The effect of soaking sago starch in acetate acids on the whiteness degree of sago flour

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Abstract. Sago flour soaking is one way to improve the white of sago that tends to turn brown and reddish because of the phenolase enzyme activity in sago. Some studies suggest that acetic acid can impede the encephalic tanning reaction that occurs in sago. This study aims to identify the characteristics of sago flour obtained from sago starch soaking in acetate solutions and to get the best of the sago flour. The method of this study uses Completely Randomized Design (CRD) with two factors, namely variations of submersion time (2 hours, 4 hours, 6 hours) and the acetic acid (CH₃COOH) concentration (0%, 0.1%, 0.25%). The data obtained were analyzed using Analysis of Variance (ANOVA) and followed by Duncan Multiple Range Test (DMRT) at a 5% significance level. Sago flour soaking with acetic acid has a significant effect on the quality of sago flour, such as the degree of whiteness, water content, and acidic level. The longer it takes to submerge and the higher the concentration of acetic acid, the degree of white, water content, and degree of acid sago flour also increases. All the results of this research qualified the quality requirements of sago flour according to the quality standard of sago flour.

1. Introduction
Sago plants have a good content required by the human body, including carbohydrates, fibre, protein, calories, sodium, fat, and potassium. Sago flour is a potential foodstuff in food processing into a wide range of food products. Sago has excellent potential in Indonesia, however the utilization of sago still in a small part. The use of sago flour is still in the form of traditional food in general. For example, in the form of consumption of staple foods. In addition to foodstuffs, the utilization of sago is also in the field of processing industries such as food industry, cosmetics, adhesive industry, and other industries as raw materials.

However, in making sago flour, the length of wet sago storage tends to make the physical properties of the sago also change, especially the colours that tend to brown and reddish. It also affects the quality of colour in the resulting sago flour. Meanwhile, colour is one of the main characteristics of a product. Especially in the food industry, the colour becomes an important attribute in assessing the quality of a foodstuff. Therefore, the white lightness that occurs in sago flour can decrease the level of quality of the sago itself physically.

The reaction of phenolase enzymes basically causes the browning that occurs in sago flour. Enzymatic browning reactions by phenolase enzymes can be inhibited by using acetic acid compounds [1].
Therefore, it is necessary to modify sago flour by utilizing acetic acid as one of the hydrophilic solvents with solubility properties and good blending ease. The modification is in the form of the soaking of acetic acid to improve the characteristics of less desirable sago flour. Soaking sago flour is one way to enhance the sago's white colour, which tends to brown and reddish. Thus, it is also necessary to conduct further testing in looking at the effect of soaking sago starch by using the acetic acid solution on the characteristics of sago flour, such as white degrees, moisture content, ash content, and degree of acidity in order to remain following the expected product quality requirements.

This study aimed to analyze characteristics of sago flour obtained from the soaking of sago starch in acetate solution and obtain the best sago flour quality following the standardization of the prevailing sago flour quality. At the same time, the purpose of this research can be used as a reference in the process of standardized quality of sago flour.

2. Methods
Tools used in this study were oven, colorimeter, furnace, pH meter, cups, digital scales, volumetric flask 1000 ml, drip pipettes, beaker, stopwatches, sieve, and label paper. The main ingredients used in this study are sago starch or wet sago and aquades. While the material used for analysis is glacial acetic acid (CH₃COOH).

2.1. Degrees of whiteness
Whiteness degree measurement using Colorimeter. Calibration of the tool was done first with a standard white plate. Each sample was placed in a special container. A glass cover was then installed to coat the surface of the sample and placed under the lens. Then, the tool sensor on the lens was brought closer to the existing sample and measured its whiteness degree value according to what appears on the tool screen. Measurements were performed by repeating each sample 3 times.

