

Analysis on the Nutrition Composition and Antioxidant Activity of Different Types of Sweet Potato Cultivars

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Abstract

In this study, we selected four different color fleshed sweet potatoes, purple- (Jizi 01), red- (Xinong 431), yellow- (Beijing 553) and white- (Shangshu 19) fleshed cultivars as test materials, analyzed nutrient composition, dietary fiber content, anthocyanins quantification, and total phenolics content, and also measured their total antioxidant activity in four different types of sweet potato. In view of differences in flesh color, the nutrient contents of different cultivars appeared to be significantly different. Starch contents of Beijing 553 and Shangshu 19 were higher, but fat contents were lower than others. Protein content of Shangshu 19 was the highest followed by Jizi 01 and Xinong 431. In addition, our analysis results confirmed that purple fleshed sweet potato possesses much higher anthocyanins content than others, even up to 6.23 mg/g dry matter. Also, dietary fiber, total phenolics content, and total antioxidant capacity of Jizi 01 were significantly higher.

Keywords

Sweet Potato, Nutrition Composition, Antioxidant Activity, Anthocynin

1. Introduction

Sweet potato (*Ipomoea batatas* [L.] Lam.) is one of the most important crops in the world because of not only its

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considerable amount of nutrient, but also phytochemicals in its root and leaves. Also, it has its advantages of high yielding, drought tolerance, and wide adaptability to various climate and farming systems over the world. Thus, it has been widely used for food and industrial application.

Among other root and tuber crops, sweet potato contains higher contents of carbohydrates, various vitamins, minerals, and protein than other vegetables [1]. It also contains much higher levels of provitamin A, vitamin C and minerals than rice or wheat [2]. In addition to the nutritional values of sweet potatoes, it has been rediscovered as a functional food containing high levels of various phytochemicals which might have various health beneficial effects [3]. Most studies on phytochemicals in roots or leaves of sweet potato indicated that their health promoting and/or disease preventing benefits were related to the high level of polyphenols. In particular, cancer-preventive effects of polyphenols in sweet potato have been widely investigated. For example, Rabah *et al.* demonstrated that sweet potato extract offered the activity of cancer prevention which was correlated with its level of phenolic content [4].

There are varieties of flesh color of sweet potatoes. It also has been noticed that the color of sweet potato may play a crucial role in their health beneficial effect. Physiological functions of color-fleshed sweet potato cultivars have been widely reported. They have proved their excellent bioactivities such as antimutagenic [5] [6], radical scavenging [7], antihyperglycemic [8], hepatoprotective [9] [10], anticancer [11] [12], antioxidant activities [13]-[16], and chemopreventive activities [17] [18]. Those studies agreed that biological effects of sweet potato may be due to the phenolic pigment, “anthocyanin”.

In this study, we selected four sweet potato cultivars with different color flesh, purple-, red-, yellow- and white-fleshed sweet potatoes. To identify novel characteristics of these different types of sweet potato, we analyzed nutrient composition and dietary fiber content, and quantified anthocyanins content of sweet potato samples. Also, Antioxidant activity and total phenolic content were tested.

2. Materials and Methods

2.1. Materials

2.1.1. Chemicals and Reagents

All solvents and chemicals were of analytical grade. The common reagents were provided by Xiandai Chemicals Co. Ltd. (Shijiazhuang, China). Peonidin-3-glucoside, 1,1-diphenyl-2-picrylhydrazyl (DPPH), 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid) (ABTS) and trolox standard was purchased from Sigma/Xinjingke (Beijing, China). Folin-Ciocalteu reagent was purchased from Merck Co. (Darmstadt, Germany), gallic acid standard was obtained from Shenggong Co. (Shanghai, China).

2.1.2. Sweet Potatoes

Purple- (Jizi 01), red- (Xinong 431), yellow- (Beijing 553) and white- (Shangshu 19) fleshed sweet potatoes were provided from Institute of Cereal and Oil Crops, Hebei Academy of Agriculture and Forestry Sciences. Four different types of sweet potatoes were grown in the same field under the same environment with reasonable yield. The tubers were selected for the uniformity of size, shape without any visual defects as analysed samples.

2.2. Methods

2.2.1. Sample Preparation

For each sweet potato sample, tubers were randomly taken, washed with tap water, diced into approximately 0.5 cm cubes, freeze-dried (general purpose freeze dryer, FD-1C-55, Boyikang experimental instrument Co., Ltd, Beijing) and ground by pestle and mortar into powder. Prepared powder was stored at -80°C until use.

2.2.2. Nutrient Composition Content Measure

Starch in sweet potato was measured by the national standard GB/T5009.9-2008 method with acid hydrolysis; Protein was conducted based on the national food safety standard GB5009.5-2010 methods, protein content in sweet potato sample was calculated with conversion ratio $\text{N} \times 6.25$; Fat was determined as described by the national standard GB/T14772-2008; Total dietary fiber in sweet potato was measured using official GB/T5009.88-2008 methods. All assay data were based on dry sample of sweet potato.

