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The Effect of Citrid Acid on Isolation of Kimpul Tumber Starch *(Xanthosoma Sagittifolium Schot)*

Fadlan Hidayat[1*], Rita Sunartaty[1], Munazari[1], Isna Safitri[1], Anita Noviyanti[2], Salfauqi Nurman[3], Safiah[4], Elvrida Rosa[5]

[1]Department of Agricultural Industrial Engineering, Faculty of Agriculture Technology, Universitas Serambi Mekkah, Banda Aceh, Indonesia

[2] Department of Biology Education, Faculty of Teacher Training and Education Universitas Serambi Mekkah, Banda Aceh, Indonesia

[3]Department of Ship Engineering, Politeknik Pelayaran Malahayati, Aceh Besar, Indonesia

[4]YPHB School of Economics, Banda Aceh, Indonesia

[5]Graduate Program, Master of Biology Education, Universitas Serambi Mekkah, Banda Aceh, Indonesia

*Corresponding Author: fadlanhidayat@serambimekkah.ac.id

Abstract. *Starch is a natural polymer that can be digested to produce energy for humans and is abundantly found in plants. Starch granules consist of two main components, namely amylose and amylopectin, both of which serve as storage forms of complex carbohydrates in plants. Carbohydrates are a primary source of energy; in addition, they can be used as basic materials for various industrial applications, such as food and bioplastics. Kimpul tubers are a type of local food crop with significant potential as an alternative food source. This study aimed to identify the effect of citric acid on the isolation of kimpul starch in terms of moisture content, carbohydrate content, fat content, protein content, fiber content, and ash content. The independent variable in this study was the concentration of citric acid (2.5%, 5%, and 7.5%), arranged using a factorial Completely Randomized Design (CRD). The results showed that soaking in a citric acid solution produced starch with moisture content ranging from 6.80–11.38%, carbohydrate content of 79.29–82.99%, fat content of 1.21–2.25%, protein content of 4.27–4.60%, fiber content of 2.70–2.87%, and ash content of 0.96–1.03%.*

Keywords: *Characteristics,Citrid acid, Kimpul tuber, Starch*

1. Introduction

Starch is a complex carbohydrate composed of a mixture of two glycosidic macromolecules, namely amylose and amylopectin, which are in the form of granules (Ikram et al., 2023). Starch is an important source of energy for humans, obtained through extraction from plants such as cereals, tubers, and grains (Onyango, 2016). The diversity of local food crops has the potential to serve as an alternative source of food rich in nutrients. Therefore, it is important to develop this potential in order to support food security in Indonesia and even globally (Saqib et al., 2025). One way to maintain food security is to implement diversification that focuses on local foods, supported by the high availability of local foods rich in carbohydrates and other nutrients. Starch has the advantage of being available year-round as a natural ingredient. In addition, it is flexible in its use and can be processed into various food and non-food products (Hidayat, Sunartaty, et al., 2023). One of them is kimpul tubers, which are a healthy local food source for the community if processed properly (Iswadi & Wibisana, 2019).

The carbohydrate and starch content in kimpul tubers is quite high, around 84.54%, but the starch content also contains a high level of amylose, 20-25%, with small starch granules. However, this makes it suitable for processing into food and good for consumption (Rahmawati

et al., 2023). Kimpul tubers, a plant commonly found growing wild, are actually very useful as a source of carbohydrates. However, the oxalate content in kimpul tubers makes this plant unpopular for general consumption among the local community, as it causes a burning sensation in the tongue and throat due to the oxalate crystals enclosed in transparent capsules containing sap (Agustin et al., 2022). High levels of oxalic acid can damage health, especially in the kidneys. Oxalate content can be reduced physically by heating and soaking using certain types of chemicals such as citric acid (Sulaiman et al., 2021).

Citric acid ($C_6H_8O_7$) is an organic acid found in citrus fruits, which is commonly used as a souring agent. It also functions as a natural preservative provided by nature and is easily obtained. This study aims to obtain starch from arrowroot tubers (Xanthosoma sagittifolium) by soaking them in citric acid ($C_6H_8O_7$) and to examine the physicochemical characteristics of the resulting starch. The results of this characterization have the potential to influence the quality and utilization of starch in various food and non-food applications.

2. Method

This research was conducted in August 2025 at the food and agricultural product analysis laboratory of Serambi Mekkah University. The materials used in this study were kimpul tubers, citric acid, and distilled water. The tools used in this study were knives, basins, analytical scales, beakers, blenders, spoons, sieves, and 100-mesh sieves. The starch production process began with reducing the size of the starch tubers. Next, the reduced tubers were mashed into a paste, then soaked in citric acid ($C_6H_8O_7$) solution for 24 hours. The resulting paste was then filtered using filter paper and left for 24 hours until a precipitate formed. The sediment is separated from the water, then dried in an oven at 70°C. Next, the dry material is ground using a blender and sieved with a 100 mesh sieve. The resulting starch is analyzed for moisture content, carbohydrate content, fat content, protein content, crude fat, and ash content (Hidayat, Indarti, et al., 2023).

