Chemical characteristics of brownies substituted with sago starch and corn starch

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Abstract. Sago (Metroxylon sp) is a native plant to southeast Asia, and is one a food commodities that contain a lot of carbohydrates. Therefore, sago is used as a staple food for several regions in Indonesia such as Maluku and Irian Jaya. In the sago community, there is very little use of sago, even though sago can be used as raw material for making various products such as noodles, cakes, cookies, crackers and brownies. The study aimed to determine the effect of substitutions of sago starch and corn starch on the chemical properties of brownies. This study used factorial Completely Randomized Design which consisted of two factors. The first factor was the percentage of sago starch (S), which consisted of 3 levels, namely S1 = 50%, S2 = 75%, and S3 = 100%. The second factor was the concentration of corn starch (T) which consisted of 2 levels, namely T1 = 15% and T2 = 20%. The parameters observed were water content, ash content, fiber content, fat content, protein content, and carbohydrate content. The best treatment for chemical test is on the T2S2 treatment with the results of water content of 23.62%, ash content 2.14%, fiber content 3.46%, fat content of 23.95%, protein content of 3.36%, and carbohydrates 50.15%.

1. Introduction

Brownies is one kind of cake that has been well known in Indonesia and become a favorite of many people. Brownies come from America and have a high fat content. Brownies is a kind of solid chocolate cake and originally is a failed and hard dough. Brownies included in the type of family cake that is brown and does not inflate, but has an inner texture that is moist and the upper part is dry textured [8]. Brownies are one type of cake that is blackish brown with a little harder texture than the cake because brownies do not need a developer or gluten [2].

Brownies can be distinguished into two kinds, namely baked brownies and steamed. These brownies are differentiated based on brownies dough maturation method. Toasted brownies dough is made with roasting method while steamed brownie dough is swam with method of steam. Different methods give characteristic differences on the final product brownies [1]. The characteristic of Brownies produce a bantate product so that with the use of little or no material developers and the replacement of flour in addition to wheat flour will not cause a significant change in brownies characteristics.
The raw material for making brownies generally uses wheat flour. The use of wheat flour becomes one of food problems in Indonesia. Indonesia is one of the countries that has the dependency of wheat when the productivity of local food in some areas in Indonesia is quite high. Basically there is still food that can be used as alternative flour, which will be able to help reduce the dependence of wheat flour. The pronunciation of local foodstuffs such as sago starch and corn starch can be used as an alternative to replace wheat [9].

Sago is a food commodity that contains a lot of carbohydrates [7]. Stating that the largest component in sago starch is carbohydrate in the form of starch. Sago starch contains 73% amilopectin and 27% Amyc. High amilopectin content of sago starch does not allow use in the processing of wet products such as bread and cake, because high amilopectin provides sticky properties and harsh textures in the product [6]. Research on the manufacture of steamed brownies from modified sago flour has been done and produce the best steamed brownies on substitution 50% sago flour [11].

The substitution of wheat flour with nonwheat flour on semi-wet food will produce a more dense and hard texture therefore one of the alternatives that can be used to soften brownis kukus by Add corn starch in the manufacturing process [10]. Corn starch can increase the elasticity and soften the cake. Research is therefore necessary to know the influence of partial substitution of sago starch and corn starch to the characteristic brownis kukus produced [5].

2. Materials and Methods

2.1 Materials
The ingredients used in this study are sago starch, wheat flour low protein (Segitiga Biru) and corn starch (Meizena). Other ingredients used as additives are sugar, eggs, margarine, cocoa powder, chocolate bar, baking soda, emulsifier (TBM), vanilla, salt. The main equipments used in this research are mixers and ovens.

2.2 Methods
The method used by this research was a factorial Complete Randomized Design (CRD), consisted of two factors. The first factor was the percentage of sago starch and wheat (S), which consists of 3 levels of S1 = 50%: 50%, S2 = 25%: 75%, and S3 0:100%. The second factor was the concentration of corn starch (T) which consisted of 2 levels, namely T1 = 15% and T2 = 20%.

2.3 Data Analysis
To test the influence of each factor and the interaction between factors on the analysis parameters, statistical analysis was performed using ANOVA (Analysis of variance). If the treatment used exerted any influence on the tested parameters, then a further Duncan test was be performed.

