Physicochemical and sensory characteristics of sweet bun produced from wheat and purple sweet potato flour

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Abstract. This study was carried out to investigate the physicochemical and sensory characteristics of sweet bun as affected by the ratio of wheat flour (WF) and purple sweet potato flour (PSPF). Six samples of breads were made from WF and PSPF in various ratio namely P₁ (100% wheat flour), P₂ (80:20), P₃ (60:40), P₄ (40:60), P₅ (20:80), and P₆ (100% PSP flour). The results showed that the ratio of WF and PSPF had significant effect (P < 0.05) on the colour value (L, a, b, and hue), browning index, specific volume, texture, anthocyanin content, crude fibre content and organoleptic value of sweet bun. The sweet bun that most acceptable by consumers was produced from 60% WF and 40% PSPF.

1. Introduction

Sweet potato is one of carbohydrate sources since it contains 25-30% carbohydrate which is higher than other tuber crops and 98% is easy to digest [1]. In addition, sweet potatoes are also good sources of important nutrition such as dietary fibre and micronutrient including anthocyanin, vitamin C, vitamin B1, vitamin B2, and various mineral [1,2,3]. The unique phytoneutrient such as batatins, batatosides and sporamins (storage protein) with unique antioxidant activity in sweet potatoes makes it potentially used as ingredients for functional food [4].

Based on the difference in colour of tuber fleshed, sweet potatoes are divided into white, red, purple, and orange sweet potatoes. Purple sweet potato (PSP) has attracted much attention because its nutritional value and heat stability of its colour with associated with its anthocyanin content [5,6]. These components can contribute to the nutritional properties especially starch and dietary fibre, colour and flavour of food products. Anthocyanin has antioxidant antimutagenic, hepatoprotective, antihypertensive and antihyperglycemic activities [7]. PSP can also used to reduce the amount of sugar in food products so it can be consumed by people who are in a sugar diet such as diabetes patient [8].

PSP has a short shelf life and is easily damaged due to its high water content, therefore it must be processed into semi-finished products such as flour (PSPF) or starch. PSPF has high shelf life due to low flour moisture content, easy to be processed into a variety of products, such as cakes [9,10], noodles [11], cookies [12], biscuits [13], and breads [14,15]. In developing functional bread product, in this study PSPF was used to substitute a partial of wheat flour to produce sweet bun with attractive colour and rich in anthocyanin and fibre. Thus, the purpose of this research was to study the physicochemical and sensory characteristics of sweet bun made from wheat flour and PSPF with various ratio.
2. Material and methods

2.1. Preparation of PSPF
PSP were obtained at harvest from a grower in Pakpak Bharat, Sumatera Utara. PSP were cleaned, peeled, and thinly sliced (2 mm thickness) and soaked in 2000 ppm sodium metabisulphite solution for 15 minutes. Tread slices were washed and dried in drying oven with 55 °C temperature for 18 hours. The dried slices were milled thinly (2 mm thickness) and soaked in 300 ppm sodium metabisulphite solution. The ratio of WF and PSPF was written in Table 1. The blend of WF and PSPF and all ingredients were taken in a bowl and mixed at high speed with the stand mixer for 10 minutes. The mixture was cut off into pieces, weighed, held into tray and allowed to stand for 1 hour at room temperature for better development. The tray contains sweet bun dough were baked at 165 ºC for 25 minutes. After baking, the sweet bun were left for 30 minutes and stored in to container before analysis.

2.2. Preparation sweet bun
The methods recommend by Hardoko et al. [16] with some modification was used. The ratio of WF and PSPF was written in the Table 1. Sample were weighed based on 100 g of flour and the ingredient for each bread were shown in Table 1. The blend of WF and PSPF and all ingredients were taken in a bowl and mixed at high speed with the stand mixer for 10 minutes. The mixture was cut off into pieces, weighed, held into tray and allowed to stand for 1 hour at room temperature for better development. The tray contains sweet bun dough were baked at 165 °C for 25 minutes. After baking, the sweet bun were left for 30 minutes and stored in to container before analysis.

Table 1. Ingredient used in various treatment of sweet bun

| Ingredient (g)                | Treatment   |
|------------------------------|-------------|
|                              | P1  | P2  | P3  | P4  | P5  | P6  |
| Wheat flour/WF (g)           | 100 | 80  | 60  | 40  | 20  | 0   |
| Purple sweet potato flour/PSPF (g) | 0   | 20  | 40  | 60  | 80  | 100 |
| Full cream liquid milk (mL)  | 70  | 70  | 70  | 70  | 70  | 70  |
| Sugar (g)                    | 30  | 30  | 30  | 30  | 30  | 30  |
| Instant yeast (g)            | 2   | 2   | 2   | 2   | 2   | 2   |
| Shortening (g)               | 10  | 10  | 10  | 10  | 10  | 10  |
| Salt (g)                     | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Bread improver (g)           | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Xanthan Gum (g)              | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |

