Pertanika J. Sci. & Technol. 30 (4): 2463 - 2476 (2022)

PERTANIKA JOURNALS

SCIENCE & TECHNOLOGY

Journal homepage: http://www.pertanika.upm.edu.my/

# Evaluation of Phytochemical and Mineral Composition of Malaysia's Purple-Flesh Sweet Potato

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## ABSTRACT

Sweet potato (*Ipomoea batatas* (L.) Lam) is one of Malaysia's underutilized main crops. However, systematic characterization of phytochemical and mineral contents of the sweet potato tuber and flour is still required for further specific food product development. Therefore, this study aims to evaluate the effects of the peeling conditions on the nutritional composition of sweet potato tuber and flour of the *Anggun 1* cultivar. The following properties were investigated in the different peeling conditions of the sweet potato tuber (unpeeled, peeled, and skin only), i.e., the phytochemical properties (total phenolic, total flavonoid, anthocyanin content) and mineral elements (calcium and iron). The results indicated a significant interaction between the peeling conditions of the sweet potato tuber and flour on all the examined properties ($p<0.05$), total flavonoid content (2615.05 mg quercetin/100g and 3362.96 mg quercetinrties ($p < 0.05$). The unpeeled sweet potato tuber and flour had the highest value of total phenolic content (3142.98 mg GAE/100g and 4303.80 mg GAE/10/100g), anthocyanin (628.35 mg/100g and 960.30 mg/100g) and iron (5.45 mg/100g for flour only). Moreover, the result had indicated a higher calcium content (701.87 mg/100g) in the skin of the sweet potato. Therefore, this study provides a broad insight into the

ARTICLE INFO

*Article history:*
Received: 29 July 2021
Accepted: 16 February 2022
Published: 15 September 2022

DOI: https://doi.org/10.47836/pjst.30.4.09

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ISSN: 0128-7680
e-ISSN: 2231-8526

sweet potato's phytochemical properties and the mineral composition, which can be used for further specific food product development and processing.

*Keywords:* Anthocyanin, calcium, iron, purple sweet potato, total flavonoid, total phenolic

## INTRODUCTION

The sweet potato is a tuber crop widely consumed in the human diet, eaten either fresh or processed in meals and beverages. Sweet potato has been ranked 7th among staple foods globally for its multiple nutritional benefits (Tan, 2015). Malaysia accounts for an increment from 26,582 in 2011 to 41,245 in 2017 tons of production, mainly from the states of Perak, Kelantan, and Terengganu (Yusoff et al., 2018). The Malaysian Agriculture and Development Institute (MARDI) has developed many famous varieties of sweet potatoes, such as Jalomas, Gendut, and VitAto. In 2017, MARDI had released three types of *Anggun* viz., *Anggun 1, Anggun 2* and *Anggun 3*. They have similar purple skin and flesh but differ in morphological characteristics (Shafienaz et al., 2019). However, *Anggun 1* (Figure 1) was recognized as the ideal one as it has the ideal shape that meets the customer demand. Moreover, it also has a high anthocyanin content, is capable of survival in low-fertility soil, and is tolerant to drought and disease, making this variety one step further than the other varieties of sweet potatoes (Shaari et al., 2021).

The sweet potato storage roots make important dietary contributions of dietary fibers, carbohydrates, minerals (calcium, magnesium, potassium, and zinc), and vitamins (C, B1, B2, E, and A). Often, minerals such as calcium (Ca) and iron (Fe) are deficient in human diets. In addition, in human diets, the recommended daily intake (RDI) of iron for males and females is 8 mg/day and 18 mg/day (Trumbo et al., 2001). The deficiency of iron is the sixth leading cause of illness and disease. Other than the mineral compounds, sweet potato also contains phytochemical properties (Alam et al., 2016), which commonly exist in the purple-flesh sweet potato phenolic and anthocyanin content, which has better radical scavenging activity than the red cabbage, grape skin, and purple corn (Rumbaoa et al., 2009). Phenolics are molecules that consist of at least one aromatic ring and one or more hydroxyl groups (Shen et al., 2009). These phenolic compounds are responsible for the antioxidant activities that scavenge the free radicals. Free radicals are unstable and highly reactive atoms or molecules with at least one or more unpaired electrons. Over-