2.4 The Process of Making Sago Starch Brownis
All ingredients used were weighed first, weighed a mixture of flour and sago starch of 1,800 gr for 18 units of experiment then mixed with flour and sago starch of 100 grams each in one experiment, with a ratio of S1: 50%: 50%, S2: 25% : 75%, S3: 0: 100%. Corn starch (15%, 20%). Sago starch, flour and corn starch are mixed first with 10 gr cocoa powder. 10 grams of chocolate bar melted together with 70 grams of margarine and 110 grams of sugar in the mixer for ± 5 minutes and added two eggs, 2 grams of vanilla, 1 gram of salt, 0.3 g of baking soda and one tablespoon of emulsifier and then mixed until fluffy ± 12 minutes. Then put in, sago starch, flour and cornstarch according to each treatment, then mixed until homogeneous ± 1 minute then poured the mixture into a baking sheet coated with baking paper, then flattened. Baked brownis dough in the oven at 175˚C for ± 30 minutes.

3. Results and Discussion

3.1 Water Content
Water content is one of the physical properties of the material which shows how much water is contained in the material. Water content is usually expressed as a percentage of water weight to wet
material or in grams of water for every 100 grams of material called wet basis water content. The weight of dry or solid material is the weight of the material after it has been heated for a certain amount of time so that the weight remains (constant).

Brownies water content obtained from the analysis results ranged from 17.301% - 23.615%. Overall average water content is 19.539%. The resulting water content is in accordance with the brownish quality standard based on SNI No. 01-3840-1995 i.e. the maximum water content of 40%. Data of variance results show that brownies water content in the treatment of addition of corn starch (T) has a significant effect (P > 0.05). While the effect of corn starch (T) raw material on water content can be seen in Figure 1.

There were significant differences in the two levels of corn starch concentrations that were tried. The water content contained in roasted brownies with 15% corn starch concentration contains lower water content (17.29%) compared to the water content at 20% concentration which is around 21.79%. This is because the number of hydroxyl groups in corn starch molecules is greater than in sago starch molecules so that the ability to absorb water is even greater. An increase in viscosity is caused by water that is in the granule and is free to move before the suspension is heated. After heating the granules are in the starch grains and cannot move freely. In addition, gelatinization temperature also affects water content. The thicker the solution, the slower the temperature is reached. Sago starch when heated is thicker than corn starch, causing the water content of sago starch brownies by the addition of corn starch more ability to absorb more water.

![Figure 1](image_url)

**Figure 1.** Effect of Corn Starch (T) concentration on sago brownies moisture content (DMRT₀.₀₅ = 3.91 and KK = 6.05% as well as different notations show a significant difference in each treatment).

### 3.2 Ash Content

Ash is the residue from burning an organic substance. Ash content is a mixture of inorganic or mineral components found in a food. Food consists of 96% organic matter and water. While the rest are mineral elements. The mineral element is also known as an inorganic substance, the ash content can indicate the total minerals in a food.

The results of the analysis showed that the influence of the use of sago starch 50: 50%, 25: 75%, 0 : 100% and the concentration of corn starch 15% and 20% had no significant effect (P > 0.05) on the content of sago brownish ash. The percentage of sago brownish ash content ranged from 2.108% to 3.750%. The phosphorus mineral content in sago and corn starchyes is equally high, namely 130% sago starch in 100 grams of material and 111% corn starch so that the ash content produced has no significant effect.
3.3 Fiber Content

Food fiber is a component of food that cannot be hydrolyzed by human digestive enzymes, but can still be hydrolyzed with acids or bases. Food fiber is a part of food derived from plants. This section generally belongs to a group of carbohydrates that cannot be digested and absorbed by the normal human digestive system. The chemical composition of various food fibers depends on the cell walls of the producing plants.

Based on the analysis of variance, the percentage of sago starch and corn starch concentrate did not have a significant effect (P> 0.05) on the content of sago brown fiber. This is presumably because the crude fiber content in sago itself is not too high, that is 0.55% in 100 grams of sago starch so that the fiber content produced in brownies has no significant effect. The percentage of crude fiber content obtained ranged from 3.042% to 5.359% with an overall average of 4.201%.

3.4 Fat Levels

Fat is a compound needed to maintain human survival, the role of fat is to provide energy of 9 calories / gram, can dissolve vitamins A, D, E, K and provide essential fatty acids for the human body. Fat began to be considered harmful to health after the existence of a study that showed a relationship between deaths from heart disease with the consumption of fat in the blood.

The results of the analysis of fat content in brownies made from sago starch using the overall soxhletation method ranged from 16.51% to 23.95% with an average of 20.28%. Fat content in brownies partially substituted using sago starch still meets the brownies standard set by the Ministry of Industry in the Indonesian National Standard (SNI. 01-2973-1992), which is a maximum of 26.93%. This shows that the fat content contained in brownies partially substituted with sago starch meets SNI requirements.