3. Result and Discussions

3.1. Moisture content

Moisture content is the percentage of water in a material which plays an important role in the durability of food (Ikram et al., 2023). The moisture content of the resulting kimpul tubers starch is presented in Figure 1.

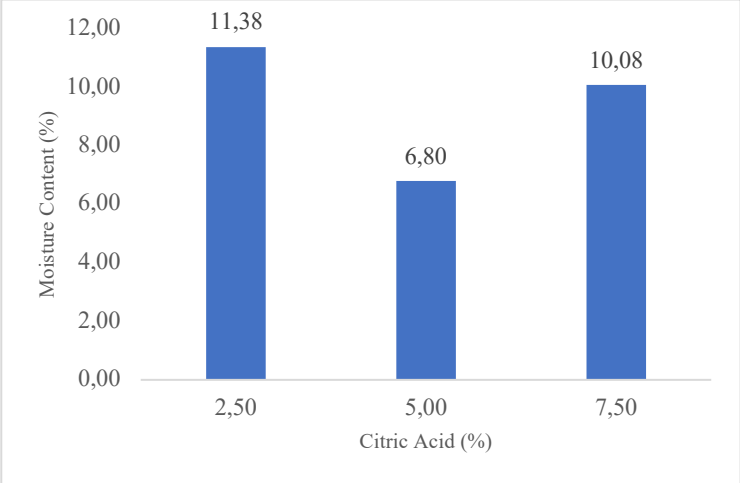

Figure 1. Moisture content of kimpul tubers starch

Figure 1 shows the effect of citric acid concentration on moisture content. At a citric acid concentration of 2.50%, the moisture content produced was 11.38%. Furthermore, when the citric acid concentration was increased to 5.00%, the moisture content decreased significantly to 6.80%. However, at a concentration of 7.50%, the water content increased again to 10.08%. These results indicate that the addition of citric acid affects the water content, but not linearly. A citric acid concentration of 5.00% produced the lowest water content, indicating that this condition was most effective in reducing water content. The increase in moisture content at a concentration of 7.50% is thought to be caused by changes in the structure or ability of the material to bind water due to excess citric acid. This moisture content value meets the criteria specified in SNI 01-3751-2006, which states that flour must have a maximum moisture content of 14.5%. This is because acidic substances contain H+ ions that bind strongly to water molecules during the soaking process, causing the flour to lose a lot of water when dried. Citric acid reduces the ability of starch to absorb water. Acids can weaken the hydrogen bonds in starch, making it difficult for water to bind to the starch granules (Lepar et al., 2024). The decrease in water content is also thought to be due to the high acidity level in the flour, which causes molecular changes and weakens and reduces the amount of bound water (Lalu et al., 2023)

3.2. Carbohydrate content

Carbohydrates are a macronutrient composed of the element carbon, hydrogen, and oxygen, which act as the main source of energy for the body (Maod et al., 2022). Carbohydrates are found in many different plant organs, including seeds, fruits, tubers, and roots, where they are used as an energy source (Santoso et al., 2021). Figure 2 shows the effect of citric acid concentration on the carbohydrate content of kimpul tubers in this study.

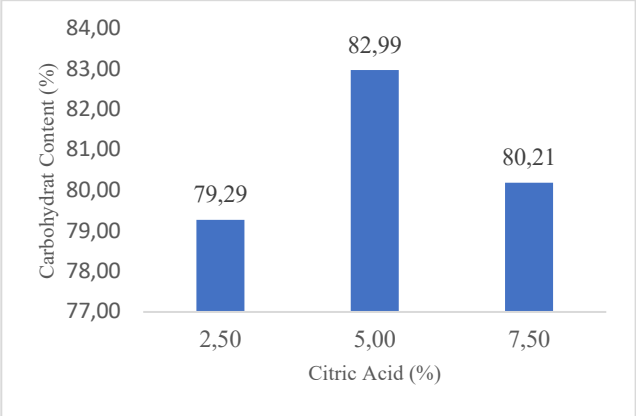

Figure 2. Carbohydrate content of kimpul tubers starch

The results showed that a citric acid concentration of 2.50% produced a carbohydrate content of 79.29%. Increasing the citric acid concentration to 5.00% increased the carbohydrate content, reaching a peak value of 82.99%. However, at a citric acid concentration of 7.50%, the carbohydrate content decreased to 80.21%. These results indicate that the addition of citric acid affects the carbohydrate content in a non-linear pattern. A citric acid concentration of 5.00% is the optimum condition because it produces the highest carbohydrate content. The decrease in carbohydrate content at a concentration of 7.50% is thought to be caused by carbohydrate degradation or changes in starch structure due to the use of higher amounts of citric acid. According to (Paiki et al., 2018), The carbohydrate content values followed the

