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Health promoting compounds in organic currant and gooseberry

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Abstract

Berries of soft fruit contain a large quantities of substances with antioxidant activity. The method of Flow Injection Analysis (FIA) with electrochemical detection for determination of antioxidant activity of soft fruits grown in organic regime (EKO) in comparison to the integrated pest management orchard (IPM) was used. Antioxidant activity was expressed as electrical charge in C (Coulombs) per gram fresh weight of fruits. Currant and gooseberry cultivars cultivated both in IPM and EKO regimes were evaluated in years 2020 and 2021. Darker cultivars reached higher values. The highest antioxidant activity was found in cultivars of black currants, lower in red, pink, green, and white currants and the lowest in white gooseberries. The highest antioxidant activity was determined among currants for the cultivar 'Triton' from the group of black currants grown in EKO regime with value 0.785 C/g in the year 2020 and for cultivar 'Ben Hope' from the group of black currants (IPM; value 1.678 C/g) in the year 2021.

Keywords: antioxidant activity, antioxidants, organic production, soft berries, human health

Introduction

Consumption of fresh vegetables and fruits has positive influence on human health by lowering the risks of several life-threatening diseases such as coronary heart disease, stroke, pulmonary disease and different types of cancer. Health benefits are due to the presence of polyphenols, flavonoids, carotenoids and vitamins. Of these phytochemicals, polyphenols are largely recognized as anti-inflammatory, antiviral, antimicrobial and antioxidant agents. Research on antioxidants, as potential therapeutic agents to prevent free radical generated damage in the human body, has gained popularity. The concentrations of phenolic and other secondary metabolites in fruits and vegetables are influenced by many factors, including soil, irrigation, and climatic conditions. Production, acreage, productivity, and consumption of soft berries, as currant and gooseberry, are increasing rapidly around the world. However, phenolic bioactive-linked antioxidant and anti-diabetic functionalities of currants and gooseberries potentially vary widely among cultivars and due to different production practices, growing conditions, time of harvest and storage conditions (Kaume et al., 2012; Sarkar et al., 2017; Talcott, 2007; Wang and Lin, 2000; Zia-Ul-Haq et al., 2014). In our study, the attempt has been made to evaluate the difference in antioxidant content of currant and gooseberry cultivars grown both in organic and integrated pest management production regimes expressed as electrical charge in Coulombs (C) of one gram fresh fruit weight.

Material and Methods

Soft fruits cultivars

Fruit samples were collected in years 2020 and 2021 in optimal harvesting maturity from experimental plantings with organic (EKO) and integrated pest management (IPM) regime in the Research and Breeding Institute of Pomology Holovousy Ltd. located at Holovousy (district Jičín, Czech Republic). The plantings were located on a gentle southern slope at an

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altitude of approximately 320 m above sea level were equipped by covering system against rain (company VOEN, Germany) and by the drip irrigation. The plantings were covered after flowering of plants and reopened after the fruit harvest. Drip irrigation was switched on automatically when the soil moisture fell below the set limit of 30% of water volume, which is the usual soil moisture according to the type in the specific planting. Experimental plantings of small fruit were established in 2012 at a spacing of 3 x 0.8 m in the form of two-stem spindles. The soil in the crop belt was covered with a foil to prevent soil contamination of the fruit and to prevent the growth of undesirable vegetation with the exclusion of the application of herbicides.

Antioxidant activity analysis

A total of 29 currant cultivars in year 2020, resp. 28 in year 2021 and 9 gooseberry cultivars in 2020 and 2021 from both organic and IPM orchards were analysed for total antioxidant capacity. Currants and gooseberries were frozen immediately after harvest and stored at -20 °C prior to analysis. After thawing at room temperature a representative sample of twenty currant sprigs (fruits without stalks) and twenty gooseberries were selected for analysis. The berries were homogenized for 10 seconds using a Nutribullet mixer. The homogenized mixture (3 g) was weighed and transferred into 15 mL centrifuge tubes, 5 mL of extraction solvent (methanol+ 0,1 % (v/v) formic acid) was added, and followed by sonication for 30 min in an ultrasonic bath (Bandelin Sonorex, Thermo Fisher Scientific, Inc., Waltham, MA, USA) for completely disintegration of the matrix and antioxidants release. For extraction, we always performed samples twice A and B. Subsequent centrifugation (EBA 200, Hettich Zentrifugen, Germany) at 5000 RPM for 15 minutes resulted in the separation of the liquid phase (supernatant) from the solid sediment. About 1.5 mL of supernatant was decanted from the sample and filtered through a syringe filter (Nylon, 0.22 µm) into 2 mL vial. Obtained extract was diluted 10 times with distilled water and stored at 8 °C before analysis.

