul meat is 80% per 100 grams and 145 Cal of the energy produced. The low content of fat and sugar makes kimpul tubers suitable for consumption by diabetics, osteoporosis, heart and hypertension and the alkaline nature of kimpul tubers is good for dental health [7].

The high carbohydrate content of kimpul tubers is between 70-80%. High levels of carbohydrates make kimpul tubers can be processed into flour and worthy of being a good food ingredient. In addition, kimpul tubers also contain other nutrients such as 2.81% protein, 0.08% fat, 67.26% water, 1.19% ash and 0.56% crude fiber. Processing kimpul tubers into flour can be an alternative to prevent damage to fresh kimpul tubers after the harvesting process. The drying process applied in the manufacture of kimpul flour can help decrease the moisture content so that the shelf life becomes longer. Kimpul flour itself is the result of the drying and milling or flouring process. Besides the long shelf life [5].

Conducted research on kimpul tuber taro flour by oven drying at 60 ° C for 5 hours, then milled and sieved with a 60 mesh sieve[1]. The research produced kimpul tuber flour with carbohydrate content of 83.57%, water content of 9.22%, ash content of 1.94%, protein content of 4.43%, fat content of 0.84%, white degree of 73.73% and energy. 359.56 kcal per 100 grams.

In addition to good nutritional content, kimpul tubers also have anti-nutritional substances in the form of calcium oxalate (CaC₂O₄) which when consumed will cause an itching sensation on the skin, mouth, throat and digestive tract. Calcium oxalate content in kimpul tubers is 1,740 mg / 100 g [1]. The safe limit for consuming oxalate for adults is 0.60-1.25 g per day for 6 consecutive weeks [8]. High levels of calcium oxalate and the onset of several adversarial symptoms can cause death, it takes a decrease in calcium oxalate levels in fresh kimpul tubers to become kimpul tuber flour [1].

Several ways that can be done to reduce the oxalic acid found in taro, namely by physical, chemical and fermentation treatment [9]. The oxalate content in kimpul tubers can be decreased physically, mechanically and chemically [5]. Boiling over high heat until the skin of the kimpul tuber peels off is a physical method that can be used to reduce oxalate levels. This can be done mechanically with the help of tools that can reduce the particle size and extract food ingredients such as stamp mills and blowers. While chemically it can be done soaking the kimpul tubers in a salt solution which causes the water in the tuber tubers to be pulled out of the network [5].

The immersion in a chemical solution is also one way to reduce calcium oxalate [1]. With the reduction of calcium oxalate in kimpul tubers, it will produce a food source that can be used as an alternative to Indonesian food, such as making kimpul tuber flour which can replace wheat flour. On research [10] Regarding the reduction of oxalate in kimpul tubers by soaking methods using acetic acid, the best results were obtained by using a 20% concentration of acetic acid solution in soaking the slices of kimpul tubers for 30 minutes which reduced oxalate levels by 66%.

In this research, a combination of physical and chemical methods will be carried out with taro varieties, namely Umbhi Kimpul (Aceh Besar). There are two physical treatments, namely boiling and steaming. Then a chemical treatment with a variety of chemicals will be used (6% NaHCO₃ solution, 20% CH₃COOH, and 10% NaCl). Physical treatment (boiling and steaming) and followed by immersion treatment with chemicals (sodium bicarbonate, acetic acid and sodium chloride) are thought to affect
the decrease in calcium oxalate in taro. The combination of physical and chemical treatments is expected
to reduce calcium oxalate levels in *kimpul* tuber flour with long boiling / steaming and chemical soaking
time. The concentration of chemicals and types of taro used were used as parameters in this study.

2. Materials and methods
The material used in this study is the *kimpul* tuber (Aceh Besar). The chemicals used for the analysis
were obtained from the Laboratory of Food and Agricultural Product Analysis, Department of
Agricultural Product Technology, Universitas Syiah Kuala. The chemicals used for the analysis were 1.25% \( \text{H}_2\text{SO}_4 \), 3 M \( \text{HCl} \), 3.25% \( \text{NaOH} \) and \( \text{KMnO}_4 \).

The equipment needed in this research includes centrifuge, drying oven, burette, beaker glass, pan,
stove, analytical scale, stainless steel knife, volume pipette, tissue, label, baking sheet, filter paper,
furnace, porcelain cup, petri dish, mill, flour, 80 mesh sieve, electric furnace, Erlenmeyer, desiccator,
static, stirrer, boiling flask, soxhlet, condenser, sleeve, measuring flask, thermometer, centrifuge tube,
vortex, beaker, aluminum foil and water bath.