2.2.3. Dry Matter and Ash Content Determination

Dry matter content was determined based on the national standard GB/T5009.3-2010 oven-drying method at 105°C for 24 h. Dry matter content of the samples was calculated from the initial and final weight of the each sample. Ash content in sweet potato were measured by the national standard GB/T5009.4-2010 method.

2.2.4. Anthocyanin Content Measure

For preparation of anthocyanin extracts, 1 g of sweet potato powder was extracted with 8 ml of acidified MeOH (1 N HCL, 85:15, v/v) to obtain a sample-to solvent ratio of 1:8. The flasks containing powder/solvent mixture were sealed with aluminum foil to avoid exposure to light. After 12 hours extraction, extraction was centrifuged (5000 rpm, 30 min) and supernatant was collected in amber glass tube. A 1.0 ml aliquot of supernatant was diluted with distilled water. The largest absorbance at diluted extraction was measured at 280 - 600 nm, and each extraction of sweet potato sample was measured at the specific wavelength which the absorbance was largest. Commercially available peonidin-3-glucoside was used as the standard; and the total anthocyanins values were reported in milligrams peonidin-3-glucoside equivalents per gram dry weight (mg/g dw).

2.2.5. Total Phenolic Content Estimation

The total phenolics in sweet potato extracts were estimated by Folin-Ciocalteu colorimetric method according to Ju Z. G. [19] with slight modification. Briefly, appropriately diluted sample extract (1 ml) was added 3.0 ml of 20 fold diluted Folin-Ciocalteu reagent and 1.0 ml 0.5 M NaOH containing 10% (w/v) Na₂CO₃. The mixture was incubated in a water bath at 50°C for 15 min, then placed in an ice-water bath for 5 min. The absorbance was measured at 650 nm and used to calculate total phenolics content using a standard curve based on gallic acid. Results were expressed as milligram of gallic acid equivalents (GAE) per gram dry weight (mg/g dw).

2.2.6. Total Antioxidant Capacity Assay

For assays of antioxidant activities, the dried powder of sweet potato samples (1.0 g) was extracted with 25 ml of 80% methanol at room temperature for 12 h, then was centrifuged (5000 rpm, 30 min) and supernatant was collected to assay antioxidant activity.

Antioxidant capacity against DPPH radicals was assayed according to Zhu F. *et al.* [20], with some modifications. Briefly, DPPH solution (60 µM; absorbance = 0.670) was prepared in 80% ethanol. The same extract samples diluted with 80% ethanol during the ABTS assay were also used in the DPPH assay. DPPH solution (3.9 ml) was added to the properly diluted extracts (0.1 ml) and vortex-shaken. The reaction was for 2 h at room temperature in the dark, and the absorbance was recorded at 515 nm. An external standard curve was obtained using Trolox standard solution at various concentrations (from 0 to 15 µM) in 80% ethanol. The absorbance of the reaction samples was compared to that of the Trolox standard, and the results were expressed as millimoles of Trolox equivalents per gram dry weight of plant material.

2.2.7. Statistical Analysis

The experiments were performed with 3 replicates. All data were analyzed by one-way analysis of variance (ANOVA). All analyses were performed with SAS 8.0 software. Duncan's multiple range tests at the 5% level for least significance were used to determine any differences in mean values between different sweet potato cultivars. Difference at $p < 0.05$ was considered to be a statistically significant.

3. Result

3.1. Nutrient Composition Content

Starch (60.1% - 71.4%) is the most predominant nutrient component of four different color fleshed sweet potato samples followed by protein (4.86% - 6.53%), small amounts of fat (0.56% - 0.76%). The nutrient contents of different types of sweet potato appeared to be significantly different in nutrient we analyzed (**Table 1**). Starch contents of yellow- (Beijing 553) and white- (Shangshu 19) fleshed sweet potatoes were higher than other two types. Protein content of Shangshu 19 was the highest followed by purple- (Jizi 01), red-fleshed sweet potato (Xinong 431). Fat contents in Jizi 01 and Xinong 431 were higher, and its in Beijing 553 and Shangshu 19 were similar. However, dietary fiber content of purple fleshed sweet potato was significantly higher than other three types of sweet potato ($p < 0.05$) (**Table 1**).

Table 1. Nutrient composition, dry matter and ash content of sweet potato samples.

Nutrients components (%)	Jizi 01	Xinong 431	Beijing 553	Shangshu 19
Starch	68.6 b	60.1 c	70.2 a	71.4 a
Protein	6.41 b	6.32 b	4.86 c	6.53 a
Fat	0.72 a	0.76 a	0.64 b	0.56 b
Dietary fiber	2.35 a	2.21 b	1.90 c	1.85 c
Dry matter	31.8 a	32.6 a	27.5 c	29.6 b
Ash	2.06 b	3.21 a	1.98 b	1.68 c

Data are reported on a 100% dry weight basis. Protein is calculated using a 6.25 conversion factor. The mark a, b, c in the same row without a common letter indicates significant difference, $p < 0.05$.

