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Physicochemical and Functional Properties of Kluwih Seed Starch *(Artocarpus Camansi)*

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Abstract. *Aceh Province is one of the areas with many crops, especially in large Aceh Regency. So far, kluwih seeds in Aceh Province have only been consumed by a small percentage of people by boiling. Kluwih seeds contain starch, protein and fat. Starch is made up of two glycosidic macromolecules namely amylose and amylopectin, while the ratio of amylose varies according to the plant source. Starch in plants is produced to store excess glucose as an energy reserve and can be a source of energy for human intake. Based on the needs of food products, starch from different sources has different physicochemical characteristics. So, it is necessary to choose the appropriate starch characteristics to meet the needs or processing of the product. The purpose of this study was to determine the influence of solvent type and soaking time on the characteristics of kluwih seed starch. The type of solvent used is Citric Acid (C6H8O7), Calcium Hydroxide (Ca (OH)$_2$) and sodium metabisulfite (Na2S2O5). The parameters analyzed were amylose content, protein content, fat content and crude fiber content. The results of the analysis of each treatment showed that immersion in citric acid solution resulted in amylose content of 18.31%, fat content ranged from 4.89-4.95%, protein content ranged from 10.06-12.75%, and crude fiber content ranged from 12.67-13.08%. In soaking in calcium hydroxide solution, the amylose content ranges from 17.03%, fat content ranges from 2.63-3.56%, protein content ranges from 9.39-10.36% and crude fiber content ranges from 11.27-13.19%. While the result of immersion in sodium metabisulfite solution with amylose content is 30.80% (Hidayat et al. 2023b), fat content ranges from 2.42-2.49%, protein content ranges from 11.25-11.99% and crude fiber content ranges from 11.30-11.75%.*

Keywords: *soaking time, starch, type of solvent, kluwih*

1. Introduction

Indonesia has a tropical climate that produces a variety of plants, one of which is the kluwih plant (*Artocarpus cammansi*. The kluwih plant produces fruits that have only been processed simply by the community, such as being greened or boiled with seeds (Fonseca and Kusmartono 2020). Aceh Province is one of the areas with many crops, especially in large Aceh Regency. So far, kluwih seeds in Aceh Province are only consumed by a small part of the community by boiling or roasting (Hidayat et al. 2023a). Kluwih fruit has a shelf life of only 2-3 days, in terms of color it will turn brown, the texture of the fruit becomes soft and rots after exceeding the shelf life. Old kluwih seeds are sold in cooked form, namely boiled, this food is widely found in rural areas but has low economic value. Referring to the starch content of kluwih seeds ranges from 30.15–39.09%.

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Kluwih seeds also contain fat of 5.59%, fiber of 8.19%, ash of 1.49%, phenol of 0.06% and carbohydrates of 64.96% (Yuda, Wijaya, and Suwariani 2018). Kluwih seeds have a kaunt so that they can be used as cemilian that is processed in boils, processed into delicious and nutritious kluwih seed chips. calcium 53 mg, copper 0.75 mg, iron 6.2 mg, magnesium 100 mg, manganese 0.45 mg, phosphorus 268 mg, potash 1,620 mg, and sodium 2 mg. The content of keluwih seeds has a lot of nutritional content so that it is used for making flour and daily snacks (Januarta, Suriani, and Damiati, 2018). According to Zamora, kluwih seeds contain starch, protein and are rich in mineral sources (Zamora et al., 2017).

Therefore, it is necessary to introduce a processing technique, such as modifying kluwih fruit into other forms of products and being able to benefit from this plant. Kluwih fruit can be used as an example of food diversification from kluwih plants that will be carried out is the manufacture of kluwih seed starch. In the study, starch development from local varieties was carried out using the chemical method. The purpose of this study is to determine the influence of solvent type and soaking time on the characteristics of kluwih seed starch.

2. Method

Research This research was carried out in October 2024 at the agricultural product processing laboratory of Universitas Serambi Mekkah and testing was carried out in several laboratories at Syiah Kuala University. The materials used in this study are kluwih seeds, sodium metabisulfite ($Na_2S_2O_5$), citric acid ($C_6H_8O_7$), calcium hydroxide Ca $(OH)_2$ and aquaades. The tools used in this study were knives, basins, ovens, analytical scales, beakers, blenders, spoons, strainers, strainers, strainers, and 100 mesh sieves.

This research procedure was carried out in several stages, namely the process of cleaning kluwih seeds with water. Then it is peeled and soaked in 3 types of chemical solutions, namely sodium metabisulfite ($Na_2S_2O_5$), citric acid ($C_6H_8O_7$) and Calcium Hydroxide ($Ca(OH)_2$) and 3 levels of soaking, namely 30 minutes, 60 minutes and 90 minutes. The next process is that the kluiwh seeds are crushed into a slurry and squeezed to obtain the starch with water. After that it is left for 30 minutes to obtain starch deposits. The drying process is using an oven. The drying temperature used is 70°C for 6 hours. The dried starch of kluwih seeds is then weighed and a sieving process of 100 mesh is carried out to obtain a uniform size. Furthermore, the starch produced was analyzed which included analysis of amylose content, fat content, protein content and crude fat.