*Figure 1*. The local sweet potato *Anggun* 1 variety

production of free radicals can damage biomolecules (lipids, proteins, DNA), which can eventually cause many chronic diseases in humans, such as cancer, cardiovascular disease, diabetes, and atherosclerosis (Fang et al., 2002; Uttara et al., 2009). An antioxidant is a stable molecule that helps to reduce the damage by donating an electron to a charged free radical and neutralizing it (Lobo et al., 2010).

Various products can be obtained from sweet potatoes, such as cookies, biscuits, muffins, noodles, and pies, with a longer shelf-life and improved characteristics. The sweet potato tuber is transformed into good processed goods, for example, flour, which is less bulky and more stable. Flour can be utilized as a thickener in soup, gravy, fabricated snacks, and bakery products (Ahmed et al., 2010). A study by Van Hal (2000) has reported that the unpeeled flour is darker than the peeled flour due to the effect on the phenolic content. It was found that the phenolic content was high on the outer surface of the sweet potato and thus increased the action of the oxidase enzyme, which led to the browning effect. Based on the common method of processing through direct grinding without peeling off its surface will shorten the processing procedure, and more nutrients are retained. In the previous study by Shaari et al. (2021), it was observed that flour processed from unpeeled sweet potatoes reduced the loss of physical and chemical properties and enhanced the stability of the sweet potato with better nutritional value, such as carbohydrate and fiber.

In Malaysia, while other crops such as rice, cassava, and potato have obtained more attention among researchers, the sweet potato has very limited available literature resources. It includes the phytochemical and nutrients contents of the different parts of the local sweet potato (Shaari et al., 2020; Zulkifli et al., 2021). Some studies have been conducted on the nutrient and phytochemical composition of the new sweet potato VitAto and the different *Anggun* varieties (Yusoff et al., 2018; Shaari et al., 2020; Zulkifli et al., 2021), but the composition of the cultivated sweet potatoes on the different peeling conditions is yet to be explored. In this current study, the different peeling conditions (unpeeled, peeled, and skin only) of the *Anggun 1* sweet potato cultivar that is grown in Malaysia are analyzed in terms of its nutritional composition through the assessments of phytochemical properties (total phenolic, total flavonoid, and anthocyanin content) and minerals (Calcium and Iron). Therefore, this study will provide knowledge and guidance on the effects of the different peeling conditions on the phytochemical properties of the *Anggun 1* sweet potato, which will be a benefit in developing comprehensive processing of sweet potato in the future.

## MATERIALS AND METHODS

### Plant Material

The sample preparation was adapted from the method described by Shaari et al. (2020). The sweet potato cultivar (*Ipomoea batatas* Lam cv. *Anggun 1*) was grown and harvested on a local farm located at Semenyih, Selangor (Malaysia). The farmers harvested the sweet

potato after 3 to 4 months of plantation according to the maturation stage (Van de Fliert & Braun, 1999). About three hundred and fifty tubers (~20 kg) were selected and transported to the laboratory. The tubers were washed with tap water to remove the dirt and soil. After being air-dried at a room temperature of 27°C, the washed tubers were stored at 4°C for further analysis.

### Preparation of Sweet Potato Raw Tubers

The sweet potato tubers were divided into three groups. In the first group (C1), unpeeled sweet potatoes were cut into slices of 5 mm in thickness (Amir et al., 2017) using a sharp stainless-steel knife (86902, John Craft, Malaysia). For the second group (C2), the sweet potatoes were peeled with a hand peeler (Peeler Stainless Steel 22, Barbarian, Thailand). For the third group (C3), the skins of the sweet potatoes were peeled about 1 mm in thickness from the tuber. All the prepared samples for phytochemical and nutritional factors were placed in an auto seal bag and kept in a desiccator to inhibit the addition or reduction of moisture.