water content values of the three treatments. This is because the determination of carbohydrate content in this study used the by difference method, which is the determination of carbohydrate content based on the difference between the total percentage of the material and the total sum of water, fat, protein, and ash content. Thus, the higher the content of other nutritional components, the lower the carbohydrate content of the material, and conversely, the lower the content of nutritional components, the higher the carbohydrate content.

3.3. Fat content

Fat is a compound composed of the elements carbon, hydrogen, and hydrogen, and acts as a source of energy for the body of 9 kilocalories per gram and helps the absorption of vitamins A, D, E, and K (Angelia, 2016). The results of the fat content analysis in this study can be seen in Figure 3.

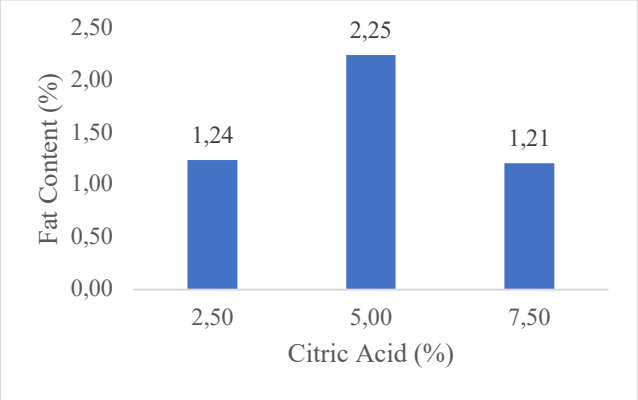

Figure 3. Fat content of kimpul tubers starch

Figure 3 shows that the effect of 2.50% citric acid concentration resulted in a fat content of 1.24%. When the citric acid concentration was increased to 5.00%, the fat content increased significantly to a maximum value of 2.25%. However, a citric acid concentration of 7.50% resulted in a fat content of 1.21%. These results indicate that variations in citric acid concentration affect fat content in a non-linear pattern. A citric acid concentration of 5.00% produced the highest fat content, which is thought to be related to changes in the structure of the material or an increase in fat release under these conditions. The decrease in fat content at a concentration of 7.50% is likely due to greater degradation or dissolution of fat as a result of using citric acid in high concentrations. In another study conducted by (Handayani et al., 2017), soaking rice in citric acid caused fat levels to decrease compared to rice that was not soaked in citric acid. This is thought to be due to the effect of citric acid on fat levels and is influenced by water content, as the presence of water causes fat to hydrolyze into glycerol and fatty acids.

3.4. Protein content

Protein is a food substance that is very important for the body, because this substance not only functions as fuel in the body but also functions as a building and regulatory substance (Lastari et al., 2016). The results of the protein content analysis in this study can be seen in Figure 4.

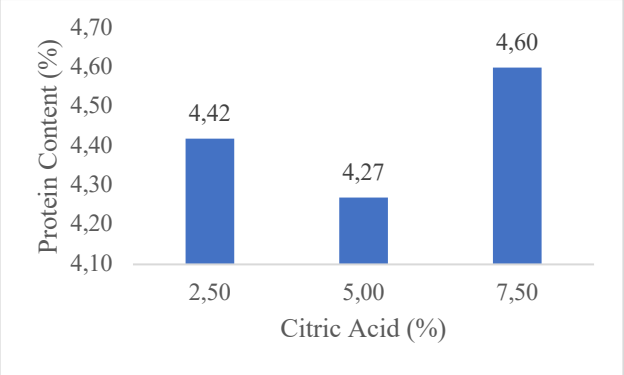

Figure 4. Protein content of kimpul tubers starch

Figure 4 shows the relationship between citric acid concentration and protein content in kimpul tubers. It can be seen that the protein content fluctuates as the citric acid concentration increases. When soaked in 2.5% citric acid, the protein content of kimpul tubers was 4.42%. This value then decreased at a concentration of 5% to 4.27%. This decrease indicates that an increase in citric acid concentration to 5% can cause some of the protein to dissolve or degrade during the soaking process. However, when soaked in 7.5% citric acid, the protein content increased again to 4.60%, which was the highest value among the treatments tested. The results of the study ranged from 4.27% to 4.60%, indicating that the protein content of kimpul tubers is still relatively low. In another study conducted by (Pertiwi et al., 2018), using citric acid solution in the process of making catfish bone gelatin resulted in a protein content that was 58.70% lower without citric acid immersion. The protein content of kimpul tubers can be increased by raising the pH of the immersion solution towards alkaline. The higher the pH of the immersion solution, the higher the protein content tends to be. Under alkaline conditions, most amino acids are negatively charged, thereby increasing protein solubility. Like charges repel each other, minimizing interactions between amino acid residues, which means that solubility will increase (Chandra et al., 2013).