The decrease in oxalate levels in *kimpul* tubers begins with physical treatment. First, by sorting the
ingredients followed by peeling the outer skin. After peeled, the taro is cut into 1 cm thickness, measured
using a ruler and the tubers *kimpul* are washed clean. 100 g of fresh *kimpul* tubers were separated for
initial analysis. Then boiling / steaming for 20 minutes with a temperature of 100\( ^\circ \text{C} \) measured using a
thermometer. After 20 minutes *kimpul* tubers that have been boiled / steamed are washed again and
drained.

2.1. Chemical treatment methods
The chemical treatment carried out was immersion using 6% \( \text{NaHCO}_3 \) solution for 60 minutes, 20% \( \text{CH}_3\text{COOH} \) for 30 minutes and 10% \( \text{NaCl} \) for 15 minutes. A container for 500 g of the sample was
provided and 1000 ml of the chemical solution that had been made was poured into the container for
each of the 3 replications. After the soaking was complete, each sample was washed again until clean
and put into a baking sheet for drying using a drying oven at 60\( ^\circ \text{C} \). Drying is carried out for 2 days by
turning the material so that the heat hits the entire surface of the material until it is even. The soaking
tubers with chemicals are crushed and reduced in size for the shading process. Calcium oxalate levels
were analyzed in *kimpul* tuber flour using the volumetric permanganometric titration method [10],
[11].

2.2. Observed parameters
Parameters observed in fresh *kimpul* tubers were calcium oxalate levels [9],[12], proximate analysis [13]
and crude fiber (SNI 01-2891-1992).

2.3. Analysis of total oxalate levels
Analysis of total calcium oxalate levels used volumetric permanganometric titration method by using a
gravimetric titration method [9], [12]. The sample was weighed as much as 1 gram and suspended in
95 ml of distilled water which was put into 250 ml Erlenmeyer. Then the 3 M \( \text{HCl} \) solution was added
as much as 5 ml. The suspension was heated for 1 hour at 100\( ^\circ \text{C} \), followed by cooling. Add water to 125
ml before filtering. The total 62.5 ml filtrate produced from the heating stage was diluted to 150 ml.
62.5 ml is taken to be heated until almost boiling. Followed by titration using \( \text{KMnO}_4 \) until it turns pink,
it almost disappears, which lasts for 30 seconds. The total oxalate content (mg / 100 g) is calculated by
the following equation.

\[
\text{calcium oxalate} = \frac{\text{volume } \text{KMnO}_4 \times 0.00225 \times 24}{\text{weight of flour} \times 5} \times 105
\]  

(1)

With:
Mass volume equivalent (1 cm\(^3\) \( \text{KMnO}_4 \) 0.05 M is equivalent to 0.00225 g anhydrous oxalic acid);
Dilution factor (2.4 is obtained from the volume of the filtrate 300 ml divided by the volume of filtrate
used 125 ml); Molar equivalent of \( \text{KMnO}_4 \) (redox number \( \text{KMnO}_4 \) 5).
2.4. Statistical analysis

In this study, using a factorial randomized block design (RBD) with 2 factors. The first factor is physical treatment (P1: boiling; P2: steaming) and the second factor is the type of solution used (L1: NaHCO3 6%; L2: CH3COOH 20%; L3: NaCl 10%). With the number of treatments, namely 6 by using 3 replications of each treatment so that 18 experimental units were obtained. The main research data obtained were then analyzed using Analysis of Variance (ANOVA). If there is a significant effect, then proceed with the Duncan Multiple Range Test (DMRT) at the 5% level.

3. Result and discussion

3.1. Moisture content

Analysis of water content in kimpul tubers was carried out in 2 series (duplo) with 3 replications each. The percentage of water content of raw kimpul tubers was 74.04% [9]. The percentage of water content of fresh kimpul tubers was 67.26% [14]. Obtained water content of kimpul tubers obtained in this study was 72.382%. The percentage obtained is the same as the water content in taro was 73% [15]. While the percentage of water content obtained by kimpul tubers was higher than the water content obtained 59.51% (bb) [10].

The water content of taro flour is 9.22% (% bb) produced in accordance with the normal limit of water content of wheat flour for food ingredients (a maximum of 14% based on SNI 01-3751-1995). The water content will be lower the longer the material is in contact with heat [16]. It's the same with research, states that the drying time has an effect on the moisture content, because drying is long enough to cause a lot of water to evaporate so that the flour is in a state of low water content or less than before. The heat will be absorbed by the kimpul tubers during the drying process, this will affect the level of dryness of the taro flour [17].

