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ORIGINAL PAPER

EVALUATION OF SELECTED QUALITATIVE PARAMETERS OF SWEET POTATO IN DEPENDENCY ON ITS CULTIVAR IN SLOVAKIA

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Abstract

In this study, selected qualitative parameters (total carotenoids, vitamin C, total polyphenols) of sweet potatoes (Ipomoea batatas L.) grown in Slovakia were evaluated. The field experiment was established in the area of the Slovak University of Agriculture in Nitra in 2017. In experiment, registered cultivar 'Beauregard' was used as a comparable cultivar. Other three cultivars ('Dubaian', 'Višnjica white', Višnjica purple') were marked according to the market place from which tubers for seedling production were bought. The sweet potatoes were grown by hillock system and plants were mulched by black non-woven textile. The seedlings were planted on the 1st June 2017. The tuber harvest were realised on the 13th September 2017 and qualitative parameters were analysed immediately after harvest. The carotenoid and polyphenol content was determined spectrophotometrically (polyphenols in lyophilised sample; expressed in mg of gallic acid equivalent.kg^{-1} of dry weight) and vitamin C content chromatographically (HPLC). The statistically significant differences of parameter content were found among tested sweet potato cultivars. The highest total carotenoid content (TCC) was found in cultivar 'Dubaian' (107.04 mg.kg^{-1} fresh weight). Generally, significant differences of TCC were detected between cultivars with orange flesh colour (64.87 mg.kg^{-1} f. w.;107.04 mg.kg^{-1} f. w.) and cultivars with purple and white flesh colour (3.02 mg.kg^{-1} f. w.; 8.00 mg.kg^{-1} f. w.). The highest content of total polyphenols was found in cultivar with purple flesh of tubers - 'Višnjica purple' (5398.77 mg GAE.kg^{-1} dry weight). Other cultivars were characterized by expressively lower values of total polyphenol content (1557.02-2412.91 mg GAE.kg^{-1} d. w.). The highest vitamin C content was determined in cultivar 'Dubaian' (436.83 f. w.), following by cultivars 'Beauregard' (309.37 f. w.), 'Višnjica purple' (233.27 f. w.) and 'Višnjica white' (205.73 f. w.). Results of this study showed significant variability of polyphenol and carotenoid content in different-coloured sweet potatoes.

Key words: Sweet potato, cultivar, carotenoids, polyphenols, vitamin C

INTRODUCTION

The sweet potato (*Ipomoea batatas*) belongs to the *Convolvulaceae* family. This species is often comparing with potato (*Solanum tuberosum*); however, these species are very different from many aspects, e. g. botanical; morphological; taste; chemical composition etc. (Loebenstein, Thottappilly, 2009). According to FAO (2018), the sweet potato world production was relatively stabilized within period 2007-2016; it varied from 101.3 to 105.4 million tonnes. The most of sweet potato tubers was produced in Asia (79%), especially in China. The Europe production of sweet potatoes, within mentioned period, presented only 0.8% of total world production.

Loebenstein and Thottappilly (2009) describe that flesh of sweet potato tubers can be orange, yellow, white or purple. Tubers of white or yellow cultivars are less sweet in comparison with orange flesh colour which is typical for sweet potato. Orange-fleshed tubers are known as rich sources of carotenoids - precursor of vitamin A (Alam et al., 2016). The carotenoid group is one of the most important classes of plant pigments which play a crucial role in defining the quality parameters of fruit and vegetables (Eldahshan and Singab, 2013). It is group of pigments soluble in fats and they have an important role from aspect of prevention of various serious diseases. Carotenoids are very effective antioxidant substances because of their activity against free radicals dangerous for human body (Riccioni, 2009).

