The effect of pre-treatment in the making of orange fleshed sweet potato flour on dried noodle’s quality

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Abstract. Orange-fleshed sweet-potato (OFSP) is excellent sources of powerful natural antioxidant and provide beneficial effects on human health, therefore it’s utilization in food products has been increasingly paid attention. In this study, the effect of pretreatment in the making of OFSP flours on dried noodle quality were investigated. The OFSP flours were obtained by subjecting the OFSP chips to different pre-treatment (soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes, soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes, steam blanching for 5 minutes). Pretreated OFSP flour then was incorporated with wheat flour in ratio 20% : 80% to produce dried noodle. The physicochemical characteristics and sensory evaluation of the dried noodle was determined. Results showed there were significant differences (P<0.05) in the physical analysis, such as cooking time, cooking loss, water absorption capacity, and elongation, and also in moisture and betacarotene content of dried noodles. No significant differences (P>0.05) were observed in the color value (L*, a*, b*) and in the color, texture and aroma from sensory evaluation of dried noodles though there was significant difference in taste. The obtained results indicated that the developed dried noodle made from pretreated OFSP flours can compare favourably with conventional noodles made from wheat flour in quality.

1. Introduction
Sweet potato (Ipomoea batatas) is an important tuber crop in Indonesia and it is rich of carbohydrate in form of starch. There are many sweet potato genotypes that cultivated in Indonesia, and one of them is orange fleshed sweet potato (OFSP). OFSP is nutritious because it contains beta carotene which has high pro-vitamin A and antioxidant activity. Its carbohydrate is ordinarily harmless due to relatively low glycemic index (GI). Therefore it can be used as raw materials of functional food [1].

Noodles are very popular food in Indonesia and other Asian countries. The consumption of noodles has been increased due to changes of food habits especially in children and teenagers. Noodles made from wheat flour, water and eggs. Their forms are long thin pieces, and they are rich in carbohydrates, deficient in proteins, vitamins, dietary fiber and other vital nutrients, so they are regarded as unhealthy food. The deficient nutrients can be supplemented by using composite flour or a mixture of wheat flour and other source such as cassava, sweet potato, soybean, maize and yam flour.
Noodle quality generally is determined by its appearance and texture. Noodles with good quality have a firm, less sticky and less soggy texture after cooking, and these properties are affected by the source of starch and other ingredients, especially by the structural matrix of starches, gluten and other proteins [3].

Sweet potato flour is an intermediate product which can be processed into various food products. Utilizing sweet potato flour in noodle production can reduce dependence on imported wheat flour, and contribute to promote the suitability of sweet potato as industrial raw materials. The processing technology to produce sweet potato flour influences the physicochemical and functional properties of flour. Based on the above view in consideration, the objective of this research were to study the effect of pre-treatment in the making of OFSP flour and to evaluate the quality of dried noodles using the composite flour of wheat and pretreated OFSP flour.

2. Materials and Methods
OFSP root was purchased from a farm at Lembah Seulawah, Saree Village, Nanggroe Aceh Darussalam Province, Indonesia. Other ingredients such as hard wheat flour, salt, eggs, kansui, and arabic gum were purchase from the market in Medan.

2.1. Production of OFSP flour
The OFSP roots were washed, peeled manually with stainless steel kitchen knife, and cut into thin pieces by using an electrical chipping machine. The chips were prepared into four flour samples. One portion served as control sample and the rests were treated by varying pretreatments i.e. soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes, soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes, and steam blanching for 5 minutes. Each treatment was made in 3 replicates. The control and treated samples were spread out uniformly on a stainless steel perforated tray and dried using a cabinet dryer oven at 55 °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 fine flour. The OFSP flour was packed, sealed in polyethylene bags and stored at room temperature (26±2 °C) for further uses.

2.2. Preparation of composite flour
OFSP flour mixed with wheat flour in ratio of 20:80 by using the mixer on low speed for ± 2 minutes, packaged in polyethylene bags, sealed and stored at ambient temperature (28 ± 2°C) before used. The composite flour was analyzed for its bulk density [4], browning index [5], water content as described by AOAC [6], β-carotene content [6], and sensory value of color and aroma by 25 semi trained panellist using 9 point hedonic scale with 9 = very like and 1 = very dislike. The color attributes (Hunter L*, a*, b* values) were measured by using a Minolta Chromameter CR-400 (Minolta Camera Co., Ltd., Tokyo, Japan). The color of products were calculated as \( \text{Hue} = \tan^{-1}(b/a) \) [7].

