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Penurunan Kadar Oksalat dalam Porang Berdasarkan Perbedaan Bentuk Sampel, Waktu Perendaman, Temperature, dan Jenis Perendam

Decreasing Of Oxalate Content in Porang Based on Different Sample Shapes, Soaking Times, Temperatures, and Soaking Solutions

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ABSTRAK: Porang memiliki kandungan oksalat yang tinggi yang tidak dapat dicerna, yang merupakan masalah latar belakang yang menjadi fokus penelitian ini. Penelitian ini menginvestigasi pengaruh kondisi perendaman terhadap penurunan kadar oksalat dalam porang, baik dalam bentuk irisan longitudinal maupun potongan dadu, menggunakan berbagai media perendaman, termasuk cuka, alkohol, dan air, dengan variasi suhu. Penelitian ini mengidentifikasi bahwa waktu perendaman optimal untuk mencapai penurunan oksalat maksimum dalam irisan longitudinal adalah 150 menit pada suhu 50°C dengan media air, menghasilkan penurunan sebesar 0.00495%, sementara untuk porang potongan dadu, penurunan terbesar terjadi selama 120 menit pada suhu 70°C dalam alkohol, menghasilkan penurunan sebesar 0.0045%. Hasil penelitian ini menyoroti pengaruh bentuk porang dan kondisi perendaman terhadap pelepasan oksalat, dengan porang dadu menunjukkan penurunan oksalat yang lebih cepat, mungkin karena luas permukaannya yang lebih kecil. Penelitian ini memberikan wawasan berharga tentang cara efektif mengurangi kadar oksalat dalam porang, yang dapat berkontribusi pada konsumsi porang yang lebih aman.
Kata Kunci: umbi, porang, kadar, oksalat, pengurangan

ABSTRACT: Porang, known for its high oxalate content that poses digestive challenges, served as the underlying problem in this study. The research investigated the impact of immersion conditions on oxalate reduction in porang, both in the form of longitudinal slices and diced pieces, using various soaking media, including vinegar, alcohol, and water, with temperature variations. The study identified that the optimal immersion time for achieving maximum oxalate reduction in longitudinal slices was 150 minutes at 50°C in water, resulting in a 0.00495% decrease. In the case of diced porang, the most significant reduction occurred after 120 minutes at 70°C in alcohol, leading to a 0.0045% decrease. These findings shed light on the influence of porang shape and soaking conditions on oxalate release, with diced porang demonstrating faster oxalate reduction, likely due to its smaller surface area. The study offers valuable insights into effectively reducing oxalate levels in porang, contributing to safer consumption.
Keywords: porang, content, oxalate, reduction

1. Introduction

The porang tuber is a widely cultivated crop in Indonesia. However, due to its high oxalate content, it is not typically consumed directly by the Indonesian people. What sets porang tubers apart from other tubers is their relatively high glucomannan content, which hovers around 65%. To maximize their shelf life without the need for any additional treatment, porang tubers are primarily processed into chips and flour, as outlined by Koswara (2013).

In a study by Ferdian et al. in 2021, Porang Tubers (*Amorphophallus oncophyllus*), a member of the Araceae family, were found to contain significant proportions of various constituents, notably glucomannan (45-65%), water (79.7%), starch (2%), and crude fiber (8%). However, the presence of calcium oxalate in these tubers poses a significant concern, as its consumption without prior treatment can lead to unpleasant sensations such as itching and burning in the mouth and tongue. Furthermore, calcium oxalate ingestion can potentially lead to health issues, particularly impacting the kidneys, as noted by Amalia and Yuliana (2013).

