Utilization of orange fleshed sweet potato flour, starch and residual flour in biscuits making

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Abstract. Orange-fleshed sweet potato (OFSP) is one type of sweet potatoes that is in great demand as it has attractive colour, high starch and fibre content, and excellent source of strong antioxidants, provide health beneficial effect. In this study, OFSP was processed into flour, starch, and residual flour from OFSP starch processing and they were used as ingredients for making biscuits to substitute the wheat flour. Ratios of wheat flour: OFSP flour: OFSP starch: residual flour were 85:5:5:5; 70:10:10:10; 55:15:15:15; and 40:20:20:20. The resulting biscuits were analysed for their textural property and sensory quality. The results showed the ratio of wheat flour, OFSP flour, starch and residual flour significantly affected the textural property and quality of sensory biscuits produced. Biscuits with the formula ratio of 55% wheat flour, and 15% OFSP flour, 15% OFSP starch and 15% OFSP residual flour had good textural properties and can also be accepted by consumers.

1. Introduction

Today, bakery products such as biscuits, breads, cakes, and pastries are becoming more important part of our daily diet. Biscuit can be described as a dry bakery product made mainly from wheat flour, oil/fat, with or without addition of other food ingredients by several of process such as involving mixing, sheeting, kneading, cutting, and also baking [1]. At least once a day, 13.4% of Indonesian people consume biscuits [2]. The increasing of biscuits consumption has an impact on increasing of wheat imports, because Indonesia as a tropical country has a climate that is not suitable for wheat growth.

Sweet potato is a food commodity that ranks 6th of important food commodities. Sweet potatoes can be used as staple foods, because it contains high carbohydrates, in addition to the content of vitamins A and minerals such as Ca and Fe also be the excess of sweet potato. Fresh sweet potatoes contain 80-90% carbohydrate of tuber dry weight and 50-80% of them in starch form. Another feature of sweet potatoes is the sugar content is high enough to provide a higher sweetness compared with other carbohydrate sources [3].

There are various types of sweet potatoes, ranging from shapes, skin colour, and tuber fleshed. The most common types are white, red, purple, yellow or orange sweet potatoes, which can also cause differences in the carotenoids content, since it is considered a source of beta carotene (pro vitamin A), as well as antioxidants, fibres, minerals, and vitamins [4], and be able to add the natural sweeteners,
colour, and flavour on food products [3]. The carotenoids contents in sweet potato of orange or yellowish-white pulp range from <0.05 to 265 µg/g [5].

The processing of sweet potato into flour and starch were identified as among of most promising option for sweet potato products [5]. The substitution of sweet potato flour and starch have been used to replace wheat flour in making various food products, including cakes [6,7,8], noodles [9], cookies [10], bread [11] and biscuits [12,13,14].

The processing of sweet potato into starch generates by products which is currently very limited in use. The solid residue produced from the starch extraction process contains the rich of fibre, which can be recovered by several processes including a milling and sieving process to produce dietary fibre [15,16]. Thus, the aim this research was to study the effect of ratio of orange fleshed sweet potato (OFSP) flour, starch, and residual flour on the sensory characteristics and physicochemical of biscuits.

2. Materials and methods

2.1. Materials
The materials used were orange fleshed sweet potato purchased from farmer in Phak Phak Barat Residence, North Sumatera Province, Indonesia. The ingredient for biscuits making including sugar, salt, baking powder, margarine, and wheat flour were obtained from the local market in Medan, North Sumatera.

2.2. Preparation of OFSP flour
OFSP tubers are sorted to select the tubers with uniform size, shape and colour. The tubers were washed, peeled and directly sliced with a thickness of ± 2 mm slices using a slicer machine to obtain sweet potato chips. The sweet potato chips are further dipped in sodium metabisulphite with concentration of 2000 ppm and then dried with drying oven at 55 °C for 12 hours until the chips become dry. The dried chips are crushed with a disc mill and sieved using a mechanical sizing device of 80 mesh. The resulting sweet potato flour is packaged in polyethylene plastic packaging before used.

2.3. Preparation of OFSP starch and residual flour
The OFSP starch extraction was carried out as described by Vasanthan [17] with slight modification. OFSP tubers were cleaned and peeled manually with stainless steel knife, shredded with a mechanical grater, blended with solution of sodium metabisulphite 2000 ppm in the ratio of 1: 3 (w / v) was added until smooth slurry was formed. The slurry was squeezed and filtered by using double-layered cheesecloth. The filtrate was collected and settled for 3 hours, so the liquid (supernatant) and starch were obtained. The starch was washed until the transparent colour appeared in water. Starch was dried using oven at 50 °C about 12 hours. This dried starch was milled again with a blender and filtered with a size of 80 mesh sieve.