2.3. Preparation of Dried Noodles
Noodles were made by mixing the mixed flour (100 g), salt (2 g), egg (20 ml), water (30 ml), arabic gum (0.5 g), and kansui (0.5 ml) by using manually electrical dough mixer, and kneaded into a stiff dough which was formed into sheet with a thickness of 3 mm by using manual noodle maker. The sheets were then cut into strands of about 20 cm long and steamed on a boiling water bath for 15 minutes, and continued with oven drying at 55 °C for 12 hours, cooled to room temperature. The resulting dried noodles were packed in polyethylene plastic bags and sealed. Dried noodles produced from 100% wheat flour is used as a control.
2.4. Analysis of dried noodle’s quality

The color of noodles were analyzed by using a Minolta Chromameter CR-400 (Minolta Camera Co., Ltd., Tokyo, Japan), and L*, a*, b* value were observed and the °Hue value was calculated as \( \tan^{-1}(b/a) \) [7].

The elongation of cooked noodled was individually determined by using texture analyzer (TA-XT2i, Stable Micro System). One string of noodle was wrapped around the 2 cm probe and elongation was measured using a test speed of 0.3 cm s\(^{-1}\) with a 10 cm distance between two rollers [8]. Moisture content and beta carotene content of noodle were determined according to AOAC [6].

2.5. Cooking quality evaluation of dried noodle

Cooking loss, cooking time and water uptake of dried noodles were determined as described in the AACC [9]. 10 g of dried noodles were boiled in 200mL of boiling tap water. The beaker was covered with a watch glass and noodles cooked to the optimum time of each individual sample, when the white core disappeared. The cooked noodles were allowed to drain and rinsed with water, then drained again for 3 minutes and then weighed (A), dried in the oven at 100°C of temperature until the constant weight was reached, then weighed again (B). The cooking loss and water uptake were then calculated and given in equation (1) and (2) as follows:

\[
\text{Cooking loss(\%)} = 1 - \frac{\text{Constant weight after drying}}{\text{sample weight (1-moisture fraction of noodle)}} \times 100
\]

\[
\text{Water uptake(\%)} = \frac{(A-B)-(\text{sample moisture \times sample weight})}{\text{sample weight (1-sample moisture)}} \times 100\%
\]

2.6. Sensory evaluation of cooked noodles

The noodle samples were cooked in boiled water for 1-2 minutes, and decanted. The noodles was poured in a plate and added seasoning (salt, mashed garlic and onion) to taste and served. The panel comprising of 25 semi-trained panelists were asked to judge the samples on a 9-point hedonic scale, where 9 = very like, 5 = neither like nor dislike and 1 = very dislike. The variables were color, aroma, taste, texture and overall acceptability.

2.7. Data analysis

The data reported 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 Discussion

3.1. Effect of pretreatment on physicochemical and sensory quality of composite flour

Table 1 shows that there was a significant difference (p>0.05) among the composite flours in the β-carotene content, but there was no significant difference in °Hue, L*, a*, b*, bulk density, browning index, water content, sensory value of color and aroma. °Hue value for all the mixed flour resulting been 74°-78°. °Hue value 54° – 90° shows yellow red products [10]. The L* parameter indicates the whiteness of flour [7]. The L* value of wheat flour was higher than composite flours, this is due to the betacarotene content in OFSP flour. The b* parameter can be used to measure the color and intensity of flour [7]. The b* value was in line with the betacarotene content. Browning index in all of composite flour and wheat flour were almost the same. Browning was a complex process that involves many factors such as substrat concentration, enzymatic activity, presence of citric acid, and also other inhibitors or promoters [10]. The composite flours were enough dry with moisture content below 14.5% stipulated standard of the Indonesian National Standard for flour [11].
The betacarotene content of composite flours consisting of 20% pretreated OFSP flour and 80% wheat flour were higher than control (100% wheat flour) except for CF1 which is a sweet potato flour pretreated by soaking in 2000 ppm of citric acid and followed by blanching for 5 minutes. Composite flour from the pretreated OFSP flour by steam blanching for 5 minutes has the highest betacarotene content. Similar result was also obtained by Haile et al.[12] where betacarotene content in pretreated OFSP flour by blanching was higher than those of pretreated by soaking in citric acid. Betacarotene can be degraded by the enzyme (peroxidases and lipoxygenases), and blanching can inactivate and delay this process. The sensory of color and aroma for all the composite flour and wheat flour were liked slightly – moderately.

