Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 2, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

NUTRITIONAL COMPOSITION OF FRESH ORGANIC VEGETABLES

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Abstract

Vegetables are important elements for rational and healthy diet due to active compounds and their nutritive values. Currently, technical progress in food industry offer new solution for processing vegetables. The purpose of this study was to determine the nutritional composition of different organic vegetables which can be used as raw materials for healthy chips. Several vegetables (beets, carrot, sweet potato, and turnip) were purchased from organic certified farms and further analysed in terms of dry matter content, total phenolic content, antioxidant activity, and ascorbic acid. When comparing the vegetables in terms of total phenolic content and antioxidant activity, 'Detroit' beets variety registered the highest values, followed by sweet potato and turnip. The ascorbic acid content of sweet potato registered the highest values, but the 'Detroit' and 'Albino' beets varieties registered values below limit of quantification. The total phenolic content and antioxidant activity registered similar trend for all analysed samples. All studied organic vegetables can be successfully used for healthy crispy snacks.

***Key words**: bioactive compounds; chips; crispy snacks; organic vegetables.*

INTRODUCTION

Vegetables represent a major category of foods for rational and healthy diet due to active compounds and their nutritive values. All over the world, vegetables play a significant role in human nutrition especially nutrients as vitamins sources (C, A, B1, B6, B9, E), minerals, dietary fiber, and phytochemicals (Dias & Ryder, 2011). Vegetables supply these nutrients in forms that are generally low in energy and fat, making them more "nutrient dense" than most other food sources (Titchenal & Dobbs, 2006). Especially roots and tubers, can also possess significant caloric value, serving as staple crops in many parts of the world (Radovich, 2011).
Daily vegetable consuming was correlated with reduced risk of heart disease, improvement of gastrointestinal health, stroke, chronic diseases such as diabetes, and some forms of cancer (Cruz et al., 2006; Dias, 2012). Because in each vegetable is available a unique combination of nutrients, humans should daily consume different and various vegetables to get a balanced and varied diet.
Most often vegetables are consumed raw or processed (Aguero et al., 2008). Fresh, raw vegetables are the major vegetable types that consumers purchase for consumption, while processed vegetables in the dried, frozen, and canned forms are also readily available (Ong & Liu, 2011).
With the growing world population (Vicente, 2022) and consumer awareness for nutritious and balanced diet (Kumar et al., 2021), the production and processing of horticultural crops, especially fruits and vegetables, have increased significantly to fulfil the demands (Ciurzyńska et al., 2020). Significant losses and waste in the fresh and processing industries are becoming a serious nutritional, economical, and environmental problem (Sagar et al., 2018; Ciurzyńska et al., 2020). Food and Agriculture Organization (FAO) has estimated the fruit and vegetable losses and waste up to 60% of the total horticulture production. The by-product generated during processing of fruit and vegetable industry alone account for the 25-30% of the horticulture product loss (Sagar et al., 2018).

Currently, technical progress in food industry offer a number of innovative processing methods to meet the requirements of both consumers and producers (Miteluț et al., 2021) for processing horticulture products as "healthy snacks" made from ingredients as dried fruit, vegetable, fruit and vegetable bars, cereal products in the form of bars or cakes. Such products are often sold in a certain amount to suggest the portion size of a single snack that should be eaten (Mielmann & Brunner, 2018). Freeze-dried fruit and fruit and vegetable bars are gaining more and more popularity (Ciurzyńska et al., 2020). As compared to fruit, vegetables are less attractive in terms of taste due to their small content of sugars, but are richer in fibre, vitamins and some minerals (Ciurzyńska et al., 2019). In order to make vegetable snacks more pleasant and tastier it can be added spices, giving them unconventional form which may be a freeze-dried vegetable bar (Ciurzyńska et al., 2019; Ciurzyńska et al., 2020) or chips. The aim of study was to determine the nutritional composition of different organic vegetables which can be used as base for healthy chips.

MATERIALS AND METHODS

Chemicals

Chemicals were purchased from many producers: acetonitrile and methanol from Honeywell (Riedel-de Haën, Seelze, Germany), formic acid from Sigma-Aldrich (GmbH, Germany); ascorbic acid, Folin-Ciocâlteu's reagent and DPPH (1,1-diphenyl-2-picrylhydrazyl) from Sigma-Aldrich Chemie GmbH (Riedstrasse, Steinheim); Trolox from Acros Organics, Fisher Scientific (Geel, Belgium); Gallic acid from Carl Roth; anhydrous sodium carbonate from Lach-Ner, (Neratovice, Czech Republic); sodium hydroxide 0.1 N from Cristal R Chim S.R.L. (Bucharest, Romania); and ultrapure water was obtained with Milli-Q water equipment (Millipore, Bedford, MA).

Samples

Vegetables such as beets 'Detroit', 'Albino', and 'Chioggia', carrot 'Flakkee' and turnip 'Purple top white globe' were purchased in 2021 from organic certified farm Grădina Corbilor S.R.L., and sweet potato 'Rok 1' from organic certified farm Beleza Store S.R.L. All vegetables were stored at 1±0.5°C and 85±5 % RH until analysis.

