Physicochemical quality of biscuits in various compositions of wheat flour, dangke flour and sago flour

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Abstract. Biscuits are processed food products made from flour; however, the supply of the flour depends heavily on foreign producers. This study aimed to examine the use of dangke flour and sago flour to substitute wheat flour in biscuit formulations. The design used was a completely randomized design (CRD) of one factor. The treatments of the compositions of wheat flour, dangke flour, and sago flour (%) in the biscuit formulation were 100: 0: 0; 80: 20: 0; 60:30:10; 40:40:20; 20:50:30; and 0:60:40 respectively. The results showed that the compositions of wheat flour, dangke flour, and sago flour had very significant effects (p<0.01) on water content, dissolved protein, aroma, texture and preference but had no significant effects on yield and biscuit fat. The best composition of wheat flour, dangke flour and sago flour was 0:60:40 in the formulation. The produced biscuits had a yield of 84.16%, a moisture content of 1.96%, dissolved protein of 19.26%, fat content of 9.55%, flavor of 6.18%, texture of 6.25% and preference of 6.02%.

1. Introduction
Biscuits are snacks that are much in demand by the public. Most biscuits are made from wheat flour, and this flour is an imported product so that its supply depends heavily on foreign producers. Based on the data from the Indonesian Flour Producers Association (Aptindo) for the period of January-June 2016, Indonesia's total wheat imports amounted to 97.349 tons with a value of 28.22 million US $. The relatively high carbohydrate content often constrains the consumption of biscuits because it is associated with obesity and diabetes.

Dangke is fresh Indonesian cheese that is rich in protein, fat and vitamins. The shelf life of dangke is relatively short so that it needs to be further processed into a more durable product. The use of dangke in biscuit products can increase its usefulness as a food source of nutrition and is preferred by the community. Despite having high protein content, the properties of dangke functionality needed in processing may have decreased due to the heating process during processing. Dangke applications in biscuit products need to be combined with other ingredients such as sago that can improve the elasticity and crispness of the products.

Sago is an Indonesian local food ingredient that has a reasonably high availability. Sago flour has relatively low protein and fat content and high carbohydrate content. High sago amylpectin content makes it potentially to be added to the biscuit formulation, because it can improve the elasticity of the dough which has implications for the crispness of the biscuit products. Indonesia's sago production in 2016 amounted to 440.516 tons and increased by 489.643 tons in 2017. The largest sago producing
provinces included Riau, Papua and Maluku, and South Sulawesi itself was also included as a province that produced sago reaching which 2,599 tons in 2016 and 2,626 in 2017 [1]

This study aimed to examine the effect of the composition of wheat flour, dangke flour and sago flour on the physicochemical and organoleptic quality of biscuits and to determine the best composition of wheat flour, dangke flour and sago flour in the biscuit formulation. This research is expected to be a reference for local product development, as well as to increase the utilization of dangke and sago.

2. Materials and Methods

2.1. Production of biscuits

Biscuit production using dangke flour and sago flour with procedure the drying of dangke was conducted using a cabinet dryer at 65°C for 4 hours and continued at 50°C for 2 hours. Before being dried, the dangke was thinly sliced to the size of 5 mm, and the dried dangke was ground with a blender and sieved with a sieve of 60 mash. The drying of sago was carried out a using cabinet dryer at 65°C for 4 hours, and after that the dried sago was ground and sieved with a sieve of 60 mash. The procedures for making biscuits shown in figure 1.

2.2. Research Design

This study used a completely randomized design (CRD) of one factor. The composition of wheat flour, dangke flour, and sago flour in biscuit formulation repeated three times. The treatment of the composition of flour, dangke flour and sago flour (%): P0 (100: 0: 0); P1 (80: 20: 0); P2 (60: 30: 10); P3 (40: 40: 20); P4 (20: 50: 30); P5 (0: 60: 40).

2.3. Parameter Measurement

2.3.1. Yield. The yield value was measured by comparing the weight of the biscuit after it was baked with the weight of the dough.

2.3.2. Water content, protein, and fat. The measurement of water content, protein, and fat was conducted by the AOAC Method [2]
2.3.3. Organoleptic quality. The organoleptic testing was carried out on the quality of aroma, texture, and general preference for biscuits using 15 semi-trained panelists and repeated three times. The organoleptic quality was expressed with a score as in Table 1.

| Scores | Flavor Description | Texture Description | Preference Description |
|--------|--------------------|---------------------|------------------------|
| 1      | Having no strong milk flavor | Strongly not crispy | Strongly dislike |
| 2      | Having no milk flavor | Not crispy | Dislike |
| 3      | Having almost no milk flavor | Fairly not crispy | Fairly dislike |
| 4      | Having neutral flavor | Neutral | Neutral |
| 5      | Having slight milk flavor | Fairly crispy | Fairly like |
| 6      | Having milk flavor | Crispy | Like |
| 7      | Having strong milk flavor | Strongly crispy | Strongly like |

2.3.4. Statistical analysis. The data from the measurement results of the parameters were analyzed by variance of CRD of one factor with 3 replications, using the SPSS 0.01 program. However, the data on fat content were analyzed descriptively. The treatments that had real and very significant effects were continued by Duncan's further test.