Total antioxidant activity was measured by FIA-ECD (Flow Injection Analysis – Electrochemical Detection) and determined as the charge in C (Coulombs) by integrating the peak area response at four of the working electrodes in series. The CoulArray electrochemical detector consists of coulometric cell with four working porous graphite electrodes and reference hydrogen-palladium electrodes. This method is based on the injection of fruit extract into the mobile carrier phase, which passes through four series-coupled electrochemical sensors of the CoulArray coulochemical detector to detect and quantify electroactive antioxidants based on the charge in C. Solvent mixture of phosphate buffer solution (0.05 mol/L) and acetonitrile (9:1; v:v) about total pH of 4.7 was utilized as mobile phase. The flow rate of the mobile phase during the measurement was 1 mL/min and the sample injection volume was 10 µL. The working electrode potentials 200, 400, 600, and 800 mV were applied to the dry reference hydrogen-palladium electrode. Antioxidant activity was expressed as electrical charge in C of one gram of fresh fruit.

Results and discussion

Results of the total antioxidant activity of currants are shown in Figure 1 and in Figure 2. Differences between fruit colored cultivars were observed, darker cultivars reached higher values.

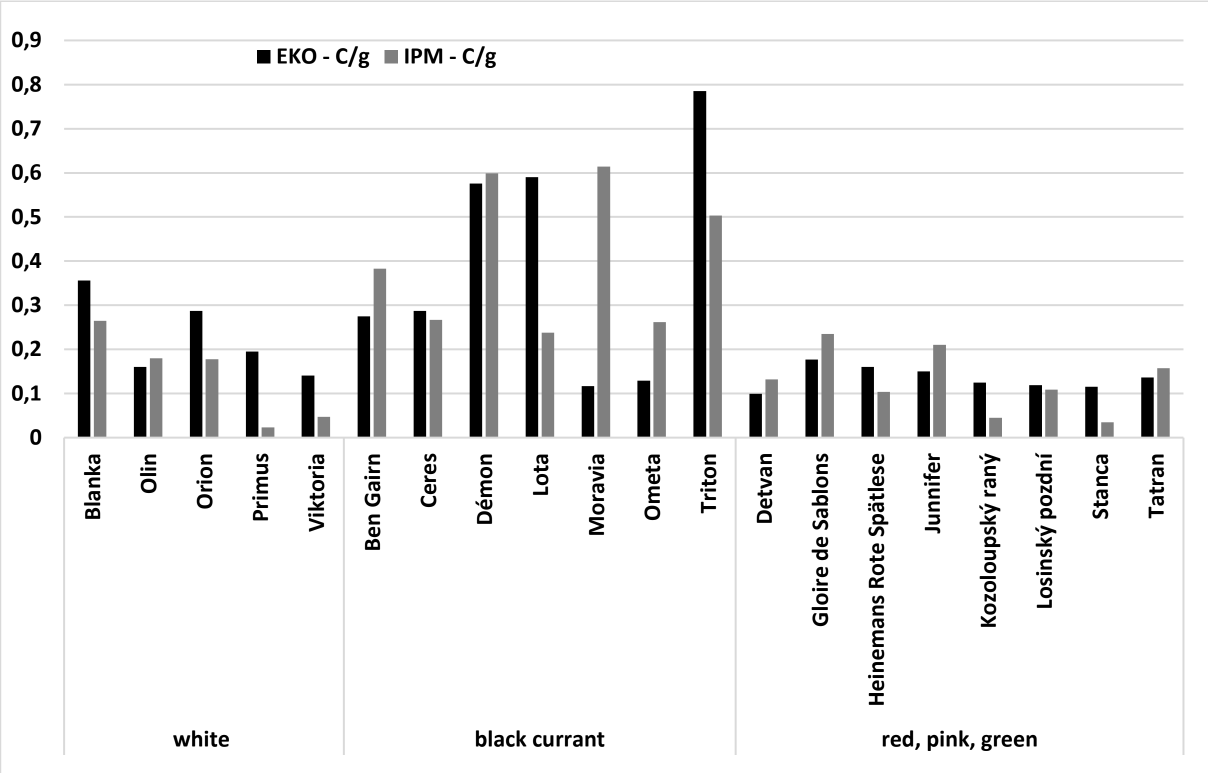

Figure 1. Total antioxidant activity of currants in 2020 (C/g)