To render Porang Tubers safe for consumption, the removal of calcium oxalate requires a pre-treatment process. Prior research has identified various acid solutions as effective agents for this purpose, including citric acid, lime

juice solution, and vinegar, as detailed by Agustin and others in 2017. The determination of calcium oxalate levels in the tubers can be achieved using the Permanganometri Method, which relies on an oxidation-reduction reaction. In this method, potassium permanganate ($KMnO_4$), a potent oxidizing agent, serves as the secondary standard solution, obviating the need for a separate indicator through its auto-indicator properties, as elucidated by Mursyidi and Rohman (2008). It is worth noting that the recommended safe daily intake of calcium oxalate for the human body should not exceed 1.25 grams per day for six consecutive weeks, as established by Knudsen et al. (2005).

Porang, renowned for its high glucomannan content, remains underutilized due to its oxalate content, which poses health risks. To mitigate oxalate levels, porang is subjected to soaking in various media, including acidic, neutral, and salt solutions. While previous research has explored different types of acids to optimize oxalate reduction, there is a notable absence of detailed investigations into the time intervals associated with various immersion media concentrations. Therefore, this study aimed to measure oxalate levels at specific time intervals using a range of soaking media concentrations, yielding experimental data throughout the soaking process.

Notably, both heating and soaking duration are critical factors influencing the reduction in calcium oxalate levels. For instance, soaking porang in a NaCl solution at 80°C resulted in a substantial 90.9% reduction in calcium oxalate levels (Widari and Rasmito, 2018). The most significant reduction, however, was achieved with the longest soaking duration, specifically 60 minutes, resulting in a 42.54% decrease (Amalia and Yuliana, 2013). These findings indicate that higher immersion temperatures enhance the dissolution and removal of calcium oxalate in tandem with the soaking solution.In research conducted by Kusuma Wardani and Handrianto (2019), 20% vinegar solution. able to reduce calcium oxalate levels in people up to 90.27%. In another experiment, it was found that average levels of calcium oxalate due to washing treatment with graded ethanol ranged from 1.28 to 0.19%. It means glucomannan levels due to treatment with stages ethanol ranged from 36.68 to 81.72%. (Kurniawati & Widjanarko, 2010) This research was aimed to study the effect of soaking time on oxalate content of porang at different soaking solutions.

2. Materials and Methods

2.1 Materials

Porang was obtained from Kembang Porang Jaya, Kembang RT 18/RW 5 Nglegi Patuk Gunungkidul, Yogyakarta, Indonesia. The tools used in this study are Basin, Knife, Filter, Cutting Board, Digital balance,,Rice cooker, Measuring cup 100 ml,Funnel, Burette and Statif, Erlenmeyer 250 ml and 100 ml, Dropper, Electric stove, Spinner. Meanwhile, materials which are used are Porang Bulbs, Water, Aquades, Kitchen Salt, Acid Vinegar, Ethanol, $KMnO_4$ 0.1 N, and H_2SO_4 2 N.

2.2 Variables

There are two different variables used which are fixed variables and independent variables. Fixed variables consist of Porang tubers 100 grams, Volume of soaking medium 1000 ml, Water Washing Media 1000 ml. Meanwhile, independent variables are divided by three variables: Porang chip shape (dice and elongated stuffing);Immersion Media;Variation of Time (30, 60, 90, 120, 150) minutes. There are five various media being used which are water(30, 40, 50, 60, and 70 °C), Salt (6, 8, 10, 12, 14) %, Vinegar (10, 15, 20, 25) , 30) %, and Ethanol (20, 30, 40, 50, 60) %.

2.2 Work Steps Preparation

2.3.1 Porang Sample Preparation Process

Porang peeled the skin, washed thoroughly using water, this aims to clean the tubers from dirt and soil. This process is accompanied by a sorting process for porang pests which are usually marked by the presence of small holes in the tubers as well as bruises or kepoyoan. Porang that has been sorted and then sliced using a knife, this slicing aims to speed up drying and facilitate the pressing and flouring process, after being sliced then porang is reduced in size using a milling machine (*crusher*) into dice and stuffing lengthwise.