3. Results and Discussion

3.1. Physicochemical Characteristics
The values of the yield, water content, dissolved protein, and fat content of biscuits obtained from various compositions of wheat flour, dangke flour, and sago flour can be seen in Table 2.

| Treatment | Yield (%) | Water content (%) | Dissolved protein (%) | Fat content (%) |
|-----------|-----------|-------------------|-----------------------|----------------|
| P0        | 84.33±3.32| 5.04±0.55         | 10.26±0.11            | 5.32           |
| P1        | 84.16±3.21| 5.3±0.54          | 10.83±0.7             | 6.38           |
| P2        | 84.50±3.77| 4.69±0.79         | 10.16±0.58            | 7.37           |
| P3        | 84.00±0.86| 3.08±0.16         | 10.26±0.63            | 7.75           |
| P4        | 84.66±0.57| 2.55±0.07         | 10.36±0.05            | 8.32           |
| P5        | 84.16±0.76| 1.96±0.54         | 19.26±0.32            | 9.55           |
| Average   | 84.30±2.08| 3.77±0.44         | 11.85±0.39            | 7.44           |

Note: the average values followed by different superscripts in the same column show very significant differences (p<0.01); the wheat flour composition: dangke flour: sago flour = P0 (100%:0%:0%), P1(80%:20%:0%), P2(60%:30%:10%), P3 (40%:40%:20%), P4(20%:50%:30%), P5(0%:60%:40%)

The treatments of the composition of wheat flour, dangke flour and sago flour on the yield of biscuits had no significant effects. This is likely because the total ingredients in making biscuits were relatively the same. Yield can be used to find out the shrinkage or increase in weight/volume after processing. In Table 2, the average value of the yield of biscuits was 84.30%, and this result is in line with [3] in which the formulation of biscuit material from the African catfish flour and soy protein isolates produced a yield value of 84.29%. The research by [4] produced biscuits with a yield of 86.8% with pumpkin flour and catfish flour. The yield of biscuits produced is relatively high because only 15.30% of the dough shrinks after 30 minutes of oven baking.

The composition of wheat flour, dangke flour, and sago flour in the formulation of biscuits had a significant effect (p<0.01) on the moisture content of biscuits. Duncan's further test results in table 2
show that there were no significant differences on the water content values in the treatments of P0, P1 and P2; however, there was a very significant difference in the P3 treatment. There were also no differences between the P3 and P4 treatments as well as the P4 and P5 treatments. The results obtained show that the water content decreased with the decreasing level of wheat flour and increasing levels of dangke flour and sago flour. Decreased water content can be caused by the binding power of water of the wheat flour higher than that of the dangke flour and sago flour both at the time of kneading and baking the products. The protein content of wheat flour used was 13%, so it is included in the category of wheat flour with high water binding capacity. The results obtained are in line with the research of [5] concerning the manufacture of bread substituting wheat flour with sago starch which showed a decrease in water content with the decreasing level of wheat flour and the increasing level of sago starch.

Based on the quality requirement of biscuits [6], the maximum moisture content of biscuits is 5%; therefore, the treatments of P0 (100%: 0%: 0%) and P1 (80%: 20%: 0%) did not meet the requirements because of the average value the water content was 5.17%. The values of water content that exceeded 5% in the two treatments were caused by the high level of flour in both treatments. Low water content can cause biscuits to have a burnt taste and darker color, and if the value of the water content is high, the texture of the biscuits is not crunchy and can be broken (checking), and flavor changes faster during storage [7].

The treatment of compositions of wheat flour, dangke flour and sago flour had a very significant effect (p<0.01) on the protein solubility of biscuit dough. Duncan's further test results in Table 2 show that the P5 treatment had higher protein solubility compared to that of the P0, P1, P2, P3 and P4 treatments. This is because the level of dangke flour in the formulation of biscuits was high resulting in the increasing solubility of the protein. The results obtained suggest that the increasing levels of dangke flour and sago flour cause protein solubility to increase. This was due to the low protein solubility of wheat flour was low whereas the protein solubility of dangke flour was high. Milk protein is more soluble than proteins from other sources. The research by [8] regarding the manufacture of fermented cassava flour produced the dissolved protein levels of 5.12% - 11.89%.