### Preparation of Sweet Potato Flour Sample

The sweet potato tubers were divided into three groups, as mentioned in Section 2.2. Then, all the samples were oven-dried at 60°C for 7–8 hours using a DO6836 oven (Memmert GmbH, Schwabach, Germany) until they reached a 6–7% moisture content (Ahmed et al., 2010). Next, the flour was obtained by grinding the dried samples using a laboratory-scale grinder (HR-20B-AEC, AEC Machinery, Malaysia) and sieved through a 300 µm sieve (AS200, Retsch, Germany). Finally, the flour samples were packaged in plastic bags, sealed, and stored in a chiller (LF817LD, ASϵC0®, Japan) at 4°C for further analysis.

### Determination of Phytochemical Properties

**Extraction of Sample.** The extraction of the sample has followed the method of (Huang et al., 2006). Approximately 1 g of sweet potato tuber and flour samples (C1, C2, and C3) were treated with 15 ml of 80% methanol and centrifuged at 1600 × g for 15 min. The supernatant was collected while the remaining suspension was re-extracted using another 10 ml of 80% methanol, and the process was repeated. The collected supernatant was combined and filtered through Whatman No. 4 filter paper into a 25 ml volumetric flask. The extracts were diluted to the volume and were stored at 4°C until further analysis.

**Total Phenolic Content (TPC).** Determination of total phenolic content (TPC) was used to determine the amount of phenolic content in the samples. According to the Folin-Ciocalteau (FC) assay, the TPC was measured by Huang et al. (2006). First, 0.2 ml of an aliquot from the prior extract was mixed with 1.0 ml of Folin-Ciocalteau's reagent and 0.8

ml of 7.5% (w/v) sodium carbonate solution. Next, the mixture was homogenized using a vortex (EE0475051, Cole Palmer, United States) and allowed to stand for 30 min at room temperature. Then, the absorbance of the sample was measured versus a blank at 765 nm using a UV-Vis spectrophotometer (LT 291, Uvsar, India). Finally, Gallic acid was used as a standard solution, and the results were expressed as gallic acid equivalent (mg GAE $g^{-1}$).

**Total Flavonoid Content.** The total flavonoid content (TFC) was determined by following the spectrophotometric method based on the aluminum chloride ($AlCl_3$) complexation (Huang et al., 2006). Approximately 0.5 ml of an aliquot from the previous extract was reacted with 1.0 ml of 2% (w/v) methanolic aluminum chloride ($AlCl_3$. $6H_2O$) and was mixed using a vortex (EE0475051, Cole Palmer, United States). The mixture was kept for 10 min at a room temperature of 27°C. Then, the absorbance was taken using a spectrophotometer at 430 nm versus a blank. The TFC of the sample was calculated using a calibration curve of quercetin and expressed as mg quercetin $g^{-1}$.

**Anthocyanin.** The anthocyanin content was determined according to Huang et al. (2006). Approximately 0.5 g of sample was extracted and centrifuged at 1600 × g for 15 min with 10 ml of acidified methanol (1% hydrochloric acid (HCl). Then, the supernatant was collected, and the suspension was extracted again using another 10 ml of acidified methanol. The process was repeated twice. Finally, the supernatant collected was combined in a 25 ml volumetric flask and diluted to volume. The absorbance was read at 530 nm. The anthocyanin content for the samples was determined according to Equation 1:

$$\text{Anthocyanin content (mg } 100g^{-1}) = A \times MW \times DF \times 100/(\varepsilon \times W) \quad (1)$$

Where;
A = absorbance
MW = molecular weight of cyanidin-3-glucoside chloride ($C_{21}H_{21}ClO_{11}$,484.84 Da)
DF = Dilution factor
ε = Molar absorptivity (34,300)
W = sample weight (g)