3.2. Dry Matter and Ash Content

Dry matter content of purple- (Jizi 01) and red-fleshed sweet potatoes (Xinong 431) were higher than others, and no significantly difference between them. Dry matter content of yellow-fleshed sweet potato (Beijing 553) was lowest. Whereas, ash content of red-fleshed sweet potato (Xinong 431) was the highest followed by Jizi 01 and Beijing 553 sweet potato, it of Shangshu 19 was lowest (**Table 1**).

3.3. Anthocyanin Content

Total anthocyanin content of Jizi 01 sweet potato was 6.23 mg PN3GE/g dw, and it was significantly higher than other types ($p < 0.05$). The amount of anthocyanins in Xinnong 431 was 2.56 mg PN3GE/g dw followed by 1.32 mg PN3GE/g dw in Beijing 553. Whereas it was undetectable for extract from Shangshu 19. The statistical result showed anthocyanin contents in four different types sweet potato were significantly different ($p < 0.05$) (**Table 2**).

3.4. Total Phenolics Content and Total Antioxidant Capacity

The total phenolic contents of extracts from four sweet potato samples were shown in **Table 2**. The rank order of total phenolic content was Jizi 01 (54.3 mg/g dw) > Xinong 431 (25.7 mg/g dw) > Beijing 553 (17.8 mg/g dw) > Shangshu 19 (9.6 mg/g dw). Corresponding fairly closely to the anthocyanin content, the total phenolic contents of extracts was significantly different each other in four sweet potato ($p < 0.05$). The antioxidant capacity of extracts was also shown in **Table 2**. Jizi 01 (81.2 mg/g dw) had the highest antioxidant capacity values followed by Shangshu 19 (55.2 mg/g dw) and Xinong 431 (50.4 mg/g dw), Beijing 553 (43.3 mg/g dw) was the lowest. Although Shangshu 19 had the lowest phenolic content, it showed significantly higher antioxidant capacity than that of Beijing 553 ($p < 0.05$).

4. Discussion

All know, daily consumption of fruit and vegetables that contain phytochemicals is highly recommended in diet due to their health protection effects. Among these phytochemicals, phenolic compounds anthocyanins have been recognized for their healthy benefit. Among our tested varieties, purple-fleshed sweet potato is attracting lots of attention from people in nutrition. The strong color of purple sweet potato is contributed by phenolic pigment called anthocyanins. For this study, we have proved the higher level of anthocyanin content in purple-fleshed sweet potato compared to other tested sweet potatoes samples, red-, yellow-, and white-fleshed sweet potato. Our purple sweet potato cultivar, Jizi 01 showed its prominent level of anthocyanins content (6.23 mg/g dw) (**Table 2**). Red-fleshed Xinong 431 and yellow-fleshed Beijing 553 also showed small amount of anthocyanins (2.56 mg/g dw and 1.32 mg/g dw), but white-fleshed Shangshu 19 showed undetectable value. In this matter, our results agree with others [14] [21]-[23].

Purple-fleshed sweet potato was also significantly high in phenolic content (54.3 mg/g dw) as well as in antioxidant capacity (81.2 mg/g dw) (**Table 2**). As we assumed, the antioxidant capacity of purple sweet potato was due to its highest phenolic content among sweet potato samples we tested. However, interestingly, Shangshu 19

Table 2. Anthocyanins content, total phenolic content, and antioxidant capacity of sweet potato samples.

Components (mg/g dw)	Jizi 01	Xinong 431	Beijing 553	Shangshu 19
Anthocyanins content	6.23 a	2.56 b	1.32 c	UD
Total phenolic content	54.3 a	25.7 b	17.8 c	9.6 d
Antioxidant capacity	81.2 a	50.4 b	43.3 c	55.2 b

Data are reported on a 100% dry weight basis. Abbreviations are as follows: UD: undetectable value. dw: dry weight. The mark a, b, c, d in the same row without a common letter indicates significant difference, $p < 0.05$.

showed significantly higher antioxidant capacity (55.2 mg/g dw) than that of Beijing 553 (43.3 mg/g dw) despite its lower phenolic content ($p < 0.05$). It might contain more antioxidant phytochemicals besides anthocyanins.

Our data showed that sweet potato contains rich starch, protein, fat and dietary fiber. Numerous studies suggested that sweet potato is rich in nutrition and nutrient balance [24]. According to Zhang L. M. *et al.* [24], sweet potato had health care function and medicinal value for different nutrient components such as carotene, vitamin (VB1, VB2, VC, VE), dietary fiber, minerals (K, Ca, Fe, P and Se), dehydroepiandrosterone, slime protein *et al.* There also have been studies documenting the benefits of sweet potato on anticancer activity [25]-[30].

5. Conclusion

In conclusion, among four different color-fleshed sweet potatoes we selected, the nutrition compositions were similar, but the quantity of nutrients was significantly different. However, purple-fleshed Jizi 01 cultivar possesses much higher anthocyanins content compared with others. Dietary fiber, total phenolics content, and total antioxidant capacity of Jizi 01 were also significantly higher than others. The high content of total phenolics likely was responsible for significantly higher antioxidant activity. Taken together, these findings indicate novel characteristics of sweet potato, particularly purple-fleshed cultivar on their potential health benefits. Thus, it is suggested that people try to develop anthocyanin enriched purple sweet potato.

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