The fat content of biscuits in this study was measured only once so that the discussion was done descriptively. Table 2 shows the higher addition of dangke flour and sago flour caused the increase of the fat percentage of the biscuits, and this is caused by dangke flour which has high fat content. The fat contents of each dangke flour, wheat flour and sago flour were 13.79%, 2% and 0.81% respectively. The biscuit formulation that fulfills the requirement for fat content was P5 treatment i.e. 9.55%. The biscuit fat standard according to SNI [6] is a minimum of 9.5%. [9] stated that full fat fresh cheese generally has a fat content of 24.5%, while low fat cheese contains fat of 7.3%, indicating that the biscuits produced can be grouped into low-fat biscuits.

3.2. Sensory Characteristics
The composition of wheat flour, dangke flour and sago flour in the formulation of biscuits had a very significant effect (p<0.01) on their aroma. Duncan's further test results in Table 3 show that there was no difference in the aroma of biscuits between the treatments of P0, P1, P2 and P3, and P1 and P4, whereas P5 was different from the other treatments. The results obtained show a reduction in the level of wheat flour and an increase in dangke flour and sago flour will increase the aroma of milk in biscuits. The aroma of milk emerged during the roasting process due to the volatile compounds found in the evaporating materials; in addition, the aroma of biscuits can also be caused by various other components such as margarine and sugar.

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### Table 3. Characteristics of biscuit sensors.

| Treatment | Aroma    | Texture | Preference |
|-----------|----------|---------|------------|
| P0        | 4.93±0.49<sup>a</sup> | 2.41±0.69<sup>a</sup> | 4.82±0.67<sup>a</sup> |
| P1        | 5.25±0.55<sup>ab</sup> | 5.02±0.77<sup>b</sup> | 4.96±0.76<sup>ab</sup> |
| P2        | 5.04±0.74<sup>a</sup> | 5.20±0.51<sup>b</sup> | 4.95±0.59<sup>ab</sup> |
| P3        | 4.97±0.45<sup>a</sup> | 5.31±0.47<sup>b</sup> | 5.31±0.49<sup>ab</sup> |
| P4        | 5.53±0.68<sup>b</sup> | 6.12±0.45<sup>c</sup> | 6.23±0.41<sup>c</sup> |
| P5        | 6.18±0.76<sup>c</sup> | 6.25±0.48<sup>c</sup> | 6.02±0.47<sup>c</sup> |
| Average   | 5.31±0.61<sup></sup> | 4.21±0.56<sup></sup> | 5.38±0.56<sup></sup> |

Note: <sup>a,b</sup>) the average values followed by different superscripts in the same column show very significant differences (p<0.01); organoleptic scores of 1 and 7 indicate from not very good to very good; the wheat flour composition: dangke flour: sago flour = P0 (100%:0%:0%), P1 (80%:20%:0%), P2 (60%:30%:10%), P3 (40%:40%:20%), P4 (20%:50%:30%), P5 (0%:60%:40%)

The treatment of the composition of the wheat flour, dangke flour and sago flour in the formulation of biscuits had a very significant effect (P <0.01) on the biscuit texture. Duncan's further test results in Table 3 show that the P0 treatment was different from the P1 treatment, P2 treatment was different from that of P3, and P4 treatment was also different from that of P5 treatment. The higher levels of dangke flour and sago flour in the formulation produced increasingly crispy biscuits. This is because sago flour has high levels of amylose and amylopectin, thus making the biscuits crispy. Hisajima [10] states that sago flour contains 27% amylose and 73% amylopectin. Comparison of amylose and amylopectin will affect the solubility and degree of starch gelatinization. The average biscuit texture score produced in this study was 4.21 (neutral). From the observation by [11] on the crispness of biscuits from flour composite, tacca tuber starch, tapioca, barley sago and corn starch, the values obtained were between 4.18 and 4.75 with the highest value in the treatment of wheat flour and sago starch of 4.75. The biscuit texture produced was less crispy possibly due to the high protein content by the addition of dangke flour.

The treatment of composition of flour, dangke flour and sago flour in the formulation of biscuits had a very significant effect (p<0.01) on biscuit preference. Duncan's further test results in table 3 show that the treatments of P0, P1 and P2 are the same, the treatments P1, P2 and P3 are the same, and the treatments of P4 and P5 are also the same. The results obtained indicate a reduction in the level of wheat flour and an increase in dangke flour and sago flour will increase biscuit preference. The average score of favorite biscuits produced in this study was approximately 5.38 (like). The result of the research by [12] showed the average value of the panellists’ preference for cake made from sago flour and danke flour ranged from 3.66 to 4.26 (like). This means that biscuits made with sago flour and dangke flour have a higher level of preference.

### 4. Conclusion

Increasing the level of dangke flour and sago flour to substitute wheat flour in the formulation of biscuits will increase the solubility of protein, aroma, texture and likeness and reduce water content. The combination of 60% dangke flour and 40% sago flour can be used to substitute flour for making biscuits.

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