## Determination of Mineral Composition

**Mineral (Calcium and Iron).** Calcium (Ca) and Iron (Fe) were determined using inductively coupled plasma-atomic emission spectrometry (ICP-AES) (Sun et al., 2011). First, 0.25 g of flour samples (C1, C2, and C3) were weighed into a polytetrafluoroethylene digestion tube, and 8 mL 65% (v/v) $HNO_3$ was added for pre-digestion. After 1 h, 30% (v/v) $H_2O_2$ was added and digested using a microwave digestion system (MARS 5, CEM Co., Matthews, NC, USA). Then, the digested solution was diluted with 100 mL Milli-Q

water (Bedford, MA, USA) and stored at 4°C in plastic tubes for further analysis. The mineral elements were measured with the following operating conditions: radio frequency power, 1280 W; nebulization chamber temperature, 20°C; sampling depth, 8 mm; cooling rate, 1.47 L $min^{-1}$; carrier gas flow rate, 1 L $min^{-1}$ and auxiliary gas flow rate, 1 L $min^{-1}$.

### Statistical Analysis

All the analyses were done in triplicate, and the data were analyzed as mean values and standard deviation (SD) using the one-way analysis of variance (ANOVA) of IBM Statistic 22.0. According to Tukey HSD (Honestly Significant Difference), significant differences were established and determined at $p \leq 0.05$. The correlation coefficient was performed using the Statistical Package for Social Sciences (SPSS Inc. Waker Drive, Chicago, IL, USA).

## RESULTS AND DISCUSSION

### Determination of Phytochemical Properties

**Total Phenolic Content (TPC).** Table 1 shows the experimental data of the total phenolic content of the sweet potato tuber and flour samples at three different conditions (C1, C2, and C3). For the tuber sample, TPC values of C1, C2, and C3 were 3142.98±27.39, 1916.37±61.46**,** and 1189.77±55.88 mg GAE $100g^{-1}$, respectively. The highest TPC was found in C1 (3142.98±27.39 mg $100g^{-1}$), and it was greater than the reported data by (Akyol et al., 2016), where they found the TPC of potato tubers ranged from 0.5 to 0.6 mg $100g^{-1}$ fresh matter. By comparing the TFC value of C2 and C3, C1 is the highest due to the accumulation of phenolic compounds in the flesh of the sweet potato (Shaari et al., 2020). After peeling the skin, the sweet potato tuber showed a significant TPC reduction

Table 1
*Effect of peeling conditions on the total phenolic, total flavonoid, and anthocyanin content of Anggun 1*

| Sample | Total phenolic content (TPC) (mg GAE $100g^{-1}$) | | Total flavonoid content (TFC) (mg quercetin $100g^{-1}$) | | Anthocyanin (mg $100^{-1}$) | |
|---|---|---|---|---|---|---|
| | **Tuber** | **Flour** | **Tuber** | **Flour** | **Tuber** | **Flour** |
| C1 | 3142.98 ± 27.39 $^{aB}$ | 4303.80 ± 35.45 $^{aA}$ | 2615.05 ± 29.34 $^{aB}$ | 3362.96 ± 34.07 $^{aA}$ | 628.35 ± 46.38 $^{aB}$ | 960.30 ± 6.75 $^{aA}$ |
| C2 | 1916.37 ± 61.46 $^{bB}$ | 4166.37 ± 30.81 $^{bA}$ | 2480.05 ± 39.48 $^{aB}$ | 2957.95 ± 63.75 $^{bA}$ | 541.46 ± 24.75 $^{aB}$ | 942.88 ± 7.54 $^{bA}$ |
| C3 | 1189.77 ± 55.88 $^{cB}$ | 2890.06 ± 74.22 $^{cA}$ | 2290.08 ± 81.92 $^{bB}$ | 2604.30 ± 66.96 $^{cA}$ | 333.48 ± 42.38 $^{bB}$ | 521.08 ± 2.26 $^{cA}$ |

± **SD** – standard deviation; **C1 –** Whole tuber; **C2 –** Peeled tuber; **C3 –** Skin of tuber. Different small letters within the same column indicate statistical difference ($p < 0.05$) among the processing conditions (C1, C2, C3), while different capital letters (A, B) within the same row indicate statistical difference ($p < 0.05$) among the different sweet potato form (raw, flour) on the Tukey's HSD comparison test.