![Figure 2](image_url)

**Figure 2.** Relationship between the value of brownies fat content with the percentage of sago starch and with the interaction of different concentrations of corn starch at DMRT<sub>0.05</sub> level 1 = 16.51, level 2 = 18.24, level 3 = 18.99, level 4 = 21.56, level 5 = 22.44, level 6 = 23.95 and KK = 82.77% (Values followed by the same letter indicate no significant difference).

The results of variance showed that the concentration of corn starch (T), the percentage of sago starch (S) and the interaction of both (TS) had a significant effect (P≤0.05) on the level of brownies fat made from sago starch. Based on Figure 2, the content of brownies fat made from sago starch which has a concentration of corn starch as much as 15% did not show a significant difference to the ratio of the percentage of sago starch 50: 50%, 25: 75% and 0: 100% while at the concentration of corn starch 20% has a significant difference to the percentage of sago starch 25: 75%. The results showed that at the lowest percentage of sago starch tested, the fat content produced would also increase. The addition of corn starch concentration did not make
the fat content increase. This is due to the low fat content of corn starch which is around 1.0%. According to Hajiana (2018), the use of more flour in the brownies processing will cause an increase in fat content does not show a real difference between treatments.

3.5 Protein Content

Protein is an essential nutrient for the body, as it acts as a fuel in the body as well as a constituent and regulator. Proteins are a source of amino acids containing elements C, H, O, and N that are not rich in fat or carbohydrates. Protein molecules contain phosphorus, sulfur, and some types of proteins that contain metal elements such as iron and copper.

![Figure 3. Effect of cornstarch concentration treatment (T) to the level protein of brownies. DMRT<sub>0.05</sub> level 1 = 2.84 and the level 2 = 4.00 and KK = 49.88% (different notation indicates there is a noticeable difference in each treatment).](image)

The results of the analysis of protein content in brownies made from sago starch as a whole ranged from 2.029% to 4.638% with an average of 3.420%. The results of variance showed that the concentration of corn starch (T) had a significant effect (P≤0.05) on the level of protein brownies made from sago starch while the percentage of sago starch (S) and the interaction of both (TS) gave no significant effect. Based on research by Imanningsih (2012), the protein content of corn starch was higher at 8.4% - 9.22% compared to tapioca flour with protein content of 6.98% while sago starch had a protein content of 1.9%.

3.6 Carbohydrate Contents

Carbohydrates are substances that serve as the main source of calories for almost all the world's population. Besides its function as a cheap source of calories, the presence of carbohydrates in food can determine the taste, color, texture and appearance of food.

The results of the analysis of carbohydrate content in brownies made from sago starch as a whole ranged from 50.152% to 58.523% with an average of 54.664%. The results of variance showed that the interaction of sago starch and cornstarch concentration had a significant effect (P≤0.05) on the level of carbohydrate brownies based on sago starch.

Based on Figure 4, the test of carbohydrate content in brownies made from sago starch which has a concentration of corn starch of 15% and 20% does not have a significant difference to the ratio of the percentage of sago starch and flour to 50: 50%, 25: 75% and 0: 100%. It is thought that the carbohydrate content in sago starch is high and carbohydrate content is added to wheat flour and corn starch so that no difference is seen between all treatments. This is in accordance S sago starch is one source of carbohydrate, the amount of carbohydrate and chemical content of every 100 grams of sago starch is as much as 94%, whereas in wheat carbohydrate content in 100 grams of wheat flour is 73% and carbohydrate content in corn starch in 100 grams which is 22.8%. Sago starch has the highest
carbohydrate content compared to several other types of starch such as tapioca, rice, wheat and corn [3].

![Figure 4. Relationship between the value of brownies carbohydrate content with the percentage of sago starch and with the interaction of different concentrations of corn starch at DMRT_0.05 level 1 = 50.152, level 2 = 53.264, level 3 = 53.668, level 4 = 55.361, level 5 = 56.894, level 6 = 58.523 and KK = 50.945% (values followed by the same letter indicate no significant difference).](image)

4. Conclusion

Brownies resulting from sago starch substitutions and corn starch affect real influence on carbohydrate levels. The higher the ratio of corn starch used then the higher the fat levels are produced. Adding higher concentrations of corn starch will increase the water content or the brownies so that the texture will be soft.

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