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FULL PAPER

Phenolic, flavonoid and anthocyanin contents of local sweet potato (*Ipomoea batatas*)

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Abstract

The sweet potato (*Ipomoea batatas*) is an annual herb of the family Convolvulaceae and ranked as the world's seventh most important food crop with a major contribution to energy and phytochemical source of nutrition. Three different conditions of sweet potatoes are unpeeled tuber (UPSP), peeled tuber (PSP) and skin of tuber (SSP). The objective of this study is to evaluate the phytochemical availability (total phenolic contents (TPC), total flavonoid contents (TFC) and anthocyanin content) in the different parts of the sweet potato tuber. Folin-Ciocalteau (FC) assay showed that phenolic contents for UPSP (41.14±1.69 mg GAE/100 g dry basis) and PSP (42.24±2.19 mg GAE/100 g dry basis) were significantly (50%) higher than SSP (26.01±2.04 mg GAE/100 g dry basis). In terms of flavonoid content, the highest value was retained in PSP (9.55±0.82 mg quercetin/100 g dry basis) followed by UPSP (3.30±0.19 mg quercetin/100 g dry basis) and SSP (1.43 ± 0.03 mg quercetin/100 g dry basis). PSP (9.43±0.08 mg/100 dry basis) had a higher anthocyanin content compared to UPSP (5.21±0.02 b mg/100 g dry basis) and SSP (5.21±0.02 b mg/100 g dry basis). The phytochemical properties were available in all conditions of the sweet potato. However, PSP was suggested to be the most preferable condition for further processing in the sweet potato industry.

1. Introduction

The sweet potato or 'Ubi Keledek' (*Ipomoea batatas*) is a staple food throughout the world. The sweet potato is well-known globally because of its desirable properties. The shape of the sweet potato can be in fusiform globular, round or ovate with a smooth, ridged or rough surface. The skin colour varies from white to yellow, orange, red, purple or brown while the flesh may be white, yellow, orange, reddish or purple (Lebot, 2009). Its weight ranges from 150 to 250 g as described by Rosnani *et al*. (2017). The sweet potato has a significant supply in terms of energy supplement and as a phytochemical source of nutrition (Shekhar *et al.,* 2015). The nutrients in sweet potatoes help in preventing cardiovascular diseases and act as anti-carcinogens (Teow *et al.,* 2007). According to Woolfe (1993), the most abundant compounds in the sweet potato are minerals, vitamins, dietary fibre, and antioxidants such as phenolic acids, anthocyanins, tocopherol and beta-carotene. The phenolic contents and total flavonoids of sweet potato range from 10.13 – 80.78 mg GAE per 100 g and 22.02 – 35.47 mg quercetin per 100 g, dry matter respectively (Huang *et al*., 2005). Huang *et al.* (2005) also reported that the content of anthocyanin ranges from 0.36 – 8.99 mg per 100 g, dry matter.

The nutritional values of crop species need to be improved to fulfil the human desire for the maintenance of optimal health. Accordingly, global scientific research is targeted at gathering knowledge of the nutritional qualities of food crops and improving their values. A lack of information in recognising the possible nutritional values of sweet potato waste will result in its underutilisation. The information available on the nutritional value of this species of sweet potato is limited and fragmented. Knowledge of the nutritional content of this cultivar and its waste will affect the way it is consumed and reduce the wastage of sweet potato. Hence, it is essential to exploit the nutrients available in the sweet potato to improve its nutritional implications. Subsequently, this study aims to evaluate the phytochemical availability (total phenolic contents (TPC), total flavonoid contents (TFC) and anthocyanin

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content) in the different parts of the sweet potato tuber.