2.3.2 Porang Soaking Process

A 100 gram sample of porang was soaked with 1000 ml of water at 25°C and a solution of salt, vinegar, ethanol in various concentrations. The solutions used in this study were water in various temperature:30, 40, 50, 60, and 70 °C; salt solution (concentrations: 6, 8, 10, 12, 14%); acetic acid (concentrations: 10, 15, 20, 25, 30%); and ethanol (concentrations: : 20, 30, 40, 50, 60%). Each of the solutions are divided by five samples of basins according to the concentration/temperature. Porang was immersed in the immersion solution with every 30 minutes of immersion water samples were taken. After soaking in various solutions for a total of 150 minutes, porang samples flour was washed with 1000 ml of distilled water twice. The solution of salt, vinegar, and ethanol will be selected with the most optimal concentration/temperature during immersion to be tested for the immersion time interval.

2.3.3 Analysis of Oxalate Levels

During the oxalate level analysis, a permanganometric titration method was employed. This method utilized a potassium permanganate (KMnO4) solution with a concentration of 0.1N. The 0.1N KMnO4 solution was prepared by diluting a 1N KMnO4 solution with distilled water (aquadest) and subsequently transferred into a burette for precise measurement.

In this permanganometric titration, a 1N sulfuric acid solution was employed as a catalyst. To initiate the process, 50 ml of water obtained from the previous immersion stage was transferred into an Erlenmeyer flask. Subsequently, 1 ml of 1N sulfuric acid was added to the flask, and the mixture was heated to a temperature of 70°C using an electric heater. The titration process commenced, and the volume of KMnO4 solution required for the solution to change color, resembling the characteristic color of

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KMnO4, was carefully monitored. The color change was observed and noted until it remained consistent, signifying the completion of the titration.

Calculation of Oxalate Content

$$Oxalate\ Levels\ (\ ppm) = \frac{Oxalae\ Levels\ (ppm)}{1000} \quad \text{Eq. 1}$$

$$Oxalate\ Levels\ (\%) = \frac{Oxalae\ Levels\ (ppm)}{1000} \quad \text{Eq. 2}$$

Vtitrant is volume of titration $KMnO_4$ (ml), Ntitrant is normality of $KMnO_4$ (0,1 N),

$$EW = \frac{MW\ calcium\ oxalate}{Calcium\ oxalate\ equivalent} \quad \text{Eq. 3}$$

EW is equaivalent weight of oxalate (Wardani et al, 2016).

Calculation of The Decrease in Oxalate Levels

$$\text{Efficiency oxalate (\%)} = \frac{Oxalate\ Levels\ (\%)}{0.19}\ x\ 100 \quad \text{Eq. 4}$$

3. Results and Discussions

3.1 Effect of Immersion Time on Salt Soaking Media on Porang Longitudinal Slices and Dice

The study involved soaking porang in the form of elongated slices and dice in salt solutions with varying concentrations (6%, 8%, 10%, 12%, and 14%) for a duration of 2.5 hours, with samples collected at 30-minute intervals.

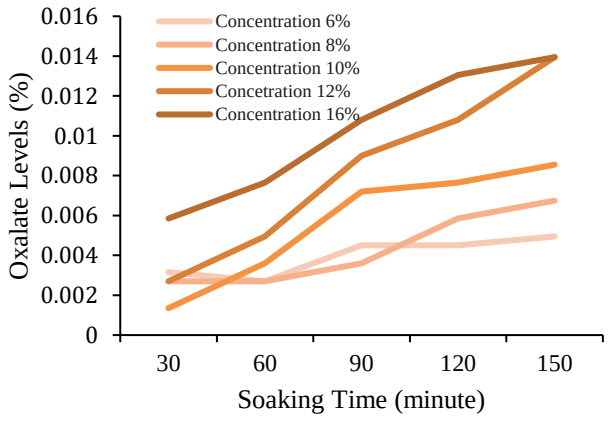

Figure 1. Relationship between Soaking Time and Oxalate Levels in Porang Elongated Slices in different Salt Media

Figure 1 shows that the most substantial reduction in oxalate levels for porang slices immersed in salt solutions occurred when the immersion time reached 150 minutes at a 14% NaCl concentration. At this point, a remarkable reduction was observed, resulting in an oxalate content of just 0.01395%. This reduction was confirmed using the titration method, where the change in color to a dark red hue indicated a decrease in oxalate content within the porang. The optimal immersion time was determined to be 150 minutes, signifying that the oxalate levels in the porang sample had been maximally reduced during the final stage of immersion (Koswara, 2013).