Solid fraction after starch extraction process contains the rich in fibre which can be recovered by a milling and sieving process to produce dietary fibre [15]. In this study, the solid residue from starch extraction was dried in oven at 60 °C for 16 hours and then dry fibres were milled with a disc mill, sieved with a 60 mesh of mechanical sieve so that it can produce residual flour.

2.4. Making biscuits
The biscuit was made by mixing wheat flour, orange fleshed sweet potato flour, starch, and residual flour according to the treatment. The other ingredients were weighed and prepared accurately as the formula in Table 1. Wheat flour, OFSP flour, starch, and residual flour were mixed with other dry ingredients such as salt and baking powder to obtain a homogeneous mixture. Shortening and sugar were stirred to form a cream using a mixer. The dry ingredients mixture was put into the cream mixture and stirred slowly with addition of water to prepare dough. The dough was then formed into sheets using a rolling pin with a thickness of 3 mm, and shaped in a circle shape with a diameter of 4 cm, placed on margarine coated tray and were kept for baking. Baking was done in a preheated oven with the
temperature of 165 °C for 20 minutes. After baking, biscuits were cooled to room temperature for 30 minutes, then put in an airtight jar.

**Table 1.** Ingredient and blending ratio from wheat flour, orange fleshed sweet potato (OFSP) flour, starch and residual flour formulation

| Ingredients                  | P1  | P2  | P3  | P4  |
|------------------------------|-----|-----|-----|-----|
| Wheat Flour (g)              | 85  | 70  | 55  | 40  |
| OFSP Flour (g)               | 5   | 10  | 15  | 20  |
| OFSP Starch (g)              | 5   | 10  | 15  | 20  |
| OFSP Residual Flour (g)      | 5   | 10  | 15  | 20  |
| Baking powder (g)            | 1.5 | 1.5 | 1.5 | 1.5 |
| Salt (g)                     | 0.5 | 0.5 | 0.5 | 0.5 |
| Sugar (g)                    | 30  | 30  | 30  | 30  |
| Shortening (g)               | 50  | 50  | 50  | 50  |
| Water (ml)                   | 40  | 30  | 30  | 40  |

2.5. **Biscuit quality analysis**

The result of biscuits was analysed for their specific volume using seed replacement test according to the approve method by AACC [18]. The texture of biscuit was analysed by using a Brookfield CT-3 Texture Analyser, parameter that was analysed are adhesiveness, hardness and % deformation.

The sensory quality was analysed by 70 not trained panellists both genders. Biscuits were cracked into quarter and identified by a three digits random number. The sample was offered to the panellists on a white plate at room temperature, and panellists evaluate the sensory properties of biscuits on the basis of colour, taste, texture, flavour, and overall acceptability with using 7-point hedonic scale (dislike extremely=1, dislike=2, rather dislike=3, neither like nor dislike=4, rather like=5, like=6, like extremely=7)

2.6. **Statistical analysis**

Study was performed by using a randomized completely design and data were obtained from 3 measurements per observation. The results were evaluated by calculating means, standard deviations, and analysis of variance (ANOVA). Analysis of statistical was performed using software SPSS ver.22 for windows. Samples with statistical different were determined significance levels with mean separation by Least Significant Ranges (LSR) method (p<0.05).

3. **Results and discussion**

3.1. **Specific volume of biscuits**

The specific volume of biscuits based on OFSP flour, starch, residual flour and wheat flour with the different ratios was affected significantly (Figure 1). Increasing substitution of wheat flour with OFSP flour, starch, and residual flour will reduce significantly affect (p<0.05) the specific volume of biscuits. Biscuit made by replacing 30% of wheat flour with 10% OFSP flour, 10% OFSP starch, and 10% residual flour has a specific volume that not different significantly affect (p>0.05) with biscuit made from 85% wheat flour. The decreasing of specific volume as increasing of wheat flour substituted is caused by the decreasing of gluten content in dough and causes the product not to expand [20]. This is also caused by fibre in residual flour and OFSP flour which may interfere the matrix structure and decrease the gas retention capacity in dough [21].
Figure 1. Effect of treatment on specific volume of biscuits (treatments were ratios of wheat flour: OFSP flour: OFSP starch: residual flour namely 85:5:5:5 (P1); 70:10:10:10 (P2); 55:15:15:15 (P3); and 40:20:20:20 (P4))