3. Results and Discussions

Starch is made up of amylose and amylopectin, while the ratio of amylose varies according to the plant source. Based on the needs of food products, starch from different sources has different physicochemical characteristics. So, it is necessary to choose the appropriate starch characteristics to meet the needs or processing of the product. For example, starch with high amylose can coat fried dough, due to its film-binding properties that give fried products a crispy texture (Joshi et al. 2013). The results of amylose levels in this study can be seen in Table 1.

The amylose content in starch is influenced by botanical characteristics and extraction methods (Castro et al. 2018). The results from Table 1 show that the amylose content in this study with immersion in citric acid solvent is 18.31%, while with lime immersion is 17.03%. The higher the amylose content in this phase, the stronger the gel texture (Joshi et al. 2013).

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Table 1. Amylose content of starch seeds

It	Solvent Type	Yield (%)	Reference
1	Solvent-free	15.99	(Sukatiningsih 2005)
2	Sodium metabisulfate	30.80	(Hidayat et al. 2023b)
3	Citric acid	18.31	This research
4	Calcium Hydroxide	17.03	This research

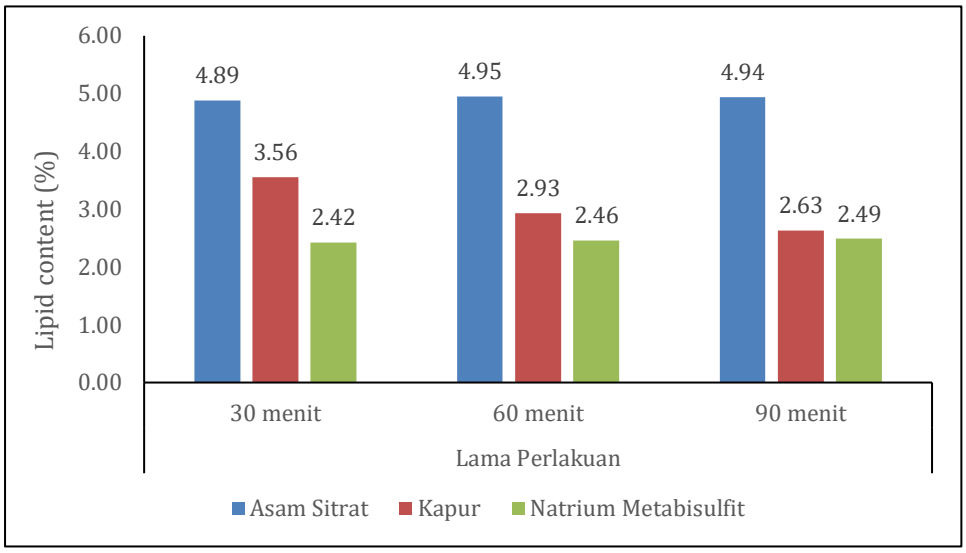

Figure 1. The starch fat content of kluwih seeds

In Figure 1, it can be seen that soaking in the citric acid solution and the duration of soaking can increase the starch fat content of kluwih seeds. The fat content produced ranged from 4.89-4.95%. Meanwhile, soaking in lime solution and soaking for a long time resulted in a fat content ranging from 2.63-3.56% and soaking in a metabisulfite solution and a long soaking resulted in a fat content ranging from 2.42-2.49%. Low fat content is caused by the length of the soaking treatment (Handayani, Rosahdi, and Viera 2017). The long soaking accelerates the movements of fat molecules to become large and will facilitate the process of fat production (Paiki et al. 2018).