Table 1. Effect of pretreatment of OFSP chips on physico-chemical and sensory quality of composite flour.

| Parameter | CF1 (n=3) | CF2 (n=3) | CF3 (n=3) | C (n=3) |
|-----------|-----------|-----------|-----------|---------|
| Color :   |           |           |           |         |
| "Hue     | 75.25±2.46 | 75.37±3.05 | 77.57±0.56 | 74.93±0.63 |
| L*        | 57.47±3.28 | 56.30±3.35 | 56.40±4.37 | 59.10±1.31 |
| a*        | 2.87±0.29  | 2.93±0.23  | 2.80±0.17  | 3.10±0.20  |
| b*        | 10.97±0.78 | 11.43±1.52 | 12.70±0.36 | 11.53±0.98 |
| Bulk density (g/ml) | 0.70±0.01 | 0.71±0.01 | 0.70±0.01 | 0.69±0.00 |
| Browning index | 0.19±0.01 | 0.188±0.01 | 0.21±0.02 | 0.219±0.02 |
| Water content (%)  | 11.3±0.38 | 11.20±0.51 | 11.48±0.26 | 11.45±0.25 |
| β-carotene content (mg/100g) | 2.40±0.02 | 3.14±0.13 | 3.67±0.11 | 2.60±0.13 |
| Sensory value of color | 5.28±0.14 | 5.59±0.02 | 5.31±0.05 | 5.44±0.16 |
| Sensory value of aroma | 5.53±0.27 | 5.41±0.19 | 5.51±0.02 | 5.35±0.05 |

**CF** = composite flour of wheat and pretreated OFSP flour. Subscript 1-3 indicated pretreated OFSP flour by: soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes (1), soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes (2), and steam blanching for 5 minutes (3). C = wheat flour (control). Means followed by different in each column are significantly different (p<0.05) (n=3)

3.2. Effect of pretreatment on physicochemical quality of dried noodle

Table 2 shows that there was a significant difference (p<0.05) in the moisture content, and β-carotene content of dried noodle, but there was no significant difference in "Hue, L*, a*, and b* value. The "Hue value for all samples of dried noodles were 79.22-80.06 which show a yellow-red color [7].

Table 2. Effect of pre-treated OFSP flour on physicochemical quality of dried noodle.

| Parameter | Composite flour with the different pretreated OFSP flour ** |
|-----------|----------------------------------------------------------|
|           | M1 (n=3) | M2 | M3 | M |
| "Hue     | 80.06±0.25 | 81.41±0.48 | 80.54±0.95 | 79.22±1.48 |
| L*        | 51.90±0.36 | 52.20±0.79 | 52.50±1.11 | 52.57±1.56 |
| a*        | 6.17±0.31  | 5.83±0.55  | 6.33±0.47  | 6.80±0.90  |
| b*        | 35.20±1.59 | 38.60±2.25 | 38.17±3.71 | 35.73±0.78 |
| Moisture content (%) | 3.41±0.66 | 6.09±0.39 | 6.58±0.29 | 4.41±0.19 |
| β-carotene content (mg/100g) | 1.52±0.17 | 2.22±0.14 | 2.31±0.18 | 1.69±0.13 |

**M** = dried noodle from composite flour of pretreated OFSP flour and wheat flour in ratio of 20 : 80. Subscript 1-3 indicated pretreated OFSP flour by: soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes (1), soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes (2), and steam blanching for 5 minutes (3). Means followed by different in each column are significantly different (p<0.05) (n=3)
The highest moisture and betacarotene content present in dried noodle from composite flour of OFSP flour that treated by steam blanching for 5 minutes, because the moisture and betacarotene content of composite flour from this composite flour was higher than other treatment (Table 1). The moisture content of all dried noodle samples were lower than 14% which is the maximum standard of moisture content for dried noodle [11]. β-carotene content of dried noodle were lower than those in composite flour. This is due to the heat process in noodle processing such as steaming and drying with high temperatures. The carotenes are easily damaged and lost during the processing. Carotenoid stability depends on the presence of, oxygen, temperature, light exposure, water activity, acidity, and the structure of carotene [14].

3.3. Effect of pretreatment on cooking quality of dried noodle

Table 3 shows that there was a significant difference (p<0.05) in the cooking time, water uptake, cooking loss, and elongation of dried noodle. The lowest cooking time was 2.16 min for the dried noodle made from composite flour of pretreated OFSP flour by steam blanching. The difference in cooking time is due to the difference in gelatination temperature [15]. In the blanching process of OFSP chip, its starch will occur pregelatinization that will decrease the gelatination temperature of flour.