($p < 0.05$) by 39.03% in C2. It might be due to removing the skin, where the skin (C3) had contributed a huge portion of TPC in C1 by 37.85%. It agreed with Mondy and Gosselin (1998), who stated that the skin of the sweet potato tuber is known to be high in phenolic content.

Similarly, the TPC of the sweet potato flour varied significantly ($p < 0.05$) under the different conditions. C1 had the highest TPC (4303.80± 35.45 mg GAE $100g^{-1}$), whereas C3 (2890.06± 74.22 mg GAE $100g^{-1}$) had the lowest. After peeling, the sweet potato flour showed a slight TPC change ($p < 0.05$) in C2, about 3.19%. This finding was contradicted by Yin et al. (2016), who had found a greater value of TPC in the skin (648.65 mg $100g^{-1}$) rather than in the flesh (89.12 mg $100g^{-1}$) of potato flour. In addition, the flour samples contained a higher TPC compared to the tuber samples. This finding agreed with the study by Ruttarattanamongkol et al. (2016), who found that the TPC flour sample of the purple-fleshed sweet potato (Phicit 65-3) was higher than the raw potato sample. The heat treatment during the drying process could cause damage to the cell structures of the sweet potato tissues and result in more easy extraction of antioxidant properties such as phenolic, flavonoid, anthocyanin, and carotenoid (Huang et al., 2006; Tokusoglu & Yildirim, 2012).

A significant difference ($p < 0.05$) was found between the tuber and flour samples in each condition. The sweet potato flour's TPC of C1, C2, and C3 increased to 4303.80±35.45, 4166.37±30.81, and 2890.06 mg GAE $100g^{-1}$ were 26.97, 54.00, and 58.83% higher than those that were in tuber conditions, respectively. These indicated that the sweet potato flour had retained more TPC than the tuber. It might be due to the drying process experienced by the sweet potato flour, where the thermal treatment had released more bound phenolic from the breakdown of cellular structure (Yang et al., 2010). Furthermore, this study has provided further support for the hypothesis that the skin contributes a high TPC to the sweet potato. According to Friedman (1997), phenolic compounds usually accumulate in the peel of potato tubers than in the flesh. Almost 50% of phenolic were found in the peel and adjoining tissues of the tubers, and their concentration decreased towards the center of the tuber (Friedman, 1997; Yang et al., 2010). Hence, to acquire more TPC from the sweet potato, the suggestion is to maximize the usage of the skin rather than discard it.

**Total Flavonoid Content (TFC).** The experimental data of total flavonoid content (TFC) for the different conditions (C1, C2, and C3) of the sweet potato tuber and flour samples are summarized in Table 1. The TFC of the sweet potato tuber sample in the different conditions of C1, C2, and C3 were 2615.05±29.43, 2480.05±39.48, and 2290.08±81.92 mg quercetin $100g^{-1}$, respectively. The TFC found in this current *Anggun* study variety with purple-fleshed was higher than the fresh white-fleshed potato (30 mg $100g^{-1}$) (Perla, Holm, & Jayanty, 2012). The result showed that C1 had the highest TFC while C3 had the lowest TFC ($p < 0.05$). There was no significant difference observed between C1 and C2. It means that peeling does not affect the reduction of TFC in sweet potato tuber.

For sweet potato flour, the measured values of TFC in C1, C2, and C3 were 3362.96±34.07, 2957.95±63.75**,** and 2604.30±66.96 mg quercetin $100g^{-1}$, respectively. The TFC of sweet potato flour varied significantly ($p < 0.05$) under different conditions. Similarly, it is shown that the highest TFC value was reported in C1 while the lowest value resulted in C3. After the peeling process, the TFC in C2 reduced significantly ($p < 0.05$) from C1 to around 12.01%. This result is in agreement with the finding by Khajehei, Merkt, Claupein, and Graeff-Hoenninger (2018), where they have found that the TFC in New Zealand yacon tubers has decreased significantly ($p < 0.05$) from 3221.47 to 1041.689 mg RE $100g^{-1}$ dry weight after the skin removal.