Figure 2 reveals that the most significant reduction in oxalate levels in diced porang occurred when the soaking time reached 90 minutes, employing a 14% NaCl concentration, resulting in a decreased oxalate content of 0.13005%. The confirmation of this reduction was established through the titration method, where the change in color to dark red indicated the reduction of oxalate in the porang samples. This study determined that the optimal immersion time for achieving the maximum reduction in oxalate levels was 90 minutes, thereby reducing oxalate content to its lowest level. Subsequent immersions did not significantly impact the oxalate levels. It is apparent that diced porang exhibited a faster release of oxalate compared to other forms. This can be attributed to the surface area of the diced porang, which is smaller, making it more susceptible to the effects of the salt immersion treatment with a 14% concentration for a shorter duration of 90 minutes, thus having a pronounced influence on the oxalate release process.

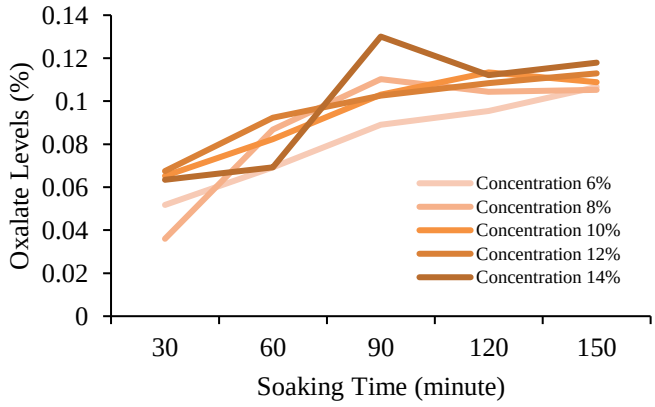

Figure 2. Relationship between Soaking Time and Oxalate Levels in Porang diced Slices in different Salt Media

3.2. Effect of Immersion Time on alcohol Soaking Media on Porang Longitudinal Slices and Dice

Porang, in the form of longitudinal slices and diced pieces, underwent a soaking process in alcohol-based solutions with different concentrations ranging from 20%, 30%, 40%, 50%, to 60%, for a duration of 2.5 hours. Samples were collected at 30-minute intervals during this soaking process.

As depicted in Figure 3, the most substantial reduction in oxalate levels within the longitudinal slices of porang immersed in alcohol-based solutions occurred after 150 minutes of soaking at a 20% alcohol concentration. This resulted in a noteworthy decrease in oxalate levels by

0.0225%. The titration method confirmed this reduction by noting the color change to dark red, indicative of reduced oxalate content in the porang. The study concluded that the optimal immersion time for achieving the maximum reduction in oxalate levels was determined to be 150 minutes, effectively reducing oxalate levels to their lowest point during the final stage of immersion.

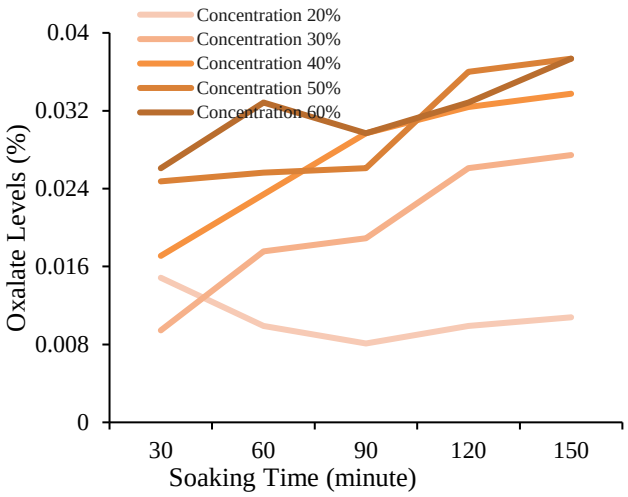

Figure 3. Relationship between Soaking Time and Oxalate Levels in Porang Elongated Slices in Alcohol Media