The average water content of kimpul tuber flour after boiling and soaking in sodium bicarbonate, acetic acid and sodium chloride were 6.331%, 7.072% and 6.383%, respectively. While the physical treatment of steaming was followed by immersion in sodium bicarbonate, acetic acid and sodium chloride, respectively, the percentage of water content was 8.355%, 7.671% and 6.077%. The result of the percentage of water content obtained is still within the limit of the water content value of the flour, that the maximum moisture content of kimpul white flour/kimpul tubers is 11.04% [19].

The results of variance showed that physical treatment (P) and chemical (L) and the interaction between the two (PL) had no significant effect (P>0.05) on the moisture content of kimpul tuber flour. The decrease in water content is thought to be related to cell wall damage. Therefore, the longer the immersion makes the permeability of the membrane become damaged as a result, more water comes out so that the water content in the kimpul tubers tends to be low [10], [11], [20], [21].

3.2. Ash content

In this study, the analysis of the ash content used a tool, namely an ashing furnace of dry ashes techniques. The ash content in food shows the mineral content in it [22]. After analyzing the ash content, the mean percentage of 3 replications (duplo) which was calculated on white kimpul tubers without treatment was 1.51%. Concerning the ash content of kimpul tubers, the percentage was 1.36%. Meanwhile, according to, raw kimpul tubers have a percentage of ash content of 1.5% [9]. The mineral content in flour is not large, but it is very important. These minerals can be found in the residue of flour that has gotten a high temperature in the ashing furnace to become white ash [23].

Kimpul tubers that are used as flour are analyzed again for the ash content, namely the type of kimpul tubers after boiling treatment (P1) followed by immersion in 6% sodium bicarbonate (L1), 20% acetic acid (L2) and 10% sodium chloride (L3). The percentage value of the ash content of the white kimpul tubers was 6.315%, 3.009%, 7.706%. The percentage value of the ash content of white kimpul tubers after steaming treatment (P2), followed by soaking in 6% sodium bicarbonate (L1), 20% acetic acid (L2) and 10% sodium chloride (L3) respectively, namely 6.723%, 3.837%, 8,643%. The result of the percentage of ash content obtained is higher than the value stated by Elkafitri [24], that the percentage of ash content in taro flour is 0.76%. The high and low percentage of ash content in kimpul tubers is probably due to differences in the amount of minerals in the tubers. The high amount of minerals can be caused by environmental factors, growth or genetic factors from plants [10], [25].
The results of variance showed that the interaction between physical treatment and chemical treatment (PL) had no significant effect ($P > 0.05$) on the amount of ash content produced in kimpul tuber flour. Physical treatment, namely boiling ($P_1$) and steaming ($P_2$) had a significant effect ($P \leq 0.05$) on the ash content of kimpul tuber flour. Chemical treatment (L) ($L_1$: NaHCO$_3$ 6%; $L_2$: CH$_3$COOH 20%; $L_3$: NaCl 10%) also showed a very significant effect ($P \leq 0.01$) on the percentage of ash content produced in kimpul tuber flour.

![Figure 1](image)

**Figure 1.** a) The effect of physical treatment (P) on the percentage of ash content of kimpul tubers (The value followed by different letters shows a very significant difference in the DMRT test $0.05$, level 1 = 3.15, level 2 = 3.15 and KK = 8.984 %); (b) the effect of chemical treatment (L) on the percentage of ash content of kimpul tubers (The value followed by different letters shows a very significant difference in the DMRT test $0.05$, level 1 = 3.15, level 2 = 3.30, level 3 = 3.30 and KK = 8.984%).

Based on the DMRT test 0.05 (Figure 1) shows that the highest percentage of ash content in kimpul tuber flour is 6.4% in the steaming treatment and the lowest percentage of ash content is 5.68% of the boiling treatment. The percentage of ash content in kimpul tuber flour is also influenced by chemical treatment (L), where the highest percentage is immersion in 10% sodium chloride (NaCl) ($L_3$), namely 8.1%. Meanwhile, the lowest percentage of ash content that was influenced by chemical treatment by immersion in acetic acid (CH$_3$COOH) 20% ($L_2$) was 3.42%.