3.5. Crude Fiber content

Dietary fiber is the edible part of plants or carbohydrate analogs, which are resistant to digestion and absorption in the human small intestine, including polysaccharides, analog carbohydrates (resistant starch and synthetic carbohydrate compounds), oligosaccharides, lignin and materials related to plant cell walls (waxes, cutin, suberin) (Paiki et al., 2018). The fiber content of kimpul tuber starch ranges from 2.70-2,87% (Figure 5).

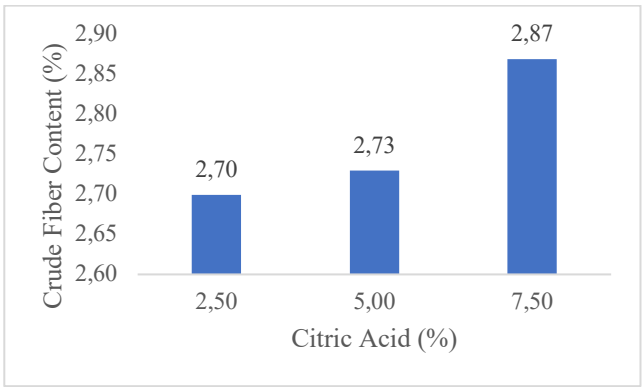

Figure 5. Crude fiber content of kimpul tubers starch

Figure 5 shows that soaking in 2.5% citric acid resulted in a crude fiber content of 2.70% in kimpul tubers. This value then increased slightly at a concentration of 5% to 2.73%. This relatively small increase indicates that increasing the citric acid concentration from 2.5% to 5% did not have a significant effect on the change in crude fiber content. Furthermore, when soaked in 7.5% citric acid, the crude fiber content increased more significantly, reaching 2.87%, which was the highest value among all treatments. This indicates that the higher the concentration of citric acid used, the greater the tendency for an increase in crude fiber content in kimpul tuber starch. This is thought to be because during soaking with citric acid, the starch granules expand due to water absorption (Paiki et al., 2018).

3.6. Ash content

Ash content is a mixture of inorganic or mineral components found in a food ingredient. The amount of minerals in a food ingredient can be determined by its ash content (Marlina & Cengristitama, 2020). The ash content in this study can be seen in Figure 6.

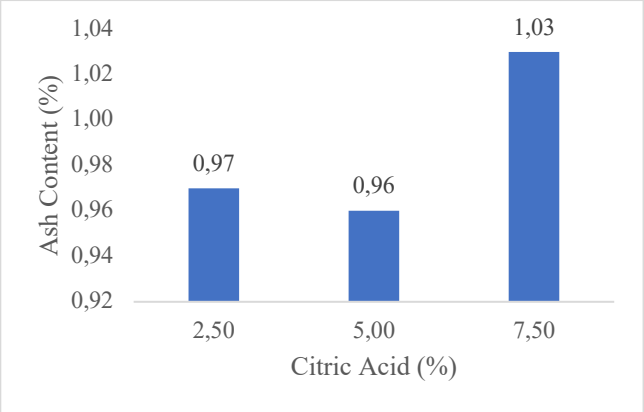

Figure 6. Ash content of kimpul tubers starch

Figure 6 shows that immersion in 2.5% citric acid resulted in a starch ash content of 0.97%. This value then decreased slightly at a concentration of 5% to 0.96%, which was the lowest value among the treatments. This decrease indicates that at medium concentrations, some minerals are likely to dissolve during the soaking process. The ash content did not decrease significantly with increasing citric acid concentration. A decrease in pH will cause minerals to change from a colloidal form to a soluble form. The dissolution of minerals contained in potato tissue results in a decrease in potato mineral content (Lepar et al., 2024). During the immersion process in citric acid, minerals are also dissolved (Ikram et al., 2023). Then it increased at a concentration of 7.5%. This indicates that changes in citric acid concentration do not affect ash content at higher concentrations.

4. Conclusions

The results showed that soaking cassava starch in citric acid at a concentration of 7.5% increased protein, crude fiber, and mineral (ash) content. This increase occurred due to modifications in the starch structure during the soaking process. Meanwhile, soaking cassava starch in citric acid at a concentration of 5% was more effective in maintaining water, carbohydrate, and fat content, thus maintaining optimal energy and moisture levels.

5. Acknowledgements

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