According to Mezzomo and Ferreira (2016), higher carotenoid intake conduces to the decrease of several cancer type risk (stomach, colon or larynx), bone calcification, eye degeneration, neurotic or cardiovascular diseases. Other important bioactive substances in sweet potatoes are polyphenols and vitamin C. Polyphenols are known by protective effect of human body against oxidative stress which may cause many diseases, e. g. cancer, aging or cardiovascular diseases (Musilová et al., 2017). Vitamin C acts as an anticarcinogenic agent and reduces the risk of cardiovascular diseases (Du et al., 2012). Xu et al. (2015) indicate that vitamin C prevents human body against cancer formation by inhibition of nitroso compounds in the stomach and stimulation of immune system.

The goal of this study was to compare the content of carotenoids, polyphenols and vitamin C in sweet potato cultivars with different flesh colour of tubers grown in Slovakia.

MATERIALS AND METHODS

The field experiment with sweet potatoes was established in Slovak University of Agriculture in Nitra in 2017. Within experiment, one certified cultivar of sweet potato 'Beauregard' with orange flesh colour was used. Other three cultivars were marked according to the market place at which tubers were purchased and sequentially used for seedling preparation (Dubai, United Arab Emirates; Višnjica, Croatia). Mentioned cultivars had an orange ('Dubaian'), white ('Višnjica white') and purple flesh colour ('Višnjica purple'). The seedlings were planted in spacing 1.2x0.30 m on 1st June 2017. The harvest of sweet potato tubers was done on 13th September 2017.

Table 1. The soil analysis before experiment establishment

	Content (mg.kg^{-1} of soil)						
pH	N_{min}	P	K	Ca	Mg	S	Humus (%)
7.18 N	10.1 M	147.5 H	477.5 VH	5850 H	765.6 VH	91.3 M	3.75 G

Note: N_{min} - mineral (inorganic) nitrogen; N - normal; M - medium; G- good; H - high; VH - very high

Table 2. The average air temperature and precipitation sum in experimental year

Month	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Temperature (°C)	-9.1	0.1	8.7	9.7	16.6	21.2	21.7	22.4	14.6
Precipitation (mm)	12.8	26.4	9.9	39.5	14.0	26.1	60.0	23.2	93.0

Note: N_{min} - mineral (inorganic) nitrogen; N - normal; M - medium; G- good; H - high; VH - very high

Within sample preparation, 6 tubers were peeled and cut to pieces 15x15 mm (approximately). Samples were sequentially mixed and prepared for qualitative analyses. The total carotenoid content was determined spectrophotometrically (Hegedűsová et al., 2015). The vitamin C content was analysed chromatographically (HPLC). The sample lyophilisation (freeze drying at -55°C) was realised for analysis of total polyphenol content which was done spectrophotometrically according to the method of Lachman et al. (2003).

A statistical analysis was performed using Statgraphic Centurion XVII (StatPoint Inc. USA). Obtained results were evaluated by analysis of variance (ANOVA) and average values were tested by Tukey HSD test performed at the significance level of 95%.

RESULTS AND DISCUSSION

The statistical analysis of obtained results showed statistically significant differences of all qualitative parameters among individual tested cultivars of sweet potatoes (Table 3). The total carotenoid content (TCC) was ranged from 3.02 mg.kg^{-1} to 107.04 mg.kg^{-1} of fresh weight (f. w.) and it was significantly affected by flesh colour of sweet potato tubers. The expressively higher values were found in the orange-coloured sweet potatoes compared to the white and purple cultivars. Comparable results of TCC in sweet potatoes were presented in the study of Grace et al. (2014) who found extremely higher TCC in the cultivar with orange flesh compared to the cultivars with other colour of tuber flesh. Values of TCC were following: 0.55 mg.kg^{-1} f. w. (purple) < 3.40 mg.kg^{-1} (light yellow) < 5.16 mg.kg^{-1} (yellow) < 95.00 mg.kg^{-1} (purple). Higher value of TCC in orange sweet potato cultivar (157.9 mg.kg^{-1} f. w.), compared to this study, was found in the study of Tang et al. (2015). The significantly lower TCC was detected in sweet potato cultivars with white (4.46 mg.kg^{-1}) and purple (2.85 mg.kg^{-1}) flesh colour. The most important and predominant carotenoid substance in sweet potatoes is β-carotene which presents 79.0-97.9% of TCC (USDA, 2015). Teow et al. (2007) found marked variability of its content in sweet potatoes in dependency on the colour of tuber flesh. The highest values of β-carotene content were found in orange cultivars (44.9-226 mg.kg^{-1} f. w.), following by purple (6.3-56.6 mg.kg^{-1}) and white (0.2-1.5 mg.kg^{-1}) cultivars. According to Wu et al. (2008), β-carotene content in orange flesh sweet