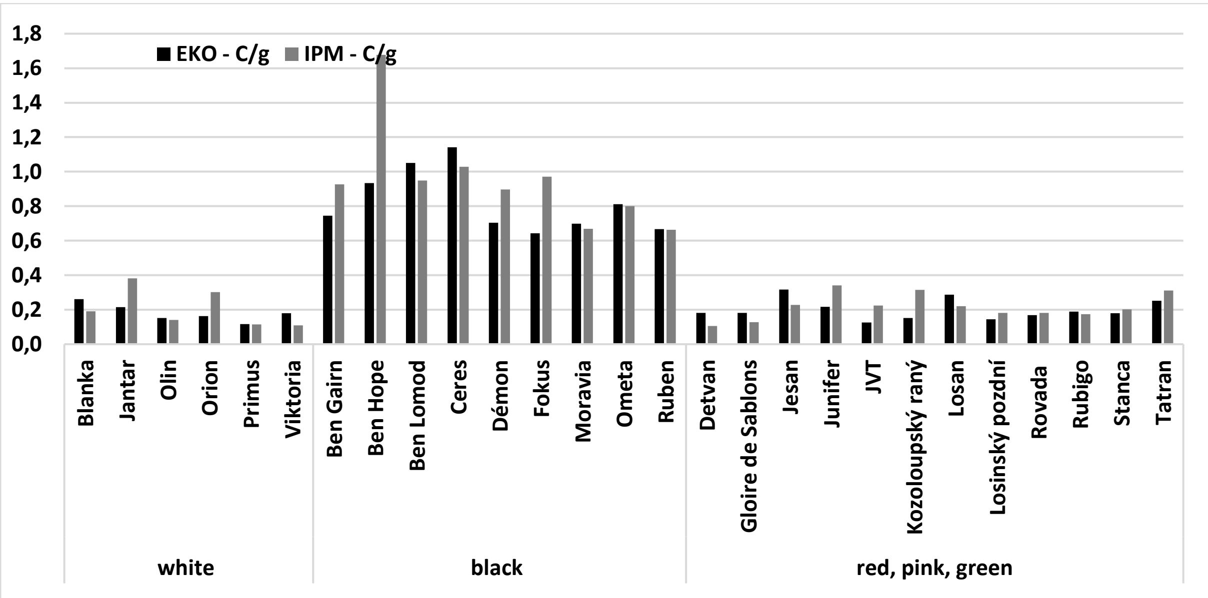

Figure 2. Total antioxidant activity of currants in 2021 (C/g)

Total highest antioxidant activity was determined among black currants. The highest antioxidant activity in 2020 was determined among currants for the cultivars 'Triton' from the group of black currants (EKO; value 0,785 C/g), for cultivar 'Gloire de Sablons' (IPM; value 0,235 C/g) from the group of red, pink and green currants and for 'Blanka' (EKO; value 0,356 C/g) from the group of white currants. In 2021 the highest antioxidant activity was determined among currants for the cultivars 'Ben Hope' from the group of black currants (IPM; value 1.678 C/g), for cultivar 'Jantar' (IPM; value 0,339 C/g) from the group of white currants and for 'Vilma' (IPM; value 0,663 C/g) from the group of red, pink and green currants. The higher antioxidant activity was determined for currants grown in organic regime in year 2020. In eleven times out of twenty cases were recorded higher values from the organic plantation. In the year 2021 differences between IPM and EKO cultivation regime was not recorded.

Analysis of gooseberries showed the same trend (Figure 3. and Figure 4). Higher antioxidant activity was determined in red fruit cultivars in comparison with white fruit cultivars. The highest antioxidant activity was in 2020 recorded for cultivars 'Karmen' (EKO; value 0,117 C/g) from the red gooseberry group and 'Mucurines' (EKO; value 0,045 C/g) in the group of white gooseberries. In the year 2021 the highest antioxidant activity was recorded for cultivars 'Hinnonmäen Punainen´ (EKO; value 0,187 C/g) from the red gooseberry group and 'Rixanta' (EKO; value 0,094 C/g) in the group of white gooseberries. Also results of analyses in 2021 showed higher antioxidant activity of gooseberry fruits grown in organic regime. Six cultivars from the organic plantation had higher value of antioxidant activity of total eight cultivars evaluated both in IPM and EKO regime. Results of analysis in 2020 showed higher antioxidant activity of gooseberry fruits grown in organic regime. Seven gooseberry cultivars in 2020, respective six cultivars in 2021 from EKO plantations had higher value of antioxidant activity of total nine evaluated cultivars in particular years.