3.2. Textural properties of biscuits

The effect of flour ratio in making biscuits was shown in Table 2. Varying the wheat flour substituted by OFSP flour, starch, and residual flour changed the hardness and % deformation of biscuits significantly affect (p<0.05), but there is no significant difference (p>0.05) in adhesiveness of biscuits as affected by wheat flour substitution. The hardness increased significantly from 478.00 to 620.67 in dough prepared from 85% of wheat flour to 40% wheat flour and 20% each of OFSP flour, starch, and residual flour. The specific volume is the best index to described the texture of biscuits. The lower of specific volume will increase the hardness of biscuits [22]. Table 2 shows that the highest adhesiveness value is found in P4 biscuits (60% substitution of wheat flour). A similar trend was found in previous study [23]. The % deformation of biscuits increase with the increasing substitution of wheat flour, and increasing of fibre will increase the deformation of biscuits. The deformation was in conformity to the hardness value, since hardness was defined as the force needed to attain a given deformation [24]. Textural quality is one of the most important attribute of desirable quality for biscuit product [25].

### Table 2. Effect of wheat flour, OFSP flour, starch, and residual flour on the textural properties of biscuits

| Parameter          | Ratio of wheat flour: OFSP Flour: OFSP Starch: OFSP Residual Flour (P) |
|--------------------|------------------------------------------------------------------------|
|                    | P1 = 85:5:5:5 | P2 = 70:10:10:10 | P3 = 55:15:15:15 | P4 = 40:20:20:20 |
| Hardness (g)       | 478.00±16.04c | 562.17±10.75b | 581.33±11.25a | 620.67±11.77a |
| Adhesiveness (gs)  | 0.24±0.02    | 0.27±0.01 | 0.28±0.01 | 0.30±0.03 |
| Deformation (%)    | 19.18±0.44d  | 20.32±0.38c | 21.68±0.78b | 23.38±0.31a |

Description: Testing is done 3 replicates, the sign (±) shows the standard deviation value. The value denoted by different letter in the same row is significantly different (p<0.05)

3.3. Sensory quality of biscuits

The Table 3 shows that there were significant differences in sensory attributes of biscuits as affected by ratio of wheat flour, OFSP flour, starch, and residual flour. It can be seen that the biscuits made by replacing 45% wheat flour with 15% each of OFSP flour, starch and residual flour was the best regarding all sensory attributes including colour, flavour, taste, texture, and overall acceptability. The sensory attributes score is increase from 15% substitution of wheat flour to those in 45% substitution, but at 60% substitution, the sensory attributes score will decrease. The results from the sensory evaluation scores by the panellists, showed that the score of biscuits ranged in 5-6 which depicted that the panellists give the score is between rather like until like.
Table 3. Effect of wheat flour, OFSP flour, starch, and residual flour on the sensory quality of biscuits

| Parameter | Ratio of wheat flour: OFSP Flour: OFSP Starch: OFSP Residual Flour (P) |
|-----------|---------------------------------------------------------------------|
|           | P1 = 85:5:5:5 | P2= 70:10:10:10 | P3 = 55:15:15:15 | P4= 40:20:20:20 |
| Colour    | 4.881±0.030b | 5.162±0.198ab | 5.405±0.008a | 5.267±0.188a |
| Flavour   | 5.176±0.087b | 5.331±0.123ab | 5.605±0.067a | 5.405±0.008a |
| Taste     | 5.157±0.099b | 5.352±0.095b  | 5.591±0.044a | 5.271±0.087b |
| Texture   | 5.1190±0.293ab| 5.267±0.084b | 5.771±0.100b | 5.467±0.017ab |
| Overall   | 5.290±0.229b | 5.457±0.029ab | 5.619±0.046a | 5.590±0.022a |

Acceptability

Description: Testing is done 3 replicates, the sign (±) shows the standard deviation value. The value denoted by different letter in the same row is significantly different (p<0.05)

4. Conclusion
Making process of orange fleshed sweet potato (OFSP) into flour and starch increased its added value, and may be a promising alternative as wheat flour substitution in food products. The solid waste fraction from OFSP starch processing can be recovered by several process include a drying, milling and sieving process to produce residual flour, at it also can be used as fibre rich ingredient in biscuits making. The research was found that the orange fleshed sweet potato (OFSP) flour, starch and also residual flour from processing of OFSP starch in combination with wheat flour was success to produce the acceptable biscuits. Based on sensory properties, wheat flour replacement with 15% OFSP flour, 15% OFSP starch and 15% OFSP residual flour yielded good quality biscuit.

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