According to Figure 4, the most significant reduction in oxalate levels within the cubed porang occurred after 30 minutes of soaking in a 40% alcohol solution, resulting in a substantial decrease in oxalate levels by 0.0468%. This reduction was verified by the titration method, which indicated the change in color to dark red, signifying a reduction in oxalate content within the porang. The study concluded that the optimal immersion time for achieving the maximum reduction in oxalate levels was 30 minutes, effectively lowering oxalate levels to their minimum during this period.

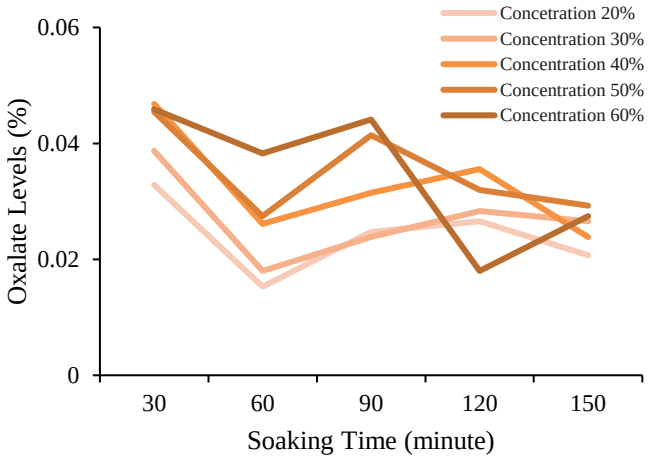

Figure 4. Relationship between Soaking Time and Oxalate Levels in Porang Diced Slices in Alcohol Media

Upon closer examination of the immersion graph, it is evident that diced porang shapes release oxalate more rapidly. This can be attributed to the smaller surface area of diced pieces, making them more susceptible to the effects of the alcohol immersion treatment with a 40% concentration for a shorter duration of 30 minutes, which has the most significant impact on the oxalate release process.

3.3 Effect of Soaking Time on Vinegar Acid Soaking Media on Longitudinal Slices and Dice

Porang, in the form of longitudinal slices and diced pieces, underwent a soaking process in vinegar-based solutions with different concentrations ranging from 10%, 15%, 20%, 25%, to 30%, for a duration of 2.5 hours. Samples were collected at 30-minute intervals during this soaking process.

As depicted in Figure 5, the most substantial reduction in oxalate levels within the longitudinal slices of porang occurred after 150 minutes of soaking in a vinegar-based solution with a concentration of 20%. This resulted in a noteworthy decrease in oxalate levels by 0.02295%. The titration method confirmed this reduction by noting the color change to dark red, indicating reduced oxalate content in the porang. The study concluded that the optimal immersion time for achieving the maximum reduction in oxalate levels was determined to be 150 minutes, effectively reducing oxalate levels to their lowest point during the final stage of immersion.

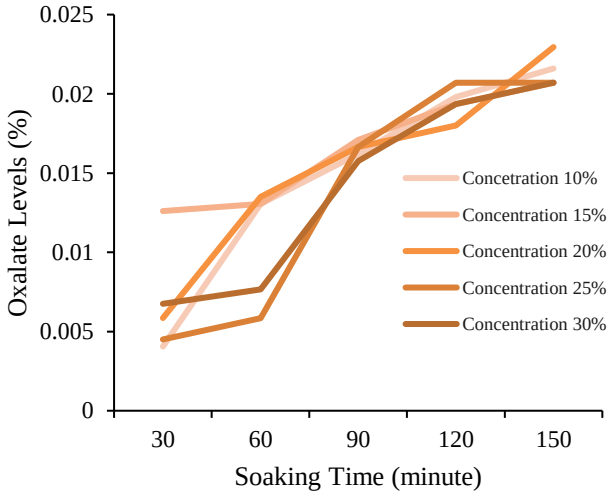

Figure 6. Relationship between Soaking Time and Oxalate Levels in Porang Elongated Slices in Vinegar Acid Media

