

Original Research Article

Effects of Different Skin Processing Conditions of Japanese Sweet Potato Powder (*Ipomoea batatas*) on Physicochemical Properties

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Abstract: Sweet potato (*Ipomoea batatas*) is among the most popular crop around the world. Physicochemical properties are an important element in the sweet potato processing industry. However, little knowledge is known about this variety of sweet potatoes. In this study, colour, moisture, ash, protein, fat, crude fibre and carbohydrate were studied subjected to three different conditions of Japanese sweet potato; whole tuber (C1), peeled tuber (C2) and skin of tuber (C3). Colour and proximate analysis were determined using the lightness (L), red/green (a) and yellow/blue (b) system and AOAC method, respectively. The result indicated that L, a and b ranged from 68.0–89.2, 0.48–5.65 and 11.67–13.27, respectively. The highest values of L, a and b were observed in C1, C3 and C1, respectively. Moisture, ash, protein, fat, carbohydrate and fibre were ranged from 5.93–7.86%, 2.64–8.11%, 4.64–5.47%, 0.06–0.70%, 65.96–86.96% and 1.00–2.43%, respectively. C1 had the highest value of moisture content while C2 showed to have the highest values of protein and carbohydrate. C3 was observed to have the significantly highest ($p < 0.05$) content of ash, lipid and crude fibre. Overall, the differences in the physicochemical properties of three different conditions of sweet potato are significant in certain properties. C1 was suggested to be the best selection for producing better quality sweet potato products. Therefore, the result obtained from this study becomes useful for further processing of sweet potatoes.

Keywords: sweet potato powder; whole tuber; peeled tuber; skin; physicochemical properties

Received: 14th June 2022

Received in Revised Form: 27th November 2022

Available Online: 11th December 2022

Published: 5th January 2023

Citation: Shaari N, Mnemoi F, Shamsudin R, *et al.* Effects of different skin processing conditions of Japanese sweet potato powder (*Ipomoea batatas*) on physicochemical properties. *Adv Agri Food Res J* 2023; 4(1): a0000191. <https://doi.org/10.36877/aafj.a0000191>

1. Introduction

Sweet potato (*Ipomoea batatas* (L.) LAM) plays an important role in solving the issues of food, energy, natural resources and environment. Indeed, it is highly nutritious and has healthy benefits. It is a potential energy contributor and is considered as a fifth essential crop (fresh weight basis) after rice, wheat, maize, and sorghum (Satheesh *et al.*, 2019). In the year 2018, 92 million tons of sweet potatoes were produced in the world (Shahbandeh, 2020). This may be due to its wide range of agronomic and nutritional advantages such as high yield even in marginal soil conditions, wide ecological adaptability, low input requirements, and shorter growing period than other root crops. Sweet potato produces the highest amount of edible energy per hectare per day (Olatunde *et al.*, 2016). Sweet potatoes were recognised as the second staple food and possess a significant role in human diets in many underdeveloped countries (Satheesh *et al.*, 2019). The cultivar is rich in carbohydrates, fibre, protein vitamins and minerals such as potassium iron (Mais *et al.*, 2008). It has a high carbohydrate content but has a low glycemic index, indicating a low digestibility of starch. It is the only starchy staple, which contains appreciable amounts of β -carotene (especially the orange-fleshed varieties), ascorbic acid and amino acid lysine that is deficient in cereal-based diets like rice (Olatunde *et al.*, 2016). The content and amount vary with a variety of sweet potatoes. For instance, the Japanese sweet potato is a variety that is not widely known and studied compared to other local sweet potatoes such as VitAto. Sweet potato is prepared in many ways, for example, as noodles, cookies, muffins. Commonly, sweet potato powder is used as a substitute in numerous sweet potato products such as bakery products, soup and gravy. The quality of the sweet potato products will depend on the selection of sweet potato powder. Therefore, the purpose of the study is to determine the effect of three different conditions of Japanese sweet potato powder on its physicochemical properties.

