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Effect of pretreatment on purple-fleshed sweet potato flour for cake making

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Abstract. The purple-fleshed sweet-potato (PFSP) flour was produced by varying pretreatment of washed chips: dipping in 0.5 and 1.0% (w/v) citric acid solution for 30 min, dipping in 0.5 and 1.0% (w/v) citric acid solution for 30 min and followed by steam blanching for 5 min. The pretreatment effect on cake quality was investigated. The results showed that PFSP flour produced from pretreatment with dipping in 0.5% citric acid for 30 min followed by steam blanching for 5 min had higher lightness (L*) value and lower browning index, higher hedonic value of color and aroma and baking expansion. The specific volume of cake from pretreated flour, untreated flour and wheat flour were 44.87, 43.83, and 50.43cm^3/g, respectively. The sensory evaluation of cake indicated that cake from pretreated PFSP flour was acceptable compare to those of cake from wheat flour.

1. Introduction

Sweet potato (*Ipomoea batatas* L. Lam) has been grown for domestic consumption in Indonesia. They are four common local varieties: the purple skin-white fleshed, yellow skin-yellow-fleshed, yellow skin-orange fleshed, and purple skin-purple fleshed. Sweet potato plays an important role in improving national food security, health, and livehoods of poor family, due to its wide range of agronomical and nutritional advantages such as high yield even in marginal soil conditions, wide ecological adaptability, low input requirements, and shorter growing period than other crops [1]. Sweet potato contains high carbohydrate content, low glycemic index [2] and dietary fiber [3]. In particular, purple-fleshed sweet potato has stronger antioxidant activity than many other vegetables due to its higher content of anthocyanin [4].

Even though they supply carbohydrate and anthocyanin that essential for proper functioning of the human body, their utilization is still limited. Most sweet potatoes are commonly consumed fresh (boiled, fried or make it into cake). Therefore, the use of sweet potato flour for bakery production would help lessen the need of imported wheat flour. The use of sweet potato increases depend on the processing technology to produce flour or starch with desirable physicochemical and functional properties along with the understanding of processing effect on their properties [5]. Therefore, the objective of this research was to study the effect of washing pre-treatment on sweet potato flour for cakes production.

2. Material and methods

The deep purpled fleshed sweet potato (PFSP) was purchased from farmers at Berastagi Village North Sumatera Province Indonesia. Roots were washed with tap water to remove dirt and soil, and after drying its surface, the washed sweetpotato was stored at 14 ^{o}C without curing before being processed. Other ingredients, such as eggs, sugar, skim milk, margarine, vanilla flavoring, xanthan gum, and baking powder were purchased from a market in Medan.

2.1. Sample preparation and treatment
The cleaned roots were peeled manually with stainless steel kitchen knife and sliced into 2 mm-thickness with the use of an electrical chipping machine. The chips were prepared into four flour samples. For the first and second group the chips were dipped in aqueous 0.5 and 1.0% (w/v) citric acid at room temperature for 30 min. For the third and fourth group, the chips were dipped in aqueous 0.5 and 1.0% citric acid followed by steam blanching for 30 minutes.

2.2. Preparation of PFSP flour
The treated chips were dried using a convection drying oven at 55 ^{o}C for 12 hours. The flour (moisture content about 10%) was obtained by milling the dried slices using a milling machine into flour with particle size of about 200 µm and the resulting flour was sieved to obtain a fine flour. The flours were then packaged in polyethylene bags, sealed and stored at ambient temperature (28 ± 2^{o}C) before being used.

2.3. Analysis of the physical and functional properties of PFSP flour samples
The physical properties of flour analyzed were color (L* value), browning index, and hedonic value of aroma and color. L* value was determined by using a Minolta Chromameter CR-400 (Minolta Camera Co., Ltd., Tokyo, Japan). Browning index was determined using the method described by Youn and Choi [6]. Hedonic value of aroma and color were tested by 15 semi trained panelist using 5 point hedonic scale with 5 = very like and 1 = very dislike.
The functional properties of PFSP flour such as water absorption index (WAI), oil absorption index (OAI) and swelling power were determined by standard methods. WAI and OAI were determined according to the methods of Niba *et al* [7]. The swelling power and solubility of flour was determined based on a method of Leach *et al.*[8] and Anderson [9], respectively. The measurement of baking expansion uses the method of Demiate *et al* [10] with minor modification.