Dry matter determination. Dry matter content was performed by drying 1 g of sample in oven (UN110 Memmert) at 105°C (Stan et al., 2021; Ticha et al., 2015) until constant weight.

Ascorbic acid determination was realized through Agilent Technologies 1200 chromatograph equipped with an UV-DAD detector and Agilent ChemStation B.04.03 software (Agilent, USA). Extraction was performed by triturate 1 g of fresh sample in 2% o-phosphoric acid in water (v/v), then homogenized for 15 min at 500 rpm (Chanforan et al., 2012; Stan et al., 2020). Obtained extract was filtered through 0.45µm RC syringe filters. Compounds separation was performed through ZORBAX XDB-C18 (4.6 x 50 mm, 1.8 µm i.d.) column with Rapid Resolution HT and analytical guard column XDB-C18 (4.6 x 12.5 mm, 5 µm i.d.) (Agilent, USA). Column temperature was set up at 30°C, injection volume at 2 µl, flow rate at 0.5 mL/min, using isocratic elution (Chanforan et al., 2012; Hoza et al., 2020) and wavelength at 244 nm. Mobile phase consist in 0.05% (v/v) formic acid in water. Calibration curve was obtained by ascorbic acid standard injection of known and different concentration.

Total polyphenol content (TPC) through Folin-Ciocâlteu (Bădulescu et al., 2019) consist in extraction of 1 g fresh sample with 10 mL of methanol (70%), incubated in dark and room temperature (approx. 21°C), then homogenized for 1 h at 500 rpm, followed by centrifugation for 5 min, 4°C and 7000 rpm. Supernatant was recovered, residue was re-extracted two more times and the final volume was 30 mL. Sample preparation for spectrophotometric measurements were realised by 2 minutes room temperature (approx. 21°C) incubation of 0.5 mL of extract mixed with 2.5 mL of Folin-Ciocâlteu reagent. After 2 mL of 7.5% Na_2CO_3 were added samples were incubated for 15 min and 50°C. Spectrophotometric measurements were performed with Specord 210 Plus UV-VIS spectrophotometer (Analytik Jena, Jena, Germany) at the 760 nm wavelength. Results were calculated and expressed in mg GAE/ 100 g fresh weight.

Antioxidant activity determination using the DPPH (2,2-diphenyl- 1-picrylhydrazyl) method (Bujor et al., 2016) consist in mixing 0.2 mL of extract with 2 mL of 0.2 mM DPPH solution in methanol and incubated for 30 minutes in dark and continuous homogenising. Also the Specord 210 Plus UV-VIS spectrophotometer (Analytik Jena, Jena, Germany) was used for spectrophotometric measurements at 515 nm wavelength. Results were calculated and expressed as mg Trolox eq./100 g fresh weight.

Statistical analysis

Obtained data are results of three independent replicates and standard deviation was calculated using Microsoft Excel.

RESULTS AND DISCUSSIONS

Quality indicators and bioactive compounds were represented by dry matter content, ascorbic acid, total phenolic content, and antioxidant activity and performed for organic vegetables as beets, carrot, sweet potato, and turnip.

Dry matter content

The dry matter results (Table 1) of fresh organic sweet potato registered 26.70% which was the highest value compared with the other analyzed vegetables. Organic beets 'Albino', 'Chioggia', and 'Detroit' obtained 23.33%, 20.46, respectively 19.55%. Organic carrot registered the lowest dry matter content.

Table 1. Dry matter content of organic vegetables

Sample	Dry matter content (%)
Sweet potato	26.70 ±0.40
Beet 'Detroit'	19.55 ±0.39
Beet 'Albino'	23.33 ±0.18
Beet 'Chioggia'	20.46 ±0.20
Carrot 'Flakkee'	13.32 ±0.18
Turnip 'Purple top white globe'	11.73 ±0.24

Ascorbic acid content

When ascorbic acid content of organic vegetables (Table 2) was performed it was determined in sweet potato, 'Detroit' beet and 'Purple top white globe' turnip. The highest amount was observed in organic sweet potato 13.48±1.17 mg ascorbic acid/100 g FW, when in 'Albino' and 'Chioggia' beets and 'Flakkee' carrot the ascorbic acid content was below limit of quantification.

Table 2. Ascorbic acid content of organic vegetables

Sample	Ascorbic acid (mg/100 g)
Sweet potato	13.48 ±1.17
Beet 'Detroit'	1.49 ±0.32
Beet 'Albino'	< LOQ
Beet 'Chioggia'	< LOQ
Carrot 'Flakkee'	< LOQ
Turnip 'Purple top white globe'	10.01 ±1.59

Total polyphenol content (TPC)

The total phenolic content and antioxidant activity present similar trend for all fresh organic vegetables analyzed. The exception was for sweet potato where TPC shown higher concentration in comparison with antioxidant activity.

In this case the highest amount of phenolic content (Figure 1) was observed in 'Detroit' beet which obtained 167.31 mg GAE/100 g FW and the lowest value was obtained by 'Albino' beet (29.17 mg GAE/100 g FW).