2.3. Analysis of sweet bun quality
The colour of sweet buns were analysed by a Minolta Chromameter CR-400 (Minolta Camera Co., Ltd., Tokyo, Japan) and the parameters of L*, a* and b* were obtained. From these parameters *Hue and browning index were calculated using the following equation [17, 18]:

\[ \text{Hue} = \tan^{-1}(b/a) \]  

(1)

\[ \text{Browning Index} = \frac{100 (x-0.31))}{0.172}, \text{and } x = \frac{(a + 1.75L*)}{(5.645L* + a* - 3.01b*)} \]  

(2)

The specific volume of sweet buns was analysed by seed replacement test according to the approve method by AACC [19]. The texture of sweet buns was analysed by a Brookfield CT-3 Texture Analyser and expressed by % deformation [20]. Anthocyanin content of sweet buns was measured according to the approve method by Giusti and Wrostal [21]. Crude fibre content of sweet buns was measured according to the approve method by AOAC [22].

The sensory characteristics was analysed using hedonic scale on 7 points (1=dislike highly, 2=dislike, 3=quite dislike, 4=neither like nor dislike, 5=quite like, 6=like, 7=like highly) by 70 untrained panellists both genders. Sweet buns were identified by a three digits random number. The sample was offered to the panellists on a white plate at room temperature and drinking water provided. Panellists was asked to evaluate the colour, odour, taste, texture, and overall acceptability of the sweet buns.
2.4. Data analysis
The research was performed by using randomized complete design with one factor namely the ratio of PSPF and WF in sweet bun formulation. Data was subjected to analysis of variance (ANOVA) using SPSS version 22.0. The resulted data was presented as means ± standard deviations from triplicate observations. Significant differences were established at p<0.05 using the method of Least Significant Range (LSR) tests.

3. Result and discussion

3.1. Effect of blending ratio of WF and PSPF on physical properties of sweet bun
The results showed that ratio of WF and PSPF had effect to physical properties of sweet buns as shown in Table 2 and Table 3.

**Table 2.** Effect of blending ratio of WF and PSPF on colour parameters of sweet bun

| Ratio of WF and PSPF (P) | L* | a* | b* | °Hue | Browning index |
|--------------------------|----|----|----|------|----------------|
| P₁ (100 : 0)*            | 70.78 | -  | -  | 105.57±4.41 |              |
| P₂ (80 : 20)             | 52.45±0.69 | 19.78±1.07 | 24.78±1.84 | 51.22±1.09 | 2.27±8.91 |
| P₃ (60 : 40)             | 45.44±3.91 | 19.78±0.69 | -2.56±0.2 | 7.37±0.68 | 1.60±2.65  |
| P₄ (40 : 60)             | 32.11±0.7 | 18.67±1.15 | -4.44±0.2 | 13.3±1.37 | 1.52±2.71 |
| P₅ (20 : 80)             | 24.78±1.50 | 13.00±0.58 | -6.22±0.39 | 25.56±1.39 | 1.17±1.77 |
| P₆ (0 : 100)             | 24.55±1.35 | 11.00±0.58 | -5.44±0.51 | 26.29±1.07 | 0.89±0.53 |

The value in the is the average of triplicate observations ± standard deviations. The value followed by different letter in the same column are significantly different (p<0.05) using Least Significant Range test.

*) Sweet bun made from 100% WF is not included in statistical analysis since it has a very different colour from sweet bun made from composite flour of PSPF and WF.

**Table 3.** Effect of blending ratio of WF and PSPF on specific volume and % deformation of the sweet bun

| Ratio of WF and PSPF (P) | Specific volume (mL/g) | Deformation (%) |
|--------------------------|------------------------|-----------------|
| P₁ (100 : 0)             | 3.43±0.09*             | 40.08±0.64bc    |
| P₂ (80 : 20)             | 2.27±0.03b             | 38.55±0.06c     |
| P₃ (60 : 40)             | 1.60±0.02c             | 38.92±0.71c     |
| P₄ (40 : 60)             | 1.52±0.05c             | 39.31±0.78bc    |
| P₅ (20 : 80)             | 1.17±0.06d             | 40.76±0.87b     |
| P₆ (0 : 100)             | 0.89±0.063c            | 44.82±0.49b     |

The value in the is the average of triplicate observations ± standard deviations. The value followed by different letter in the same column are significantly different (p<0.05) using Least Significant Range test.

Table 2 shows the significant difference of the L*, a*, b* and °Hue value among the sweet buns. Sweet bun made from 100% WF (P₁) had the highest L* value and the more addition of PSPF will decrease the lightness of the product and resulted a darker sweet bun crumb. The similar result was found in previous study [14]. The addition of PSPF also decreased the value of redness (a) and yellowness (b). The darker sweet bun crumb colour with the increasing amount of PSPF can be attributed to the anthocyanin pigments [23]. Sweet bun made from 100% WF had the highest browning index, and the increasing of PSPF addition will significantly decrease (p<0.05) the browning index of sweet bun. The changes of colour were associated with an increase in reducing sugars with the increasing amount of PSPF, which promote the Maillard reaction resulting in the browning colour of sweet bun crumb [24].
Table 3 shows the significant differences (p<0.05) in specific volume among of sweet buns. Sweet bun made from 100% WF (P1) had the highest value of specific volume. The increasing of PSPF addition will decrease significantly (p<0.05) the specific volume due to the decreasing of gluten content and increasing fibre content in dough [25]. The results of this study were agreed with previous studies [26].