2.4. Cakes production
PFSP flour with the higher L* and hedonic value and the lower browning index was used for cake production. Wheat flour and PFSP flour without pretreatment were used as control. The formulation for cake according to Bennion and Pamford [11] was followed for the production of cake with modification: flour (100 g), baking powder (3 g), egg (125 g), sugar (100 g), skim milk (50 g), margarine (10 g) and vanilla flavoring (2 g).

Flour and baking powder were blended manually to get a uniform distribution. Egg, sugar, skim milk, margarine and vanilla flavoring were mixed by using handled mixer (HR 1538 Phillips) at high speed for 6 minutes. The flour mix was added into the cream and dough was mixed for 3 minutes at low speed. The dough was poured into baking pans, then placed in a preheated oven and baked at 180 ^{o}C for 35 minutes. Cakes were allowed to cool for 30 minutes at the pans at room temperature.

2.5. Analysis of cake quality
Resulting cakes were analyzed for their color (L* value) by using a Minolta Chromameter CR-400 (Minolta Camera Co.,Ltd., Tokyo, Japan). The volume of the cake was measured using seed replacement test according to the approve method by AACC [13].

A panel of 15 semi-trained judges of both genders aged 18-21 years evaluated the cakes on a 5 point hedonic scale (1=dislike extremely, 2=dislike, 3= neither like nor dislike, 4= like, 5= like extremely). Cakes were sliced into quarter and identified by a three-digit random number. The sampels were offered to the judges on a white plate at room temperature. The plates were cleansed with water before they are used for the next samples.

2.6. Data analysis

Data using completely randomized design were analyzed using SAS Version 9.2 for windows. The data reported in all tables are an average of triplicate observations subjected to one-way analysis of variance (ANOVA). Differences between the ranges of the properties were determined using the method of Least Significant Difference (LSD) tests at 95% confidence level (P< 0.05).

3. Results and discussions

3.1. Effect of pretreatment on physical and functional properties of PFSP flour

Table 1 shows that there was a significant difference at the 5% level in the lightness (L* value), browning index and hedonic value of color, but there is no significant difference in the hedonic value of aroma among the samples. The PFSP flour made from chips that dipped in citric acid 0.5% or 1.0% had the higher L* value (lightness) and lower browning index, but their acceptability in aroma and color are lower, this was due to the pale appearance of its color. PFSP flour made from chips that dipped in in citric acid 1.0% followed by steam blanching for 30 minutes had the higher acceptability in aroma and color but its lightness (L* value) was lowest and its browning index is higher than other pretreated flour, so its color appearance was darker than other flour. This was due to the structure of anthocyanin was depended on medium pH [14]. The PFSP flour made from chips that dipped in citric acid 0.5% followed by steam blanching 30 minutes was more acceptable in its color appearance than other flour.

Table 1. Effect of pretreatment on physical properties of PFSP flour

Pretreatment	Parameter			
	Color (L* value)	Browning Index	Hedonic Value: Aroma	Hedonic Value: Color
CA 0.5	44.93 ±0.37b [b]	0.78±0.09 [b]	3.55±0.06	2.97±0.28 bc
CA 1.0	46.64±0.33a [a]	0.76±0.03 [b]	3.54±0.0	2.60±0.17c
BCA 0.5	45.62±0.94b [b]	0.84±0.06 [b]	3.48±0.27	4.00±0.53a
BCA 1.0	40.66±0.03d[d]	0.86±0.07 [b]	3.62±0.16	4.35±0.10a
Control	43.23±0.16c [c]	1.12±0.09 [a]	3.50±0.19	3.16±0.06b

*) CA 0.5 and CA 1.0 = the chips were dipped in aqueous 0.5 and 1.0% (w/v) citric acid at room temperature for 30 min, respectively. BCA 0.5 and BCA 1.0 = the chips were dipped in aqueous 0.5 and 1.0% citric acid followed by steam blanching for 30 minutes, respectively. Control was PFSP flour without washing pretreatment
The values are expressed as the mean of three replications.
Means followed by different letter in the same column are significantly different among drying temperature (p<0.05)

Table 2 shows the results of functional properties of pretreated and untreated flour. At the 5% level there were significance difference in WAI, OAI, swelling power, and baking expansion of pretreated PFSP flour. The washing pre-treatment with higher concentration of citric acid and blanching caused the water absorption index and swelling power increase, while the oil absorption index was decreased. The similar result was reported by Jangchud *et al.*[5]. Blanching can cause the gelatinization of starch and consequently will disrupt the starch granule and increase the starch-water interaction, resulting in an increase of WAI and swelling power [15]. Blanching also cause an increased of baking expansion due to increasing viscosity and internal bubble pressure which resulted the disruption of cell at the end of oven rise [16]. There is no significance difference in solubility of pretreated and untreated PFSP flour.