After the sweet potato tuber was processed into flour, a significant difference ($p < 0.05$) was obtained between the tuber and flour samples. The TFC of C1, C2, and C3 of the flour sample was significantly higher ($p < 0.05$) than those tuber samples by 22.24, 16.16, and 12.07%, respectively. In addition, this study has shown that the skin of the sweet potato tuber and flour samples have a large contribution of TFC to the unpeeled sweet potato. It agrees with the result of the yacon tuber skin that contains high amounts of TFC (Khajehei et al., 2018). TFC represents the most common group of plant phenolic compounds, and their existence will influence the flavor and color of fruits and vegetables (Akyol et al., 2016). Furthermore, major bioactive compounds promote many potential health benefits, which have been used against chronic diseases, such as antiviral, cancer, inflammation, cardiovascular and neurodegenerative disorders. Therefore, from a quality and nutritional perspective, the suggestion for sweet potato consumption, including its skin, could maximize the intake of TFC in the human body.

**Anthocyanin.** As illustrated in Table 1, the anthocyanin content for the different conditions (C1, C2, and C3) of the sweet potato tuber and flour samples were observed. Based on the results obtained from the tuber sample, the anthocyanin content of C1, C2, and C3 were 628.35**±**46.38, 541.46±24.75, and 333.48±42.38 mg $100g^{-1}$, respectively. All the conditions in this current study showed a higher anthocyanin content than the potato studied by Yin et al. (2016). A significant ($p < 0.05$) highest value of anthocyanin content was exhibited in C1 and C2, while C3 showed the lowest value. There was no significant difference found between C1 and C2. This result was supported by the finding of Steed and Truong (2008), who had also found the insignificant value of anthocyanin content between unpeeled and peeled sweet potatoes. Therefore, it was suggested that peeling did not affect the reduction of the anthocyanin content. Furthermore, this current study found that the average anthocyanin content in the peeled sweet potato (C2) is higher than the skin (C3) by 1.6 times. In contrast to this finding, Steed and Truong (2008) and Albishi et al. (2013) have found more anthocyanin content in the skin than in peeled potatoes. This difference may result from multiple factors such as variety, several cultivars investigated, the thickness of skin peeled, and the methods of anthocyanin extraction.

Meanwhile, the anthocyanin content for C1, C2, and C3 in the sweet potato flour ranged from 521.08 to 960.30 mg/100g. On average, C1 had the highest anthocyanin (960.30±6.75 mg/100g), whereas C3 had the lowest anthocyanin (521.08±2.26 mg $100g^{-1}$). The results showed a significant difference ($p < 0.05$) between each condition. After peeling, there was a slight change in the anthocyanin content of C2, about 1.81% ($p < 0.05$). Contrary to the result of the sweet potato tuber, peeling affects the anthocyanin content of the sweet potato flour. In addition, the mean anthocyanin content in the C2 was higher than in C3 by 44.74% ($p < 0.05$).

The anthocyanin content of the sweet potato tuber was significantly increased ($p < 0.05$) after being processed into flour. Higher anthocyanin content in the sweet potato flour rather than in the tuber was expected due to the inactivated enzymes that degraded the anthocyanin pigments and other antioxidant compounds (Aziz et al., 2018). Sweet potato is a good source of anthocyanin, and the level of this compound is increased when it is processed in a different form. Moreover, the evidence that has been presented in this section provides that the unpeeled sweet potato has reported higher rates of anthocyanin content compared to other conditions. This high value is contributed by the skin of the sweet potato, which is rich in anthocyanin content. Anthocyanin is often associated with preventive health effects and reduces risks of age-related macular degeneration (Jang et al., 2005), anti-carcinogenic activity, and cardiovascular disorders (Mazza, 2007). Therefore, concerning this aspect, it is suggested that the sweet potato is consumed unpeeled rather than peeled to maximize the anthocyanin intake.