2. Materials and methods

2.1 Preparation of sample

The method of sample preparation followed the method by Nurfarhana *et al.* (2019). In brief, sweet potatoes (*Ipomoea batatas*) of the Anggun 1 variety were obtained from a farm in Semenyih, Selangor. Variability was controlled by selecting sweet potatoes from the same variety known as Anggun 1. The whole tuber was cleaned and divided into three parts; unpeeled tuber, peeled tuber and skin of tuber as shown in Figure 1. All the parts were sliced thinly at 5 mm thickness and oven-dried at 60ºC for 24 hrs. The dried samples were ground and sifted to pass through a 250 µm sieve. The sweet potato powder was kept in an airtight container at 4ºC for further analysis.

Figure 1. SSP (Left), UPSP (Middle) and PSP (Right)

2.2 Preparation of Anggun 1 extracts

Sweet potato powders from the three different parts were extracted according to the method of Huang et al. (2005). About 1 g of each sample was treated with 80% methanol (15 mL) and centrifuged at 1600 x *g* for 15 mins. The suspension was re-extracted using another 10 mL of 80% methanol as before. The supernatant was combined and filtered through Whatman No. 4 filter paper and diluted to 25 mL. The extract was stored at 4ºC for further analysis.

2.3 Determination of phytochemical properties

2.3.1 Total phenolic content

Total phenolic content was determined using Folin-Ciocalteau (FC) assay (Huang *et al.,* 2005). The aliquot of extract 0.2 mL was treated using 1.0 mL of Folin-Ciocalteau's reagent and 0.8 mL of 7.5% saturated sodium carbonate solution. After being homogenised using a vortex, the mixture was kept for 30 mins at room temperature. Then, the absorbance was measured versus a blank at 765 nm in a spectrophotometer. The results were expressed as gallic acid equivalent (mg GAE/100 g dry matter) using a gallic acid standard calibration curve. The results were evaluated in triplicate.

2.3.2 Flavonoid content

The spectrophotometric method based on aluminium chloride ($AlCl_3$) complexation was used to determine the content of flavonoid according to previously described steps by Huang *et al.* (2005). An aliquot (0.5 mL) from the extract of the sample in methanol was treated with 1.0 mL of 2% methanolic Aluminium Chloride ($AlCl_3.6H_2O$) and homogeneously mixed using a vortex. After 10 mins, the absorbance was read using a spectrophotometer at 430 nm versus blank. The samples were analysed and calculated using a calibration curve of quercetin for quantification. The results were expressed as mg quercetin/100 g dry matter.

2.3.3 Anthocyanin

The content of anthocyanin was determined according to Huang *et al.* (2005). The sample (0.5 g) was extracted with 10 mL of acidified methanol (1% Hydrochloric Acid (HCl)) and centrifuged at 1600 x *g* for 15 mins. The suspension was re-extracted using an additional 10 mL of acidified methanol. All the supernatant was collected and diluted to 25 mL. The absorbance was measured at 530 nm. The anthocyanin content was determined using the equation below:

$$\text{Anthocyanin content (mg/100 g of dry matter)} = A \times MW \times DF \times 100/(\varepsilon \times W)$$

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

2.4 Statistical analysis

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

3. Results and discussion

3.1 Phytochemical properties

The total phenolic content (TPC) of Anggun 1 for different treatments were expressed as mg GAE/100 g sample and are shown in Table 1. The phenolic content for each analysed sample in the study was observed for UPSP (41.14±1.69 mg GAE/100 g dry basis), PSP

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Table 1. Phytochemical properties of different parts of sweet potato powders

Sample/ treatment	Total phenolic content (mg GAE 100 $^{-1}$, Dry Basis)	Total flavonoid content (mg quercetin 100 $^{-1}$, Dry Basis)	Anthocyanin (mg 100 $^{-1}$, Dry Basis)
UPSP [1]	41.14±1.69 [a]	3.30±0.19 [b]	5.21±0.03 [b]
PSP [2]	42.24±2.19 [a]	9.55±0.82 [a]	9.43±0.08 [a]
SSP [3]	26.01±2.04 [b]	1.43±0.03 [c]	5.21±0.02 [b]