Table 2. Effect of pretreatment on functional properties of PFSP flour

Preatreatment	Parameter				
	WAI (g/g)	OAI (g/g)	Swelling Power (%)	Solubility (%)	Baking Expansion (ml/g)
CA 0.5	2.33±0.20[c]	1.44±0.14[b]	5.61±0.74[bc]	3.55±0.35	0.92±0.46[ab]
CA 1.0	2.55±0.65[c]	1.43±0.19[b]	6.35±0.56a[b]	3.58±0.12	0.89±0.00[a]
BCA 0.5	2.93±0.15[b]	1.38±0.09[b]	6.51±0.39[ab]	3.56±0.63	0.98±0.07[a]
BCA 1.0	3.83±0.56[a]	1.26±0.00[b]	6.69±0.60[a]	3.61±0.22	0.89±0.04[b]
Control	1.90±0.11[d]	1.73±0.13[a]	5.19±0.22[c]	3.43±0.13	0.90±0.01[ab]

*) CA 0.5 and CA 1.0 = the chips were dipped in aqueous 0.5 and 1.0% (w/v) citric acid at room temperature for 30 min, respectively. BCA 0.5 and BCA 1.0 = the chips were dipped in aqueous 0.5 and 1.0% citric acid followed by steam blanching for 30 minutes, respectively. Control was PFSP flour without pretreatment
The values are expressed as the mean of three replications.
Means followed by different in each column are significantly different among drying temperature (p<0.05)

3.2. Quality of cake from pretreated PFSP flour compared with untreated PFSP flour and wheat flour

The quality of cake made from pretreated PFSP flour compared with untreated PFSP flour and wheat flour are presented in Table 3. Cake made from wheat flour had a higher L* and b* value. This result showed that cake made from wheat flour had a higher lightness than cake from PFSP flour. There is no significant difference (P>0.05) in specific volume among the cakes, but cake made from untreated PFSP flour had the lowest specific volume. There is no significant difference in aroma of cake among the cakes, but there are significant differences (P<0.05) in color, taste and texture. Cake made from wheat flour still has a higher hedonic value in color, taste and texture than cake made from pretretaed and untreated PFSP flour. There are no significant difference in color, and taste of pretreated and untreated PFSP flour, but untreated PFSP flour had a higher hedonic value in texture than pretreated flour. Respondent were neither like nor dislike cake made pretreated PFSP flour.

Table 3. Quality of cake from pretreated OFSP flour compared with untreated OFSP and wheat flour

Parameter	BCA 0.5	Untreated OFSP Flour	Wheat Flour
Color			
- L*	21;08±3.23[b]	22.81±1.17[b]	69.50±0.62[a]
- a*	10.65±1.40[a]	8.65±1.12[c]	9.73±1.22[b]
- b*	1.07±0.40[c]	5.83±1.03[b]	39.76±1.03[a]
Specific Volume (ml/g)	44.87±2.30[a]	43.89±4.54[a]	50.43±5.24[a]
Hedonic Value			
- Color	3.30±0.20[b]	3.30±0.17[b]	3.93±0.35[a]
- Aroma	3.30±0.45	3.40±0.20	3.76±0.20
- Taste	3.16±0.28[b]	3.13±0.1[b]	3.86±0.30[a]
- Texture	2.61±0.30[c]	3.08±0.20[b]	3.58±0.20[a]

*) BCA 0.5 was the flour made from chips that dipped in aqueous 0.5 citric acid followed by steam blanching for 30 minutes.
The values are expressed as the mean of three replications.
Means followed by different in the same raw are significantly different among drying temperature (p<0.05)

4. Conclusion

The study has shown that different pretreatments have an effect on the quality of flour produced. PFSP flour made from chips that pretreated with soaking in citric acif 0.5% followed by steam blanching 30 minutes has a higher hedonic value in color and baking expansion so it then was used in cake production. Cake made from pretreated PFSP flour has similar specific volume with cake made from untreated PFSP flour and wheat flour, but in general still has a lower acceptability in sensory properties. Pretreated PFSP flour is an alternative flour in the production of cakes.

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