2. Materials and Methods

2.1 Sample Preparation

The method of sample preparation was adapted from Shaari *et al.* (2019). The sweet potato used for this experiment was obtained from a commercial farm in Semenyih, Selangor, Malaysia. The variability of raw material was controlled by selecting matured sweet potatoes from the same variety known as the Japanese sweet potato (Figure 1). About 10 kg of tubers were harvested and washed with tap water to remove adhering soil. After air-drying, all the

tubers were divided into three portions and processed into three conditions; whole tuber (C1), peeled tuber (C2) and skin of tuber (C3). All the conditions were oven-dried at 60°C for 24 hours. Then, the samples were ground and sifted through a 250 µm sieve. The powders were kept in an airtight container at 4°C for further analysis.

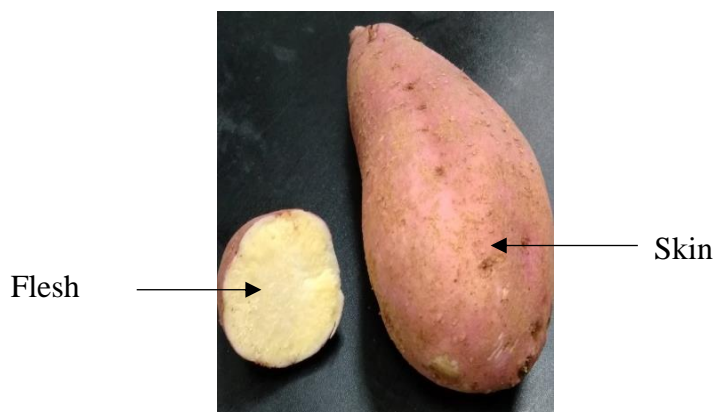


Figure 1. Japanese sweet potato.

2.2. Hunter Colour

Colour values were determined according to the method described by Trude *et al.* (2005). The colour attributes (Hunter L a and b values) were measured with a spectrophotometer (UltraScan PRO HunterLab). The colour was expressed in L a b, where the L represents lightness (L = 0 yields black and L = 100 denotes white), the a expresses red (+) or green (-), and the b indicates yellow (+) or blue (-). L, a and b parameters were measured against a white calibration plate and were directly obtained from the apparatus.

2.3. Proximate Analysis

Proximate analysis is important to evaluate the chemical composition of the sweet potatoes. The properties determined in this study include moisture, ash, protein, fat, carbohydrate and crude fibre. The readings of all the samples were taken in triplicates.

Moisture content refers to the water content in the sweet potato. The information of moisture content is important because it will affect the weight of the sweet potatoes. The moisture content was determined using the AOAC method (AOAC, 2016) whereby 100 g of the sample were weighed after having dried in an oven (UNB 400, Memmert, Germany) at 105°C until the weight is constant. Thereafter, the final weight was then recorded. The moisture content was calculated using the formula shown in Equation (1):

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Final weight}} \times 100 \quad (1)$$

Ash content reflects the inorganic residue that remained in the sample after all the water and organic matter were removed. The ash content was determined using the drying ash method. About 2 g of sample (C1, C2, and C3) were weighed and placed in a muffle furnace for 2–4 hours at 525°C until the residue was completely white. The ash content was calculated using the following formula shown in Equation (2):

$$\text{Ash content (\%)} = \frac{\text{Mass of ash}}{\text{Mass of dry weight}} \times 100 \quad (2)$$

Protein content was evaluated using the Kjeldahl method (Kenneth & Association of Official Analytical Chemist, 1990). This method involved protein digestion and distillation. For the digestion of protein, 2 g of sample and 2 tablets of Kjeldahl Catalyst were added into a Kjeldahl flask. Next, 25 mL of concentrated sulphuric acid (H₂SO₄) was added into the Kjeldahl flask. The Kjeldahl flask was then subjected to the digestion process at a temperature above 420°C for 1 hour. The flask was allowed to cool after 1 hour digestion. After that, the distillation process was run automatically using the Kjeltec distillation apparatus (Kjeltec™ 2300, Foss Analytical, Denmark). After 1–5 minutes of the distillation process, the reading indicating the percentage content for the sample was taken and recorded.