### 3.3. Calcium oxalate levels

Calcium oxalate has a molecular formula, namely CaC$_2$O$_4$. Fresh kimpul tubers have calcium oxalate levels of 1096.2 mg per 100 grams of ingredients [9]. The results of calculating the levels of oxalate in white taro / kimpul tubers before physical and chemical treatment were 42.35 mg / 100 g. The results of his analysis regarding the content of calcium oxalate in kimpul tubers, namely 56.58 mg / 100 g of material [26].

When the kimpul tubers go through a physical treatment process, namely boiling and steaming and soaking in chemicals, followed by drying using an oven before being made into flour causes the calcium oxalate level to decrease. The decrease is caused by damaged cell walls so that calcium oxalate comes out and dissolves in hot water or in heating treatment [27]. The soaking process that can dissolve and reduce calcium oxalate when removing the soaking solution [28]. The heating treatments such as boiling, soaking in warm water, steaming, roasting and drying can also make it easier to dissolve calcium oxalate [29].

According to Amalia *et al.* [27] the percentage reduction in oxalate levels in the boiling process reached 79.53%. However, the percentage reduction in oxalate is considered to still not meet the allowable limit of total oxalate levels, namely 71 mg / 100g of material [20]. The boiling process various types of water-soluble oxalates were dissolved in the boiling water, causing a decrease in oxalate levels [30].

Fresh kimpul tubers are made into flour because the oxalate content in the flour is less. In addition, the oxalate content decreases in value during the food processing process [31]. So that the quality of taro flour is very good for consumption [32]. Kimpul tuber flour is produced through a drying process
using an oven to reduce the moisture content of the *kimpul* tubers. Taro flour can be used to make products that have a high selling value [33], [34].

The results of variance showed that physical treatment (T) had no significant effect (P > 0.05) on calcium oxalate levels in *kimpul* tubers. Meanwhile, chemical treatment (L) had a significant effect (P ≤ 0.05), and the interaction between physical treatment and chemical treatment (PL) had a very significant effect (P ≤ 0.01) on calcium oxalate levels in *kimpul* tubers.

**Figure 2.** The effect of chemical treatment (L) on the calcium oxalate content of *kimpul* tuber flour (The value followed by different letters shows a significant difference in the DMRT test 0.05, level 1 = 3.15, level 2 = 3.3, level 3 = 3.3 and KK = 20.58%).

**Figure 3.** The effect of the interaction between physical treatment and chemical treatment (PL) on calcium oxalate levels in *kimpul* tubers (The value followed by different letters shows a significant difference in the DMRT test 0.05, level 1 = 3.15, level 2 = 3.3, level 3 = 3.37, level 4 = 3.43, level 5 = 3.46, level 6 = 3.46 and KK = 20.58%).

The DMRT test result of 0.05 (Figure 2) shows that the lowest calcium oxalate content of *kimpul* tuber flour is from the immersion treatment in 20% CH$_3$COOH (L$_2$), namely 21.32 mg / 100 g of material. While the DMRT test results of 0.05 (Figure 3) show that the lowest oxalate content was obtained, namely 13.62 mg / 100 g from the boiling treatment by soaking in 20% CH$_3$COOH and also the lowest calcium oxalate content obtained from the steaming treatment with immersion in 6% NaHCO$_3$, that is 22.28. Candra and Yuwono [35] shows the results of research regarding the decrease in calcium oxalate levels by boiling treatment at 90°C in *kimpul* flour of 0.31 mg / 100 g from the initial calcium oxalate content of *kimpul* flour 1.83 mg / 100 g.

The results of the analysis of calcium oxalate levels showed a decrease in each treatment. Drying done on *kimpul* tuber slices is also one of the supporting factors to reduce the calcium oxalate content.
in *kimpul* tubers. Calcium oxalate levels in *kimpul* tuber flour showed that *kimpul* tuber flour had lower levels of calcium oxalate than fresh *kimpul* tubers. The loss of water content in *kimpul* tubers during the drying treatment can also reduce the value of water content which triggers a reduction in calcium oxalate levels in *kimpul* tubers. The low levels of calcium oxalate in *kimpul* tuber flour are also supported by chemical immersion treatment. The chemical that reacts can reduce the calcium oxalate in the bulb tuber [36].

### 3.4. Crude fiber content

Crude fiber consists of lignin, cellulose and a small portion of hemicellulose [4], [37]. Raw taro fiber is 1.46 g / 100 g of material [38], [39]. While the chemical composition of taro in the form of crude fiber is 0.8 g in 100 grams of material [40], [41]. The initial crude fiber content test results in *kimpul* tubers were 1,130 g. According to [42], that the nutritional content in the form of crude fiber in raw taro is 0.7 g and after boiling treatment the content of crude fiber in taro is 0.9 g, this indicates an increase in the amount of crude fiber content in taro.