Table 3 shows the significant difference (p<0.065) in deformation parameter among sweet buns. Sweet bun made from 100% PSPF (P6) had the significantly (p<0.05) higher % deformation than the other samples. The dough resistance to deformation is an indicator of the ability of dough to retain gas [27], the higher dough resistance to deformation will decrease the % deformation. The increasing of PSPF addition in the dough formulation will increase % deformation in sweet bun.

3.2. Effect of blending ratio of WF and PSPF on chemical properties of sweet bun

The results showed that blending ratio of WF and PSPF had the effect on chemical properties of sweet bun, as shown in Table 4.

Table 4. Effect of blending ratio of WF and PSPF on anthocyanin and crude fibre content of sweet bun

| Ratio of WF and PSPF (P) | Anthocyanin content (ppm) | Crude fibre content (%) |
|-------------------------|---------------------------|-------------------------|
| P1 (100 : 0)            | no                        | 3.55±0.16b              |
| P2 (80 : 20)            | 19.13±1.28c               | 3.30±0.17c              |
| P3 (60 : 40)            | 30.13±2.18d               | 3.72±0.23bc             |
| P4 (40 : 60)            | 41.21±3.78c               | 3.74±0.28b              |
| P5 (20 : 80)            | 51.16±4.62b               | 5.59±0.29a              |
| P6 (0 : 100)            | 62.37±5.84a               | 5.96±0.21a              |

The value in the is the average of triplicate observations ±standard deviations. The value followed by different letter in the same column are significantly different (p<0.05) using Least Significant Range test. no=not observed

Table 4 shows the significant difference (p<0.05) of anthocyanin and crude fibre content among sweet buns. Sweet bun made from 100% PSPF (P6) had the highest anthocyanin content. This is due to sweet bun made from 100% PSPF contains anthocyanin [2]. Table 4 shows the significant difference (p<0.05) of crude fibre content among sweet buns. Sweet bun made from 100% PSPF (P6) had the higher crude fibre content. Sweet potato had a higher crude fibre than wheat [28].

3.3. Effect of blending ratio of WF and PSPF on sensory properties of sweet bun

The results showed that blending ratio WF and PSPF had effect to sensory characteristics of sweet bun. The results are shown in Table 5.

Table 5. Effect of blending ratio of WF and PSPF on sensory characteristics of sweet bun

| Ratio of WF and PSPF (P) | Colour            | Odour            | Taste            | Texture          | Overall Acceptability |
|-------------------------|-------------------|------------------|------------------|------------------|-----------------------|
| P1 (100 : 0)            | 5.39±0.28a        | 5.51±0.39a       | 5.62±0.28a       | 5.54±0.33a       | 5.69±0.26a            |
| P2 (80 : 20)            | 3.84±0.24d        | 4.86±0.12b       | 4.99±0.07bc      | 5.1±0.03b        | 4.57±0.34d            |
| P3 (60 : 40)            | 4.72±0.32c        | 4.97±0.21b       | 5.09±0.1b        | 5.19±0.13b       | 5.1±0.09b             |
| P4 (40 : 60)            | 5.23±0.13ab       | 4.84±0.2b        | 4.94±0.06bc      | 4.87±0.08b       | 5.08±0.08bc           |
| P5 (20 : 80)            | 4.94±0.20abc      | 4.69±0.13b       | 4.75±0.2c        | 4.5±0.24c        | 4.7±0.12d             |
| P6 (0 : 100)            | 4.85±0.26bc       | 4.71±0.08b       | 4.73±0.16c       | 4.26±0.21c       | 4.72±0.15cd           |

The value in the is the average of triplicate observations ±standard deviations. The value followed by different letter in the same column are significantly different (p<0.05) using Least Significant Range test.

Table 5 shows that panellists quite like the colour, odour, taste, texture, and overall acceptability of the sweet buns. The results show that the ratio bending WF and PSPF had significant effect (p<0.05)
on the colour, odour, taste, texture, and overall acceptability hedonic value. This result showed that sweet bun made from 100% wheat flour is most acceptable by panellists than bread made from a mixture of wheat flour and PSP flour, but the sweet bun made from 40% wheat flour and 60% PSPF is still acceptable, especially in term of anthocyanin and crude fibre content and also texture parameters.

4. Conclusions
The ratio blending ratio of WF and PSPF had highly significant effect on the colour, browning index, specific volume, % deformation, anthocyanin content, crude fibre content and the hedonic value of the sweet buns. This research concluded that the sweet bun which had the best physicochemical and sensory characteristics was sweet bun P3 produced from 60% WF and 40% PSPF.

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