The fat content was determined by following the Soxhlet extraction method using Soxtec™ 2050, Foss Analytical, Denmark. An amount of 1 g of sample powder was added to the labelled thimbles and covered with cotton wool. Then, 80 mL of petroleum ether was poured into an aluminium cup. The Soxhlet apparatus was allowed to reflux for 75 minutes. After that, the aluminium cup was dried at 105°C for 1 hour and allowed to cool. The cooled aluminium cup was then weighed. The fat percentage was calculated according to (Kenneth & Association of Official Analytical Chemists, 1990) following Equation (3):

$$\text{Fat content (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100 \quad (3)$$

The crude fibre content was analysed using the method described by AOAC (1990) using fibertec analysis (Fibertec™ 2010, Foss Analytical, Denmark). About 1 g of sample and 1 g of Celite 545 diamotaceous were dissolved in 200 mL of boiling 0.25N H₂SO₄ for 30 minutes using the fibertec machine. The mixture was filtered through the crucible and rinsed with hot water. Then, 200 mL of boiled 0.313N sodium hydroxide (NaOH) was added to the crucible and boiled for another 30 minutes. The sample was filtered and rinsed again using hot water. Next, the crucible with the sample was dried in an oven at 105°C until a constant weight was achieved. The dried sample was then placed in a furnace at 550°C for 4 hours until a complete burn was attained. Cooled the crucible in a desiccator until a constant weight was achieved and calculated using the formula shown in Equation (4) (AOAC,1990):

$$\text{Crude fibre (\%)} = \frac{\text{Weight of residue without ash}}{\text{Weight of sample}} \times 100 \quad (4)$$

Carbohydrate content was calculated using the difference method. The carbohydrate content was calculated by subtracting the percentage of ash, moisture, fat and fibre from the total weight of the sample. This method followed the formula by Rand *et al.* (1991) which is shown in Equation (5):

$$\text{Carbohydrate (\%)} = 100 - (\text{ash (\%)} + \text{moisture (\%)} + \text{protein (\%)} + \text{fat (\%)} + \text{fibre (\%)}) \quad (5)$$

2.4. Statistical Analysis

The data collected was analysed using SPSS Statistics 22.0 Edition. One-way Analysis of Variance (ANOVA) and Duncan's test were used to evaluate the significant differences between mean values. All the values were measured at a confidence level of 95% ($p < 0.05$). Each analysis was done in triplicate.

3. Results and Discussions

3.1. Hunter Colour

Results for the colour parameters L, a and b subjected to three conditions of sweet potato (C1, C2 and C3) are presented in Table 1. The ranges of colour parameters L, a and b were ranged from 68.0–89.2, 0.48–5.65 and 11.67–13.27, respectively. C1 was found to have the significantly ($p < 0.05$) highest value of L (89.2) followed by C2 (84.76) and C3 (68.0). This result showed that C1 powder was lighter in colour than C2 and C3. A higher value of L reflected the whiter product, which is desired in food processing. It is because the L value is commonly related to the freshness of food (Pankaj *et al.*, 2013). The brighter colour of sweet potato powder will give better quality for the end products of sweet potato. For the a value, C3 showed significantly ($p < 0.05$) highest value (5.65) compared to C2 (1.82) and C1 (0.48). All the a values for three conditions showed positive values which mean that the sweet potato powder was rich in red colouration. Since this variety of sweet potato is purple in colour, the high value of a might be related to the anthocyanin content (Chin-Chia *et al.*, 2019). For the b value, all the conditions showed a yellowness colour because all the values were positive. C1 had the highest value of b compared to other conditions. However, the value was not significant from C2 but significantly ($p < 0.05$) with C3. The yellowness colour of food is related to the flavonoid content. The high colour value of b might be caused by the accumulation of flavonoids through the combination of flesh and skin (Ana *et al.*, 2017).

Table 1. Hunter Colour of orange Japanese sweet potato flour.