2.2. Water content
Measurement of moisture content was done by oven method (AOAC 2005). The cups were first preheated in the oven for 30 minutes at 100°C, then cooled to remove moisture and weighed. Samples were put into a cup that had previously weighed heavily initially. Then weigh the sample weight as much as 2 g with the cup before the oven. After that, each sample was put in the oven for 6 hours at 1050°C. Then the materials were removed and refrigerated for 30 minutes after it was weighed. Measurements were performed by repeating each sample 3 times.

The calculation of the moisture content value was completed with the formula:

\[
\text{Moisture content (\% ww)} = \frac{W_1 - W_2}{W_1 - C} \times 100\%
\]

\( W_1 = \) weight of the cup + sample before drying (g),
\( W_2 = \) weight of the cup + sample after drying (g), and
\( C = \) weight of empty cup (g).

2.3. Ash content
The cup of the sample was burned in a furnace for 15 minutes then cooled in a desiccator. Then, the cup was cooled and weighed. Then a sample of 2 g in the cup was weighed and turned into ashes in the furnace until it was obtained white ash and the weight remains. The ashes were carried out in 2 stages, namely at 400°C and then continued at 550°C, then cooled in the desiccator and weighed. The calculation of ash levels was parallel to the equation as follows:

\[
\text{Ash content (\%)} = \frac{W_2 - C}{W_1 - C} \times 100\%
\]

\( W_1 = \) weight of the cup + sample before burning (g),
3. Research design

The research design used in this study was a Complete Randomized Design (CRD) factorial consisting of two factors with three treatment levels within three replays (table 1). These factors include:

Factor I: Length of soaking time
- T1 = 2 hours
- T2 = 4 hours
- T3 = 6 hours

Factor II: Concentration of Acetate Acids
- K1 = Control (0%)
- K2 = 0.1%
- K3 = 0.25%

Data analysis in this study was then completed using a statistical variety test. The data obtained was tested using ANOVA or Analysis Of Variance variety test using SPSS 22 application. One-way ANOVA first tested the data to see if the treatment had a significant influence on the materials' character. Suppose the results of the analysis show a noticeable difference in each therapy given. In that case, the next test is carried out Duncan multiple range test (DMRT), to determine if there is a significant difference in each treatment given.

| Treatment | Length of soaking time | Concentration of acetate acids | Notation of the treatments |
|-----------|------------------------|-------------------------------|---------------------------|
|           | Control (0%)           |                               | T1K1                      |
| 2 hours   | 0.10%                  |                               | T1K2                      |
|           | 0.25%                  |                               | T1K3                      |
|           | Control (0%)           |                               | T2K1                      |
| 4 hours   | 0.10%                  |                               | T2K2                      |
|           | 0.25%                  |                               | T2K3                      |
|           | Control (0%)           |                               | T3K1                      |
| 6 hours   | 0.10%                  |                               | T3K2                      |
|           | 0.25%                  |                               | T3K3                      |

4. Results and discussion

4.1. Degrees of whiteness

Whiteness degree measurement was done to measure the level of white colour in sago starch. The colour of sago starch can generally be influenced by various things, such as genetic and starch extraction processes. One of the processes of extraction of sago starch can affect the white colour of the sago, i.e., the type of water used. The higher whiteness degree value indicates the excellent quality of sago starch.
Figure 1. The effect of soaking sago starch in acetic acid solvent against the whiteness degree of sago flour.

Based on the diagram shown in figure 1, the length of soaking time and concentration of acetate acids could affect the level of whiteness degrees in sago flour. This could be seen from the average whiteness degree value of sago flour, where the longer the soaking and the higher the concentration of acetic acid, the higher the degree of whiteness. This result showed that acetic acid compounds could inhibit the sago's browning reaction due to the enzyme fenolase. The higher the concentration of the acetic acid solution used, the higher the acidity level so that the enzyme fenolase could not be done to the maximum. This result was according to research [1], which stated that enzymatic browning reactions by fenolase enzymes were inactive in acidic states. In addition, the longer the soaking time, the higher the level of enzyme inactivation that could cause a browning reaction in the starch would be more maximal. Therefore the result of the whiteness degree value would be higher. This was according to research [1] which stated that the length of soaking time of acetic acid in modified breadfruit flour has a noticeable effect on its whiteness degree.