Results were expressed as mean ± standard deviation (n=3). Different superscripts in each column indicate significant difference ($p<0.05$). All data expressed in dry weight basis. [1]UPSP: Powder from unpeeled sweet potato. [2]PSP: Powder from peeled sweet potato. [3]SSP: Powder from the skin of the sweet potato

(42.24±2.19 mg GAE/100 g dry basis) and SSP (26.01±2.04 mg GAE/100 g dry basis). The TPC for UPSP and PSP were observed to be 50% significantly higher ($p>0.05$) than SSP. This might be due to the accumulation of phenolic compounds in the flesh of the sweet potato. The data obtained for UPSP, PSP and SPP were consistent with previous studies by Huang *et al*. (2005), which was 10.13 – 80.78 mg GAE/100 g dry basis and Teow *et al*. (2007) at 0.1 – 42.2 mg GAE/100 g dry basis. However, the study by Ahmed *et al.* (2010) reported a contrastingly lower value for the TPC of unpeeled and peeled sweet potato (4.29 – 8.33 mg/100 g dry basis). The various conditions and type of sweet potato may have contributed to this difference. Ahmed *et al*. (2010) dried the samples at different temperatures (55, 60 and 65ºC) for 7 – 8 hrs prior to analysis while Huang *et al.* (2005) did not. Furthermore, there was no significant difference observed between UPSP and PSP (Table 1). This finding is in line with a previous study reported by Truong *et al.* (2007).These results indicate that there is no beneficial effect in terms of phenolic content in using unpeeled tuber for product processing.

Table 1 shows that the flavonoid content is significantly highest ($p>0.05$) in PSP at 9.55±0.82 mg quercetin/100 g dry basis, followed by UPSP (3.30±0.19 mg quercetin/100 g dry basis) and SSP (1.43±0.03 mg quercetin/100 g dry basis). This data correlates with the high TPC in PSP. It has been observed that a high TPC reflects a high flavonoid content. In comparison, the flavonoid contents of UPSP, PSP and SSP were much higher than the potato (0.13 mg/kg fresh weight) (Chu *et al.,* 2000). The flavonoid contents in apples (26.4 – 73.9 µg/g of fresh weight) (Price *et al.,* 1999) and blueberries and blackberries (21 – 390 mg/100 g of fresh weight) (Sellappan *et al.,* 2002) were observed to be much higher compared than in UPSP, PSP and SSP. The flavonoid content of SSP reported in the present study is lower than the potato peel reported by Mendel Friedman *et al.* (2017).

Anthocyanins are an essential group of flavonoid compounds that result in various flesh colours (Wang *et al.,* 2018). Kahkonen *et al.* (2003) stated that edible plants with purple, red or blue colours form the most essential sources of anthocyanins. Among the analysed three conditions of Anggun tuber, PSP showed the significantly richest ($p>0.05$) content of anthocyanins (9.43±0.08 mg/100 g dry basis), followed by UPSP (5.21±0.02 b mg/100 g dry basis) and SSP (5.21±0.02 b mg/100 dry basis). There was no significant difference between UPSP and SSP. The major components in purple and red-fleshed sweet potatoes with high anthocyanins are peonidin and cyanidin as reported by several investigators (Furuta *et al*., 1998; Oki *et al.,* 2002; Suda *et al.,* 2003; Harada *et al.,* 2004). The anthocyanin content of PSP is comparable with the anthocyanin content of red and purple fruits and vegetables (0.02 to 6 mg anthocyanins/fresh weight) (Wrolstad, 2000).

4. Conclusion

The phenolic, flavonoid and anthocyanin contents of three different conditions (UPSP, PSP and SSP) of Anggun 1 were investigated. The results showed the effect of different parts on the total phenolic content, flavonoid content and anthocyanin content. Sweet potato flour enhances the quality of food products from the aspects of colour, flavour, natural sweetness and supplemented nutrients. Therefore, flour from PSP is suggested to produce better quality products which are more appealing to product developers and consumers.

Conflict of Interest

The authors claim no conflict of interest.

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