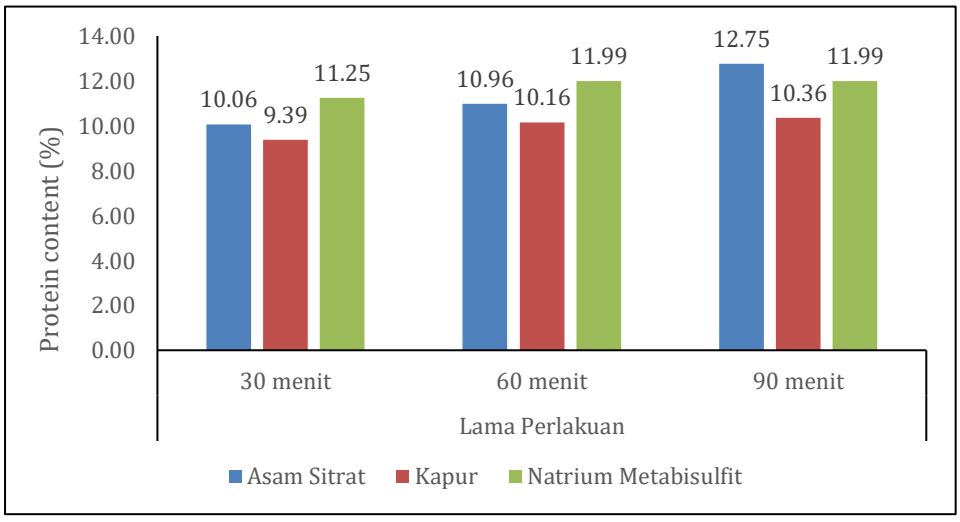

Figure 2. Protein content of kluwih seed starch

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In Figure 1, it can be seen that soaking in citric acid solution and soaking time can increase the protein content of kluwih seed starch. The highest protein content was produced in the soaking treatment in citric acid solution and the soaking time of 90 minutes was 12.75%. In this study, the soaking time limit is 90 minutes, if it exceeds 90 minutes, there will be a decrease in protein levels. This is suspected because water-soluble proteins are also dissolved during the process of soaking with citric acid (Paiki et al. 2018). Meanwhile, soaking in lime solution and soaking time produced protein levels ranging from 9.39-10.36%. In soaking in sodium metabisulfite solution and soaking for a long time, protein levels tend to increase steadily ranging from 11.25-11.99%. The main function of sulfites is as a disulfide bond breaker on proteins, so that the protein matrix that covers starch will come loose resulting in a measurable amount of free protein will be even larger. During immersion in the sodium metabisulfite solution, there is direct contact between the protein and the sulfite which causes protein disintegration so that the free protein becomes loose. There is a decrease in protein levels with the longer the soaking time. The breakdown of proteins into simpler compounds allows these compounds to be further degraded as well as water soluble (Akbar and Yunianta 2014). According to Marlina (2020), temperature affects the protein levels produced, The lower the temperature and the higher the concentration of immersion used, the more protein levels will be contained (Marlina and Cengristitama 2020). In this study, the pH used is alkaline, the higher the pH of the soaking, the higher the protein content will increase ±7(Chandra, Inggrid, and Verawati 2013).

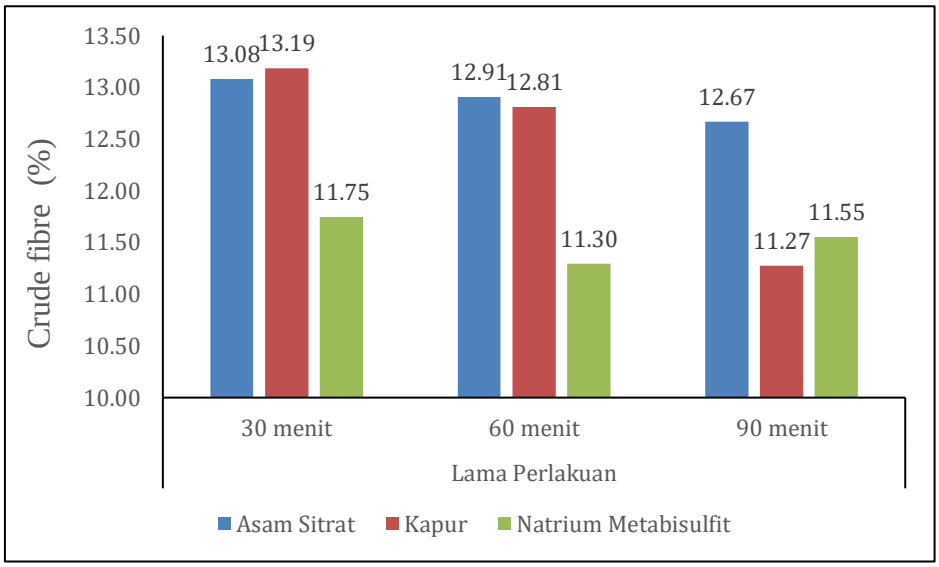

Figure 3. Crude fiber content of kluwih seed starch

In Figure 3, it can be seen that the immersion in the lime solution and the soaking time ranged from 11.27-3.19%, while the soaking in the citric acid solution and the soaking time produced a crude fiber content ranging from 12.67-13.08% and the soaking in sodium metabisulfite solution and the soaking time produced a crude fiber content ranging from 11.30-11.75%. Each treatment showed that the effect of the soaking time could lead to a decrease in crude fiber levels. This is suspected due to the decomposition of coarse fibers by the activity of microorganisms. Organism activity occurs due to the presence of nutrients contained in crude fiber, namely polysaccharides. This results in organisms utilizing carbon sources as food sources during storage. In addition, the decrease in crude

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fiber content can be affected by an increase in moisture content that is able to affect the growth and activity of microorganisms during storage (Akbar and Yunianta 2014).

4. Conclusions

The results of the analysis of each treatment showed that immersion in citric acid solution resulted in amylose content of 18.31%, fat content ranged from 4.89-4.95%, protein content ranged from 10.06-12.75%, and crude fiber content ranged from 12.67-13.08%. In soaking in calcium hydroxide solution, the amylose content ranges from 17.03%, fat content ranges from 2.63-3.56%, protein content ranges from 9.39-10.36% and crude fiber content ranges from 11.27-13.19%. Meanwhile, the results of immersion in sodium metabisulfite solution with amylose content ranged from 2.42-2.49%, protein content ranged from 11.25-11.99% and crude fiber content ranged from 11.30-11.75%.

5. Acknowledgements

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