It appears from the Figure 7 that the most significant reduction in oxalate levels within the cubed porang occurred after 150 minutes of soaking in a vinegar-based solution with a concentration of 30%. This resulted in a substantial decrease in oxalate levels by 0.0225%. The titration method confirmed this reduction, as evidenced by the color change to dark red, signifying a reduction in oxalate content in the porang. The study concluded that the optimal immersion

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time for achieving the maximum reduction in oxalate levels was 150 minutes, effectively lowering oxalate levels to their minimum during the final stage of immersion. It becomes evident that diced porang shapes exhibit a more rapid release of oxalate.

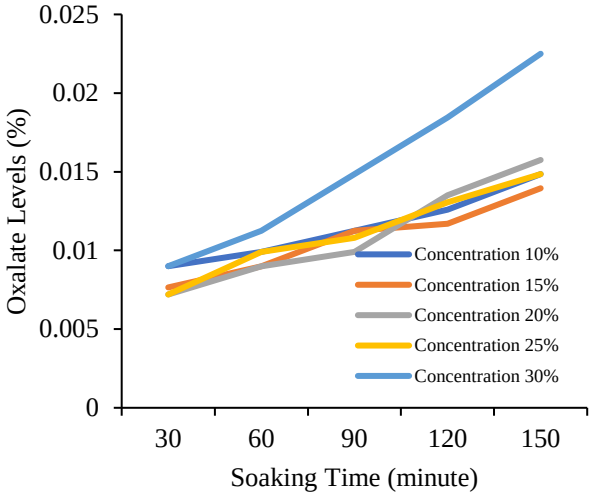

Figure 7. Relationship between Soaking Time and Oxalate Levels in Porang Diced Slices in Vinegar Acid Media

This phenomenon can be attributed to the smaller surface area of the diced pieces, making them more susceptible to the effects of the vinegar soaking treatment with a 30% concentration within a duration of 150 minutes, which exerts the most substantial influence on the oxalate release process. Previous findings reported that the treatment with acetic acid and the duration of immersion can reduce the total oxalate content in fresh yam beans. After the immersion in an acetic acid solution, the total oxalate content was reduced by up to 66%, amounting to 443 mg/100 g. This is supported by the analysis of the characteristics of yam beans, which revealed a moisture content of 59.51%, ash content of 1.36%, fat content of 0.19%, protein content of 2.28%, carbohydrate content of 35.66%, oxalate content of 1.313 mg/100 g, and the composition of calcium oxalate elements in yam beans after immersion in acetic acid solution with C at 48.30%, O at 49.59%, and Ca at 01.45% (Estiasih and Krisna, 2017).

3.4 Effect of Immersion Time on Water Media on Longitudinal Slices and Dice at Different Temperatures

Porang, in the form of longitudinal slices and diced pieces, was subjected to a soaking process in an water-based medium with temperature variations, ranging from 30°C, 40°C, 50°C, 60°C, to 70°C, for a duration of 2.5 hours. Samples were collected at 30-minute intervals during this soaking process.