Data from ANOVA's diversity analysis of the whiteness degree of sago flour based on variations in the length of soaking time and concentration of the acetic acid solution is shown in table 2.

| Length of soaking time (T) | Control | 0,1%  | 0,25%  | Average |
|----------------------------|---------|-------|--------|---------|
| 2 hours                    | 89,71¹  | 90,93² | 92,39³  | 91,01   |
| 4 hours                    | 90,95⁵  | 92,28⁶ | 92,88⁷  | 92,04   |
| 6 hours                    | 91,62⁸  | 92,35⁹ | 93,14¹⁰ | 92,37   |
| Average                    | 90,76   | 91,86  | 92,81  | 91,81   |
| DMRT 5%                    |         |       |        | 0,000   |

* Different notations show a real difference in α = 0,05.

Table 2 shows that soaking of sago starch with long variations in soaking and concentration of acetic acid solution significantly influenced the whiteness degree of sago flour at a significance level of 0.05 (p<0.05) a DMRT value of 0.000. Meanwhile, the difference in notation in the values in the table could show a noticeable difference between each factor that exists at a rate of 0.05. In this case, the concentration factor of acetic acid solution exerts a more noticeable influence on each sample than the treatment at various soaking times. This could be seen with the same notation at the soaking length of 4 hours and 6 hours at a concentration of 0.1%, which the notation indicated that between the two treatments did not exert a noticeable different influence on the whiteness degree of sago flour at a rate of the significance of 0.05.
The average whiteness degree score produced in this study is 91.81%. The results of the whiteness degree analysis were higher than the research conducted by [2], which obtained the highest whiteness degree value of 82.40%. Based on the quality requirements of sago flour [3], the whiter the colour of the sago, the better the sago. Colour becomes a reference for consumer preferences in choosing foodstuffs, both for primary and secondary products. As for sago, starch with whiteness colour is relatively preferred by consumers, while starch with dull colour and tend to brown is not a priority of consumer choice.

4.2. Water content
Water content is the content of water contained in foodstuff expressed in per cent. Water has a profound effect on the good or bad of foodstuffs and the stability of the material at the time of storage. If the moisture content of a material is too high, then its resistance at the time of storage will be low and can increase the risk of damage when stored. Therefore, The Indonesian National Standard issued a standard regarding the water content of sago flour, which was a maximum of 13%ww.

![Figure 2. The effect of soaking sago starch in acetic acid solvent against the water content of sago flour.](image)

Based on the results of the analysis shown by the diagram in figure 2, it could be obtained that the longer the soaking time and the higher the concentration of acetic acid solution, the higher the water content of sago flour. Because of the longer of soaking time, granules in sago starch become more inflated and able to absorb more water.

In addition, the increase in the value of water content could also be caused by the concentration of acetic acid solution. This was thought to be due to acid compounds hydrolyzing starch chains in the sago and caused starch chains to be reduced to shorter. Such conditions made sago starch easier to absorb water. This result was following research [1], which stated that the value of water content in breadfruit flour increased when given the treatment in the form of soaking with acetic acid solution, where the higher the concentration, the higher the water content value was also higher.

The drying process could also influence the difference in the value of water content. Drying temperatures could affect the rate of the decreased water content of materials where higher dryer air temperature will accelerate drying food to equilibrium water levels [4].