potatoes were significantly higher (55.9-231.1 mg.kg^{-1} f. w.) compared to cultivars with yellow (23.0 mg.kg^{-1}), white (7.8 mg.kg^{-1}) and purple (0.60 mg.kg^{-1}) flesh colour.

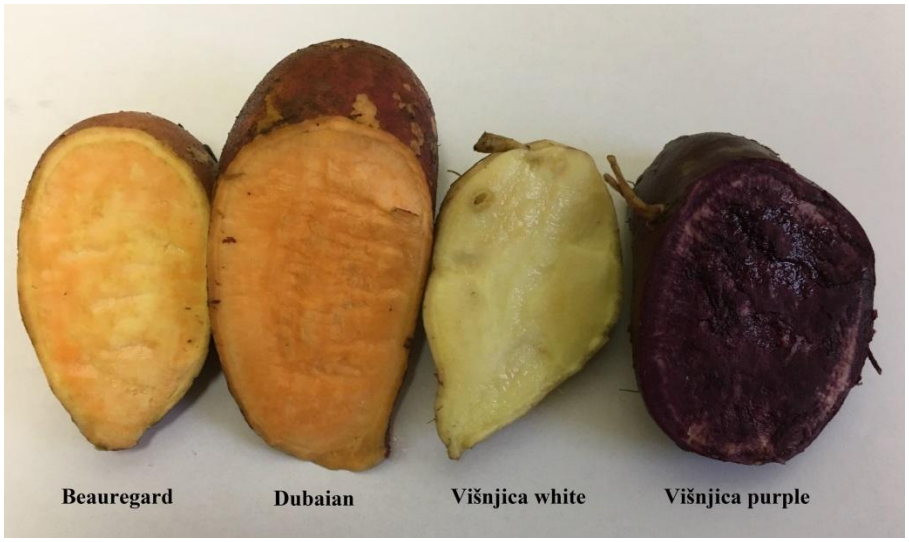

Figure 1. Tested sweet potato cultivars

Table 3. Qualitative parameters of sweet potato grown in Slovakia

Cultivar	Total carotenoids (mg.kg^{-1} f. w.)	Vitamin C (mg.kg^{-1} f. w.)	Total polyphenols (mg GAE.kg^{-1} d. w.)
Beauregard	64.86 ±0.98^{b}	309.37 ±2.70^{b}	2160.50 ±15.35^{c}
Dubaian	107.04 ±1.41^{a}	436.83 ±1.95^{a}	2412.91 ±26.67^{b}
Višnjica purple	8.80 ±0.25^{c}	233.27 ±1.92^{c}	5398.77 ±24.55^{a}
Višnjica white	3.02 ±0.13^{d}	205.73 ±2.19^{d}	1557.02 ±20.36^{d}