The highest water uptake is found in dried noodles from composite flour of pretreated OFSP flour by soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes. The water uptake of dried noodles tended to increase with increasing the cooking time. Blending of wheat flour with pretreated OFSP flour by blanching and soaking in 2000 ppm sodium metabisulphite followed by blanching significantly (p<0.05) decreased the cooking loss (%) of dried noodle. Cooking loss is the amount of dry matter that dissolve in water during cooking [9].

Elongation is the distance to break the noodle strands that shows the extensibility of noodles and relates with the tensile strength [8]. The lowest elongation found on dried noodle from composite flour of pretreated OFSP flour by soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes. Dried noodle made from wheat flour had a highest elongation. The elongation of noodles were determined by the presence of gluten in wheat flour which formed elastic dough and resulting the better texture of noodle [13].

| Parameter            | Pre-treatment of OFSP Flour in composite flour*** |
|----------------------|-----------------------------------------------|
|                      | M₁  | M₂  | M₃  | M₄  |
| Cooking time (min)   | 3.09±0.09a | 2.5±0.07b | 2.16±0.11c | 2.56±0.45b |
| Water uptake (%)     | 187.18±7.91a | 160.55±10.41b | 110.91±6.29c | 167.42±17.39ab |
| Cooking loss (%)     | 29.29±3.9a | 16.54±2.23b | 14.53±1.49b | 26.47±2.56a |
| Elongation (%)       | 8.85±0.62c | 12.05±1.01a | 9.19±0.89b | 13.63±0.67a |

***) M = dried noodle from composite flour of pretreated OFSP flour and wheat flour in ratio of 20 : 80. Subscript 1-3 indicated pretreated OFSP flour by: soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes (1), soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes (2), and steam blanching for 5 minutes (3). M = dried noodle from 100% wheat flour (control). Means followed by different in each column are significantly different (p<0.05) (n=3)

3.4. Effect of pretreatment on sensory attributes of dried noodle

Table 4 shows that there was a significant difference (p<0.05) in taste of dried noodle, but there was no significant difference (p>0.05) in the other attributes of sensory. This result shows that in general, consumer acceptance of noodles from composite flour is the same as noodles made from 100% wheat flour (control).

Assessing the best pretreatment in making OFSP flour was based on sensory quality, betacarotene content, moisture content, cooking quality and elongation. The result showed that the composite flour
of 20% pretreated OFSP flour by soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes and 80% wheat flour (M2) was the best treatment for dried noodle production. The dried noodle made from this composite flour had a protein content 8.35±0.32% and no significantly different than those in commercial dried noodle made from 100% wheat flour which is 9.00±0.20%.

**Table 4.** Effect of pretreatment on sensory quality of cooked dried noodle.

| Parameter          | Pre-treatment of OFSP Flour in composite flour** |
|--------------------|-----------------------------------------------|
|                    | M1       | M2       | M3       | M4       |
| Color              | 5.31±0.41| 5.15±0.71| 4.87±0.05| 4.92±0.26|
| Aroma              | 5.36±0.22| 5.61±0.27| 5.23±0.14| 5.72±0.12|
| Taste              | 5.11±0.09^b| 5.47±0.08^a| 5.00±0.11^b| 5.41±0.13^a|
| Texture            | 5.41±0.29| 5.17±0.50| 5.33±0.06| 5.48±0.04|
| Overall acceptability | 5.29±0.13| 5.31±0.20| 5.09±0.13| 5.27±0.10|

**M = dried noodle from composite flour of pretreated OFSP flour and wheat flour in ratio of 20:80. Subscript 1-3 indicated pretreated OFSP flour by: soaking in 2000 ppm citric acid solution for 15 minutes followed by steam blanching for 5 minutes (1), soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes (2), and steam blanching for 5 minutes (3). M = dried noodle from 100% wheat flour (control). Means followed by different in each column are significantly different (p<0.05) (n=3)**

4. Conclusion
The study has provided some insights for processing and preparation of sweet potato flours that to be used for making dried noodle. The pretreatment that produce the OFSP flour with the best physicochemical and sensory quality was soaking in 2000 ppm sodium metabisulphite solution for 15 minutes followed by steam blanching for 5 minutes. The dried noodle made from composite flour from 20% pretreated OFSP flour and 80% wheat flour has the cooking time, water absorption, cooking loss, elongation, and protein content those are similar to commercial dried noodle. Pretreated OFSP flour is alternative flour in the production of dried noodle.

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