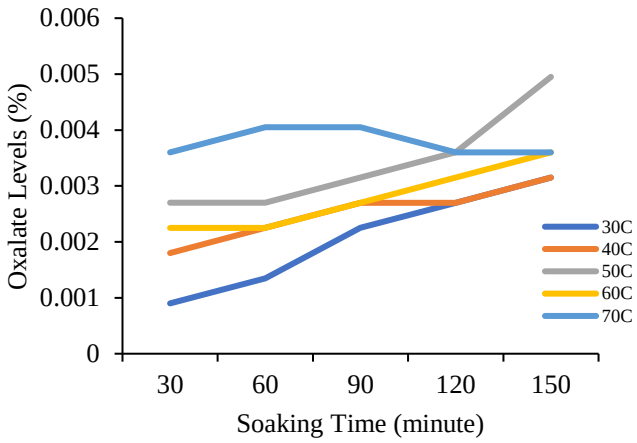

Figure 8. Relationship between Soaking Time and Oxalate Levels in Elongated Porang Slices in Water at different Temperatures

It appears from Figure 8 that the most significant reduction in oxalate levels within the longitudinal slices of porang soaked in water occurred after 150 minutes of immersion at a temperature of 50°C. This resulted in a noteworthy decrease in oxalate content by 0.00495%. The titration method confirmed this reduction, as indicated by the color change to dark red, signifying a reduction in oxalate content within the porang. The study concluded that the optimal immersion time for achieving the maximum reduction in oxalate levels was determined to be 150 minutes, effectively lowering oxalate levels to their minimum during the final stage of immersion.

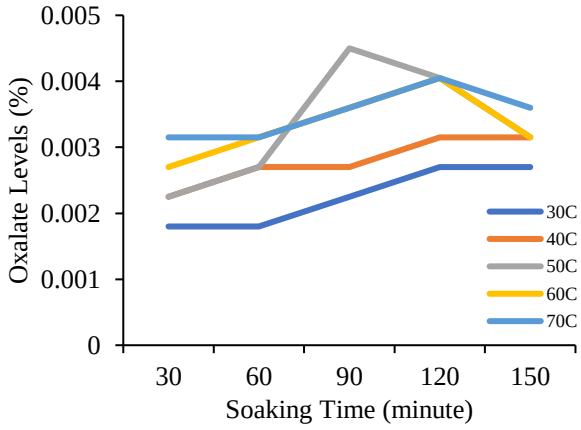

Figure 9. Relationship between Soaking Time and Oxalate Levels in Diced Porang Slices in Water at different Temperatures

From Figure 9, it is evident that the most substantial reduction in oxalate levels within diced porang soaked in alcohol occurred after 120 minutes of immersion at a temperature of 70°C. This resulted in a significant decrease in oxalate levels by 0.0045%. The reduction was confirmed using the titration method, as evidenced by the change in color to dark red, indicating a decrease in oxalate content within the porang. The study concluded that the optimal

immersion time for achieving the maximum reduction in oxalate levels was determined to be 120 minutes, effectively lowering oxalate levels to their minimum during this period. This is attributed to the smaller surface area of the diced pieces, making them more susceptible to the effects of the alcohol soaking treatment at a temperature of 70°C within a duration of 120 minutes, which has the most significant impact on the oxalate release process. Previous researchers reported that the most significant reduction in calcium oxalate content in porang tuber samples was achieved through soaking at 60°C, resulting in a remarkable reduction of 53.91%. Furthermore, soaking the porang tubers for a duration of 60 minutes also led to the most substantial reduction in calcium oxalate, amounting to 42.54% (Wardhani and Arifiyana, 2020).

4. Conclusions

In conclusion, the study's findings suggest that the most effective reduction in oxalate levels within porang samples, whether in the form of longitudinal slices or diced pieces, varies depending on the soaking medium and temperature conditions. For longitudinal slices, the optimal immersion time was 150 minutes at 50°C when soaking in water, resulting in a significant decrease in oxalate content. Meanwhile, diced porang exhibited a faster release of oxalate, with the most substantial reduction occurring after 120 minutes at 70°C when soaked in alcohol. This outcome is attributed to the smaller surface area of diced pieces. These insights highlight the importance of tailoring the soaking conditions to the specific porang form and soaking medium to achieve maximum oxalate reduction, offering valuable information for further optimization of porang processing techniques.

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