Data on ANOVA’s variety analysis of sago flour water content after soaking with an acetic acid solution is shown in table 3.

| Length of soaking time (T) | Concentration (K) | Average |
|---------------------------|-------------------|---------|
|                           | Control           | 0,1%    | 0,25%   |
| 2 hours                   | 10.50<sup>a</sup> | 10.50<sup>a</sup> | 11.50<sup>b,c</sup> | 10.83 |
| 4 hours                   | 10.50<sup>a</sup> | 10.77<sup>a</sup> | 11.50<sup>b,c</sup> | 10.92 |
| 6 hours                   | 11.00<sup>a,b</sup>| 11.00<sup>a,b</sup> | 12.00<sup>c</sup> | 11.33 |
Table 3 shows that soaking of sago starch with long variations in soaking and concentration of acetic acid solution significantly influenced sago flour water content at a rate of the significance of 0.05 (p<0.05). The highest water content value of sago flour was shown in the treatment of 6 hours soaking and concentration of 0.25%bb, which was 12%bb. Meanwhile, as indicated by the 2-hour soaking length treatment at all concentrations, the lowest water content obtained was 10.5%bb. Although the overall treatment exerted a significant influence, the analysis results also showed some notations that tended to be the same between several values on different factors. The difference in the classification of the notation indicated the location of the treatment that was able to have a significant influence on the water content of sago flour. Some of the treatments in question were at a concentration level of 0.1% with a soaking length of 4 hours and 6 hours and at a concentration of 0.25% with a soaking length of 4 hours and 6 hours.

Water has a profound effect on the good or bad of foodstuffs and the stability of the material at the time of storage. Based on the analysis results, the value of water content obtained in each treatment was below 13%ww. This indicated that the water content value obtained in this study qualifies for the quality of sago flour [3], which is a maximum of 13%ww.

4.3. Ash content
Ash content is a mixture of inorganic components or minerals found in a foodstuff. Organic materials in the combustion process will burn, but the inorganic components are not considered ash content. In addition to showing the mineral content of foodstuffs, ash levels can also show the purity and cleanliness of existing foodstuffs.

Based on the diagram in figure 3, it could be seen that the highest ash levels were shown in the 4-hour soaking length treatment and the concentration of 0.1% and 0.25%, which was 0.17%. Meanwhile, the lowest ash levels obtained were indicated by the 6-hour soaking length treatment at a concentration of 0.25%, which was 0.07%. Meanwhile, the average value of ash produced in each treatment was 0.12%. Meanwhile, the initial ash rate was 0.19%. This indicates that the value of ash levels obtained in this study qualified the quality of sago flour [3], which is a maximum of 0.5%.

![Figure 3](image-url)

**Figure 3.** The effect of soaking sago starch in acetic acid solvent against the ash content of sago flour.

Data from ANOVA analysis for sago flour ash levels after soaking with an acetic acid solution was shown in table 4.
Table 4. The results of ash content value of sago flour after soaking to acetate acids.

| Length of soaking time | Concentration (K) | Average |
|------------------------|-------------------|---------|
|                        | Control           | 0.1%    | 0.25%   |
| 2 hours                | 0.10<sup>a,b</sup> | 0.12<sup>a,b,c</sup> | 0.11<sup>a,b,c</sup> | 0.11 |
| 4 hours                | 0.12<sup>a,b,c</sup> | 0.17<sup>c</sup> | 0.16<sup>b,c</sup> | 0.15 |
| 6 hours                | 0.12<sup>a,b,c</sup> | 0.14<sup>c</sup> | 0.07<sup>a</sup> | 0.11 |
| Average                | 0.12             | 0.14    | 0.07    | 0.12 |

DMRT 5% 0.075

* Different notations show a real difference in α = 0.05.

Table 4 shows that the soaking of sago starch in acetic acid solution had no noticeable effect on sago flour ash content produced at a rate of the significance of 0.05 (p<0.05). This was thought to be due to acetic acid being used as one of the organic acids. So that during the process of acid, the content of acetic acid also burned along with the organic content and water on the sago. Therefore, whether soaked with an acetic acid solution or not, it would not affect the ash content of sago flour. This result was following research conducted by [5], which stated that acetic acid, an ingredient in his study, is an organic acid and did not contain minerals. At the time of ashes, it would be burned. The proportion of ash levels in foodstuff is generally influenced by several factors such as species, the state of soil nutrients, plant maturity, climate, area of growth, and age of sago cutting [2]. So the treatment with soaking of acetic acid would not have a noticeable effect on the ash content of sago flour.