## Determination of Mineral Composition

**Calcium.** The variation of calcium for different conditions in the sweet potato flour is shown in Table 2. The present study's finding indicates that C1, C2, and C3 have exhibited a calcium content of 242.33±6.20, 216.98±10.93, and 701.87±2.61 mg $100g^{-1}$, respectively. The calcium content of C2 showed a higher value than Boni et al. (2018), which reported the calcium content ranged from 30 to 47 mg $100g^{-1}$ for peeled sweet potato cultivars of *Kabode*, *Irenei, Fatoni, Tib,* and *BelaBela*. The change in calcium content in the sweet potatoes may be attributed to the differences in cultivars, climate, soil type, geographical location, and several other factors (Boni et al., 2018). Furthermore, C3 has significantly shown the highest ($p < 0.05$) calcium content of other conditions. The greatest difference was noted, in which the calcium content was as much as three times higher in the skin (C3) than in the flesh (C2). Similar observations have been made by Czech et al. (2020), who have also found calcium content in all citrus fruits to be more than 50% higher ($p < 0.05$) in the peel than in the pulp. Therefore, removing the sweet potato skin greatly reduces its nutritional value and allows this element to enter the environment. A finding has shown that the human digestive tract absorbs calcium of vegetable origin; hence, its loss should be limited by including the sweet potato skin during consumption (Yang et al., 2012).

Table 2
*Effect of peeling condition on the calcium and iron content of Anggun 1*

| Sample | Mineral (Calcium) (mg $100g^{-1}$) | Mineral (Iron) (mg $100g^{-1}$) |
|---|---|---|
| | **Flour** | **Flour** |
| C1 | 242.33 ± 6.20 $^{b}$ | 5.45 ± 3.04 $^{b}$ |
| C2 | 216.98 ± 10.93 $^{a}$ | 5.26 ± 1.30 $^{ab}$ |
| C3 | 701.87 ± 2.61 $^{c}$ | 4.84 ± 0.93 $^{ab}$ |

± **SD** – standard deviation; **C1 –** Whole tuber; **C2 –** Peeled tuber; **C3 –** Skin of tuber. Results involving flour only. Different small letters within the same column indicate statistical difference ($p < 0.05$) among the processing conditions (C1, C2, C3), while different capital letters (a,b) within the same row indicate statistical difference ($p < 0.05$) among the different sweet potato form (raw, flour) on the Tukey's HSD comparison test.

**Iron.** Table 2 presents the effects of the conditions (C1, C2, C3) on the iron content of sweet potato flour. The means of iron contents for C1, C2, and C3 were obtained as follows, 5.45±3.04, 5.26±1.30**,** and 4.84±0.93 mg $100g^{-1}$, respectively. However, no significant difference ($p > 0.05$) was found between the conditions. Ju et al. (2017) found a lower iron content in the sweet potato, ranging from 0.782 to 1.818 mg $100g^{-1}$. On the other hand, Dako et al. (2016) and Senanayake et al. (2013) have found a higher iron content in the sweet potato varieties from Sri Lanka (4.2 to 6.3 mg $100g^{-1}$) and Ethiopia (8.7 to 11.45 mg $100g^{-1}$). Iron is responsible for many metabolic reactions. It involves a component of heme proteins, such as hemoglobin and myoglobin, in the human body. In addition, it is also a part of enzymes, such as cytochromes, catalases, and peroxidases (Antoine et al., 2012). Hence, C1, C2, and C3 cannot be classified as 'rich in' or a 'source of' iron due to the lower iron content. As suggested, the intake of sweet potatoes should be complemented with other food components to achieve the desired RDI.

## CONCLUSION

This study determines the effects of peeling on the phytochemical properties and mineral elements of the most important sweet potato cultivar (cv. *Anggun 1*) harvested in the western region of Malaysia. The result showed that the peeling conditions had significant effects ($p < 0.05$) on some quality attributes, including the phytochemical and mineral content. On the other hand, the unpeeled sweet potato tuber and flour had a better nutritional composition by assessing phytochemical properties and mineral elements compared to other peeling conditions. Therefore, it is proven that the unpeeled sweet potato has a more significant condition in improving the quality of the sweet potato and could contribute to more potential applications in the food industry. Therefore, to maximize sweet potato usage and minimize its waste, it is suggested that the food processing industry uses unpeeled sweet potatoes.

## ACKNOWLEDGMENTS

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.

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