Fresh *kimpul* tubers that were made into flour were re-analyzed for crude fiber content. The boiling treatment of *kimpul* tuber flour soaked in a solution of 6% sodium bicarbonate (L₁), 20% acetic acid (L₂) and 10% sodium chloride (L₃) had values of 0.568 g, 0.777 g and 0.236 g respectively. The crude fiber in *kimpul* tubers that have become flour is 0.128 g [5], [43]. *Kimpul* white tuber flour / *kimpul* tubers were also analyzed for crude fiber content by steaming treatment which was then immersed in a solution of 6% sodium bicarbonate (L₁), 20% acetic acid (L₂) and 10% sodium chloride (L₃) respectively, namely 1.126 g, 0.758 g and 1.288 g. *Kimpul* tubers that are made into flour contain high crude fiber over the longer drying time. This is because the water content is more and more evaporated so that the crude fiber will be more concentrated. The higher the fiber content of the product is due to the longer drying time is performed.

The results of variance showed that chemical treatment (L) had no significant effect (P> 0.05) on crude fiber content of *kimpul* tuber flour. While physical treatment (P) had a very significant effect (P≤0.01) and the interaction of physical treatment and chemical treatment (PL) had a significant effect (P≤0.05) on the fiber content of *kimpul* tuber flour.

![Figure 4](image-url)  
**Figure 4.** The effect of physical treatment (P) on crude fiber content in *kimpul* tuber flour (The value followed by different letters shows a significant difference in the DMRT test 0.05, level 1 = 3.15, level 2 = 3.15, and KK = 29.404%).
Figure 5. The effect of the interaction between physical treatment and chemical treatment (PL) on crude fiber content in kimpul tuber flour is produced. The value followed by different letters shows a significant difference in the DMRT test 0.05, level 1 = 3.15, level 2 = 3.3, level 3 = 3.37, level 4 = 3.43, level 5 = 3.46, level 6 = 3.46 and KK = 29.404%).

Based on the DMRT test of 0.05 (Figure 5) shows that the highest crude fiber content in kimpul tuber flour was obtained from the physical treatment of boiling followed by immersion in CH$_3$COOH 20% (P$_1$L$_2$), namely 0.78 g and the lowest level was 0.24 g of the boiling treatment. then immersed in 10% NaCl solution (P$_1$L$_3$). While the physical treatment of steaming produced the highest crude fiber content in the continued chemical treatment of immersion in 10% NaCl solution which was 1.29 g and the lowest crude fiber content soaked in 20% CH$_3$COOH solution was 0.76 g. The results showed a decrease in crude fiber content from fresh kimpul tubers to kimpul tuber flour. Drying affects the decrease in crude fiber content in kimpul tuber flour. The higher the temperature and the longer the drying time, the lower the nutritional value of foodstuffs, especially flour. This is due to reactions between nutrient molecules, damage to nutrients that cannot withstand high temperatures or the emergence of complex molecules that cannot be broken down by enzymes [44-46].

4. Conclusions
The lowest oxalate content of kimpul flour obtained, namely 13.62 mg / 100 g of material from the boiling treatment by immersion in 20% CH$_3$COOH. While the steaming treatment with the lowest levels of calcium oxalate in kimpul tuber flour, namely 22.28 mg / 100 g after soaking in 6% NaHCO$_3$. The two values obtained from the test results were lower than the calcium oxalate content of fresh kimpul tubers, which was 42.35 mg / 100 g. The decrease in calcium oxalate levels was calculated as much as 67.84% from the initial level in the boiling treatment. Whereas in the steaming treatment the decreased levels of calcium oxalate in kimpul tuber flour were as much as 47.40% of the initial calcium oxalate content of fresh kimpul tubers. More boiling treatment can reduce calcium oxalate levels in kimpul tubers until the final result of kimpul tuber flour is calculated as the calcium oxalate levels decrease. Immersion treatment in chemical solutions can also make the calcium oxalate level in kimpul tubers so that the value decreases into flour. The combination of physical and chemical treatments that have been tested has been proven to reduce calcium oxalate levels in kimpul tubers. So that kimpul tubers and purple taro are safe for consumption because they have met the recommended threshold of 71 mg / 100 gr [20], [9].
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