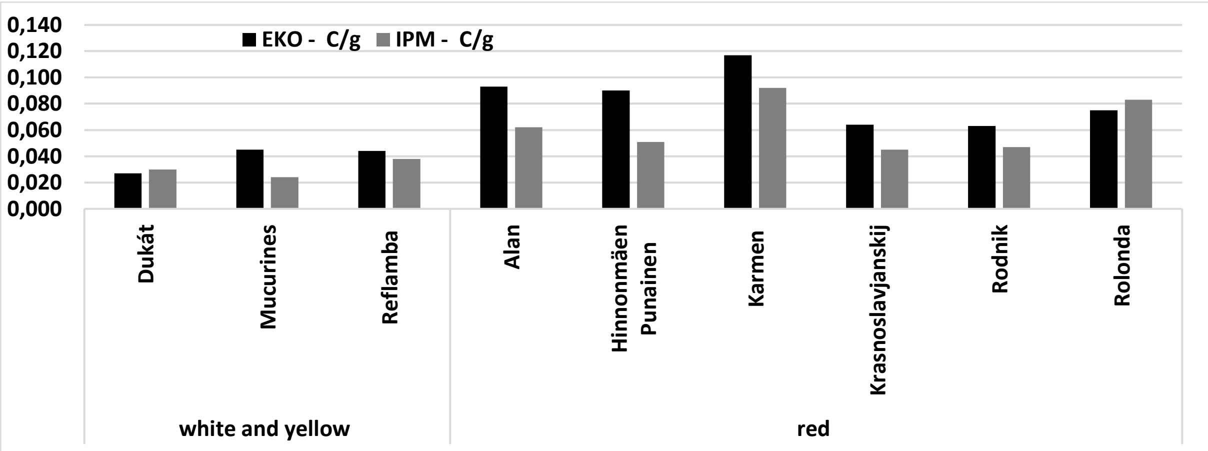

Figure 3. Total antioxidant activity of gooseberries in 2020 (C/g)

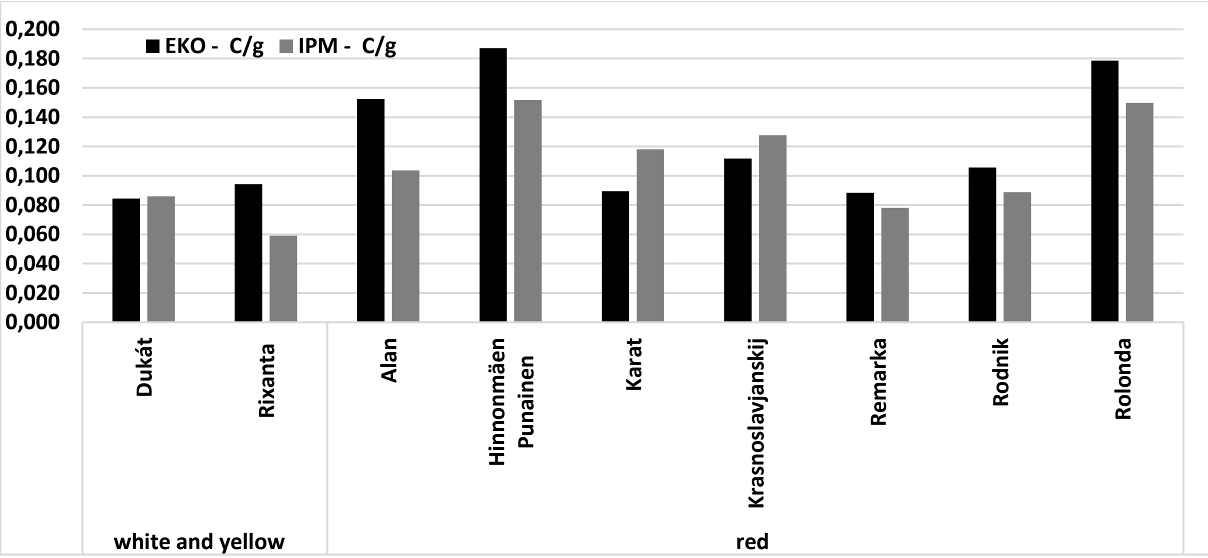

Figure 4. Total antioxidant activity of gooseberries in year 2021 (C/g)

Conclusion

The FIA-ECD method of antioxidant activity analysis with multichannel electrochemical detection expressed as the charge in C was proven in practice as a reliable and very fast method of evaluation of antioxidant activity of fruit extracts. It is noteworthy that carried out analyses showed the higher antioxidant activity of fruits grown in the organic regime compared to the IPM growing system. The higher antioxidant activity determined for cultivars grown in EKO conditions correlates with results reported in the literature (Benbrook, 2020; Kazimierczak, 2008). Substances with antioxidant activity are among the so-called secondary plant metabolites. Their synthesis responds to environmental conditions (climate, soil type, weather, pest infestation or pest control). It is belived that fruits grown under the organic regime are forced to be more self-protected against diseases and pests and therefore contains more antioxidants than fruits protected chemical substances.

Acknowledgements

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