4.4. Degree of acidity

The diagram in figure 4 can show the results of the analysis of the degree of acidity of sago flour. The analysis results showed that the higher the concentration of the acetic acid solution, the resulting pH is also lower; thus, the degree of acidity was also higher. Soaking sago flour at a concentration of 0% or water produces a sago pH of 7.41 which means it was alkaline. While in soaking with concentrations of 0.1% and 0.25% respectively by 6.57 and 6.39, which means acidic. This was following [1] that the higher the concentration of acetic acid used, the smaller the pH value.

![Figure 4](image_url)  
*Figure 4. The effect of soaking sago starch in acetic acid solvent against the degree of acidity of sago flour.*

The analysis results also showed the length of soaking, which had no significant effect on the degree of acidity of sago flour. The results of the analysis could also be seen in table 5. This was thought to be due to acetic acid being a weak acid when in water and was among the simplest forms of acid. So the pH value produced at each soaking length was not so significant. Following [6], acetic acid, commonly referred to as vinegar, was a weak acid compound.

Data from ANOVA analysis for the degree of acidity of sago flour against long variations in soaking and concentration of acetic acid is shown in table 5.
Table 5. The results of the degree of acidity value of sago flour after soaking to acetate acids.

| Length of soaking time (T) | Concentration (K) | Average |
|---------------------------|-------------------|---------|
|                           | Control           | 0.1%    | 0.25%  |         |
| 2 hours                   | 7.17<sup>c</sup>  | 6.63<sup>b</sup> | 6.40<sup>a</sup> | 6.73    |
| 4 hours                   | 7.43<sup>d</sup>  | 6.53<sup>b</sup> | 6.37<sup>a</sup> | 6.78    |
| 6 hours                   | 7.63<sup>e</sup>  | 6.53<sup>b</sup> | 6.40<sup>a</sup> | 6.86    |
| Average                   | 7.41              | 6.57    | 6.39    | 6.79    |

DMRT 5% 0.000

* Different notations show a real difference in α = 0.05.

Table 5 shows that soaking of sago starch with long variations in soaking and concentration of acetic acid solution significantly influenced the degree of acidity of sago flour produced at a level of significance of 0.05 (p<0.05). The analysis results also showed the same notation at each of the old soaking values at a concentration of 0.1% and a concentration of 0.25%. This indicated that the long treatment of soaking time had no significant effect on the degree of acidity of sago flour, especially at concentrations of 0.1% and 0.25%.

The analysis results produced in this study were an average pH value in each treatment given at 6.79. The lower the pH value, the higher the degree of acidity. The pH value below 7 indicates the acidity value of a material, while the pH value above 7 indicates the base value of an ingredient. Meanwhile, the limit of acidity degree value shown in [3] was a maximum of 4 mL NaOH. NaOH itself was one of the ingredients of alkaline acid titration that belongs to the classification of strong bases. Meanwhile, [7] in one of his books also argues about the quality standards of sago flour/starch for food and feed in international trade, where the specification of the pH value of sago flour for food was at least 5. This showed that the results of the analysis of acidity degree on sago quality standards both nationally and internationally.

5. Conclusion

Based on the results of research on the effect of soaking sago starch in acetate acids on the whiteness degree of sago flour, could be obtained several conclusions, including:

- Soaking sago flour with acetate acid treatment significantly influenced the quality of sago flour, including whiteness degrees, water content, and degree of acidity.
- Treatment with the best whiteness degree value was obtained at the length of soaking time of 6 hours with a concentration of 0.25%. Which, although the longer the soaking time and the higher the concentration of acetate acids used, then the higher the value of whiteness degrees obtained also higher, but some factors such as water content and degree of acidity in the material must also be considered to meet still the quality standards imposed.
- Soaking sago flour with varieties of the length of soaking time and concentration acetate acids on colour quality, water content, ash level, and degree of acidity in this study qualified the quality of sago flour based on the standardization of the quality of the prevailing sago flour.

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