Sweet potato obtained 62.96 mg GAE/100 g FW which was the second best value obtained for total phenolic content comparing with other organic vegetables.

Antioxidant activity

The highest antioxidant activity (Figure 2) was obtained when 'Detroit' beet was analysed with 1694.83 mg equiv Trolox/ 100 g FW, followed by 'Purple top white globe' turnip with 382.75 mg equiv Trolox/100 g FW.

The lowest antioxidant activity was registered by sweet potato 186.29 mg equiv Trolox/ 100 g FW.

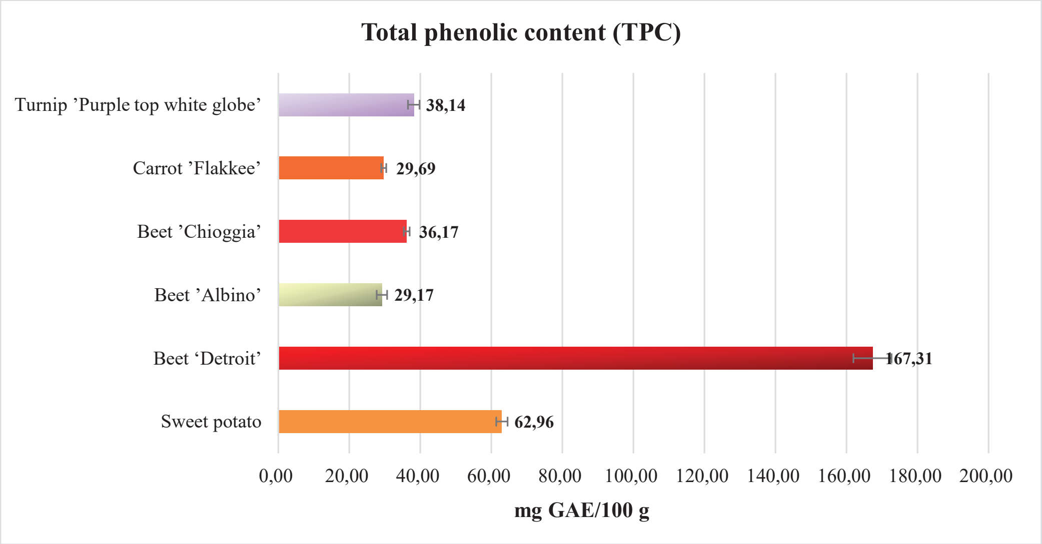

Figure 1. Total phenolic content in organic vegetables

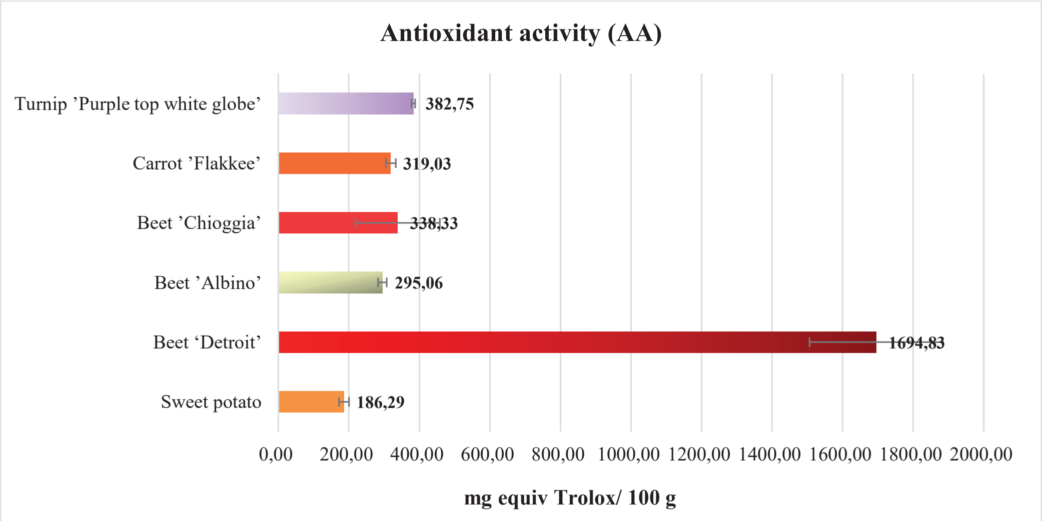

Figure 2. Antioxidant activity values in organic vegetables

CONCLUSIONS

When comparing the vegetables in terms of total phenolic content and antioxidant activity, ‘Detroit’ beets variety registered the highest values, followed by sweet potato and turnip.
The ascorbic acid content of sweet potato registered the highest values, but the ‘Detroit’ and ‘Albino’ beets varieties registered values below limit of quantification.
The total phenolic content and antioxidant activity registered similar trend for all analysed samples. All studied organic vegetables can be successfully used for healthy crispy snacks.

ACKNOWLEDGEMENTS

This work was supported by a grant of the University of Agronomic Sciences and Veterinary Medicine of Bucharest, project number 2021-0031/14.07.2021, acronym EcoLegDry, within IPC 2021.

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