Note: f. w. - fresh weight; d. w. - dry weight; GAE - gallic acid equivalent

The total polyphenol content (TPC) in sweet potatoes was ranged from 1557.02 mg.kg^{-1} to 5398.77 mg GAE (gallic acid equivalent).kg^{-1} of dry weight (d. w.). The highest TPC was found in purple cultivar and its value was expressively higher compared to orange and white cultivars. The significant variability of TPC in differently coloured sweet potato cultivars was stated in several previous studies. Ji et al. (2015) found the highest TPC in purple cultivar (6230 mg.kg^{-1} d. w.), followed by red (2560 mg.kg^{-1}), yellow (1320 mg.kg^{-1}) and white (undetected value) cultivars. The significantly higher value of TPC in purple sweet potatoes, compared to different-coloured cultivars, was also presented by Grace et al. (2014). Values of TPC was increasing in following cultivar order: 2780 mg.kg^{-1} d. w. (light yellow) < 2830 mg.kg^{-1} (yellow) < 2870 mg.kg^{-1} (orange) < 39920 mg.kg^{-1} (purple). Similarly to previous studies, significant variability of TPC, dependent on the tuber flesh colour of sweet potatoes, were also presented by Teow et al. (2007). The average TPC values in sweet potato cultivars were following: yellow (22 mg chlorogenic acid equivalent.kg^{-1} f. w.) < light orange (119 mg CAE.kg^{-1}) < orange (208.7 mg CAE.kg^{-1}) < light purple (252.5 mg CAE.kg^{-1}) < purple (557.8 mg CAE.kg^{-1}). The fact that purple sweet potatoes are richer source of polyphenols was also showed in the study of Tang et al. (2015). TPC values in purple cultivar were significantly higher (6310 mg.kg^{-1} d. w.) in comparison with orange (617 mg.kg^{-1}), white (470 mg.kg^{-1}) and yellow (415 mg.kg^{-1}) cultivars.

The vitamin C content was, similarly as carotenoids and polyphenols, significantly affected by sweet potato cultivar. The vitamin C content was following ranged: white cultivar 'Višnjica white' (205.73 mg.kg^{-1} f. w.) < purple cultivar 'Višnjica purple' (233.27 mg.kg^{-1}) < orange cultivars 'Beauregard' (309.37 mg.kg^{-1}) and 'Dubaian' (436.83 mg.kg^{-1}). Compared to obtained results, Barrera and Picha (2014) found lower content of vitamin C in sweet potato cultivar 'Beauregard' (269 mg.kg^{-1} f. w.). Mitra et al. (2012) analysed the vitamin C content in fifteen sweet potato cultivars with orange flesh colour. Authors found the variability of its values from 128.7 mg.kg^{-1} to 268.2 mg.kg^{-1} f. w. The significant variability of vitamin C content, depending on the cultivar and different flesh colour, was also found in the experiment with sweet potatoes realised by Yildirim et al. (2011). The highest vitamin C content (average) was found in cultivars with creamy flesh (311.7 mg.kg^{-1} f. w.), followed by yellow (309 mg.kg^{-1}) and orange (279 mg.kg^{-1}) cultivars of sweet potatoes. This fact is in contrast with our study where the orange cultivars were expressed by significantly higher vitamin C content compared to cultivars with other tuber flesh colour. Aywa et al. (2013) analysed the vitamin C content in sweet potato cultivars grown in different localities in Western Kenya and its values were relatively steady: white cultivar (48.5 mg.kg^{-1} f. w.) < purple cultivar (54.2 mg.kg^{-1}) < yellow cultivar (55.5 mg.kg^{-1}) < orange cultivar (56.2 mg.kg^{-1}).

CONCLUSIONS

The sweet potato is less-grown vegetable species in Slovakia but interest about this crop is gradually increasing. It is an interesting because of tuber taste but also its quality. The sweet potato is a good source of several health-promoting substances, including carotenoids, polyphenols or vitamin C. Results of this study confirm fact that cultivar is one of the most important factors influencing on the vegetable quality. Tested cultivars with orange tuber flesh were characterized by higher content of carotenoids and vitamin C. The expressively highest content of carotenoids (107.04 $mg.kg^{-1}$ fresh weight) and vitamin C (436.83 $mg.kg^{-1}$ fresh weight) was found in cultivar 'Dubaian'. On the contrary, the highest polyphenol content was found in purple cultivar of sweet potato 'Višnjica purple' (5398.77 $mg.kg^{-1}$ dry weight).

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