Samples	L	a	b
C1	89.20±0.006 ^a	0.48±0.03 ^c	13.27± 0.03 ^{ab}
C2	84.76±0.01 ^b	1.82±0.02 ^b	13.25±0.03 ^b
C3	68.0±0.006 ^c	5.65±0,02 ^a	11.67±0.07 ^c

Values are means ± standard deviation (n=3), and values followed by the same lowercase letters in the same row are not significantly different ($p>0.05$)

C1: Powder from whole tuber

C2: Powder from peeled tuber

C3: Powder from skin of tuber

3.2. Proximate Analysis

Furthermore, the results from proximate analysis are presented in Table 2. The moisture content was observed to be significantly ($p<0.05$) high in C1 (7.86%) followed by C2 (7.17%) and C3 (5.93%). A higher level of moisture content could lead to microbial spoilage and subsequent deterioration in quality. Therefore, the sweet potato powder produced should have a low level of moisture content to avoid spoilage due to the microbial activity (Nafeesa *et al.*, 2012). Hal (2000) stated that a value of 12.5% was considered as critical moisture content of flour within a locality at an ambient temperature of 27–29°C while 10% has been recommended for long term storage. All the results showed that the value of moisture below 13%. Therefore, the moisture content of sweet potato powders produced was safe for storage starch and will create a good quality of end product.

It can be seen from the data in Table 2 that the C3 reported significantly more ash content than the other two conditions; C1 and C2. The range of ash content reported in this study was 2.64–8.11% which is higher than the previous study by Nafeesa *et al.* (2012). The observed data showed that the peel (C3) contained high value of ash content than flesh. Interestingly, this result was in agreement with Nafeesa *et al.* (2012) and Woolfe (1992) findings which showed that the ash content of the sweet potato peel is higher compared to the flesh.

The protein content was reported significantly ($p<0.05$) higher in C2 (5.47%) compared to C1 (4.86%) and C3 (4.64%). The results obtained were higher than the protein content reported by Nafeesa *et al.* (2012). The protein content for this variety was observed to be higher in the flesh compared to the skin.

Looking at Table 2, it is apparent that the skin (C3) (0.70%) showed significantly more lipid or fat content than C2 (0.27%) and C1 (0.06%). Overall, the sweet potato powders produced were contained low lipid or fat content. This finding is consistent with Aina *et al.* (2009) that also reported low content of fat for 21 Caribbean sweet potato cultivars.

Table 2 also illustrates the carbohydrate content of three different conditions of sweet potato powder. From the Table, C2 (86.96%) showed a high value of carbohydrate but not significant from C1 (85.74%). However, it was significant from C3 (65.96%). The carbohydrate content was observed to be higher in the flesh compared to the skin. The value of carbohydrates in C1 and C2 were in range with the typical sweet potato reported by Rodrigues *et al.* (2016) which is 85.8–88.2%.

The crude fibres for all samples were ranged from 1.00–2.43%. The skin (C3) (2.43%) was found to have the significantly ($p < 0.05$) highest crude fibre content compared to two other conditions; C1 (1.00%) and C2 (1.51%). The crude fibre obtained in the present study was low compared to the study by Rodrigues *et al.* (2016) which was between 2.57–3.68%.

Table 2. Proximate composition of orange Japanese sweet potato powder.

Samples	C1	C2	C3
Moisture (%)	7.86±0.014 ^a	7.17±0.01 ^b	5.93±0.012 ^c
Ash (%)	2.64±0.13 ^c	3.55±0.11 ^b	8.11±0.26 ^a
Protein (%)	4.86±0.034 ^b	5.47±0.01 ^a	4.64±0.037 ^c
Lipid (%)	0.06±0.05 ^c	0.27±0.11 ^b	0.70±0.12 ^a
Carbohydrate (%)	85.74±1.27 ^b	86.96±1.56 ^{a,b}	65.96±2.62 ^c
Crude fibre (%)	1.00±0.02 ^c	1.51±0.35 ^{b,c}	2.43±0.37 ^a

Values are means ± standard deviation (n=3), and values followed by the same lowercase letters in the same row are not significantly different ($p > 0.05$)

4. Conclusion

The purpose of the current study was to determine the effects of three different conditions (C1, C2 and C3) of Japanese sweet potato on its physicochemical properties. This study was set out to determine whether the different conditions of sweet potato will affect the physicochemical properties. This study has found that generally, the conditions of sweet potato powder affect most the physicochemical properties. The findings of this study suggest that the whole tuber (C1) has a better quality of physicochemical properties which can be used as a substitute in the processing of sweet potato products.

Acknowledgement: The authors express their gratitude to the Universiti Putra Malaysia for providing financial and technical support under grant GP-IPB/2018/9660301 to conduct this research work.

Conflicts of Interest: The authors declare no conflicts of interest.

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