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Ascorbic acid and vitamin C analysis in organic currant and gooseberry

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Abstract

Ascorbic acid and vitamin C content of soft fruits was determined in currant and gooseberry cultivars cultivated both in IPM and EKO regimes in years 2020 and 2021. Totally 20 cultivars of currants and 9 gooseberries were involved in evaluation content of ascorbic acid in year 2020 and 29 currant and 8 gooseberry cultivars were analysed for vitamin C content in year 2021. Differences in content of ascorbic acid and vitamin C between the fruit colored cultivars were observed. Darker cultivars reached higher values. The highest ascorbic acid and vitamin C was found in black currant cultivars, lower in red, pink, green and white currants and the lowest in white gooseberries. The highest ascorbic acid content was recorded in black currant group in range 104.2 − 249.1 mg/100 g of fresh fruit weight in 2020 and vitamin C 35.5 – 139.8 mg/100 g of fresh fruit weight in 2021. Cultivars of black currant grown in EKO production showed higher content of ascorbic acid and vitamin C than cultivars grown in IPM.

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

Introduction

Soft berries as currant and gooseberry belong to the best dietary sources of bioactive compounds (BAC). They are also very delicious with low energy and are often consumed in fresh form when the most BAC are still active and in the greatest amount. The bioactive compounds in berries contain mainly phenolic compounds such as phenolic acids, flavonoids-flavonols, anthocyanins, tannins. To bioactive compounds belong other antioxidants such as vitamins (ascorbic acid) and minerals with antioxidant properties. The composition and content of BAC in berries is variable depending on the cultivar, growing location, environmental conditions, plant nutrition, irrigation, ripeness stage and time of harvest. Subsequent storage conditions or processing methods are also important for preservation of the BAC high content in fruits. These compounds are of great interest for nutritionists and food technologists due to the opportunity to use BAC as functional foods ingredients. Nutraceuticals and functional foods have become very popular for people due to the consumer demands for healthy nutraceutical foods that could possibly reduce some health risks and improve various health conditions. Regular 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. Production, acreage, productivity, and consumption of soft berries, as currant and gooseberry, are increasing rapidly around the world. It is accepted that a diet rich in ascorbic acid has various health advantages (Wintergerst et al., 2006; Reczek and Chandel, 2015; Carr and Maggini, 2017; van Gorkom et al., 2018). The content of vitamin C

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and ascorbic acid was determined both for currants and gooseberries grown in organic regime (EKO) in comparison to the integrated pest management orchard (IPM). In this work the content of vitamin C and ascorbic acid in mg/100 g of fresh fruit weight was evaluated in black, white, red, pink and green currant cultivars and in red, white and yellow gooseberry cultivars. It is accepted that a diet rich in ascorbate has various health advantages (Wintergerst et al., 2006; Reczek and Chandel, 2015; Carr and Maggini, 2017; van Gorkom et al., 2018). The content of vitamin C and ascorbic acid was determined both for currants and gooseberries grown in organic regime (EKO) in comparison to the integrated pest management orchard (IPM).

Materials and methods

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 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.

Totally 20 currant and 9 gooseberry cultivars in 2020 were involved in evaluation of the ascorbic acid content in 2020 and 29 currant and 8 gooseberry cultivars were analysed for the vitamin C content in 2021. Currant and gooseberry samples were homogenized on a Retsch GM200 knife mill without stalks. 2 g in 2020 respectively 5 g in 2021 of mixed fruit was weighed into a 100 mL volumetric flask containing a metaphosphoric acid solution (20 g/L) and then made up to the mark this solution. The flask was mixed well and the extracts obtained were vacuum filtered. In 2020 extract was filtered through a 0.45 µm membrane filter into vials and analysed. However, vitamin C is defined as the sum of L-ascorbic acid and L-dehydroascorbic acid so in 2021 reduction step was added. L-dehydroascorbic acid was reduced to L-ascorbic acid by L-cysteine. Reduction step was immediately performed on the filtrates by pipetting 20 mL of filtrate into the beaker, followed by adding 10 mL of L-cysteine solution (40 g/L). The pH was adjusted to between 7.0 and 7.2 by the addition of trisodium phosphate solution (200 g/L) and stirred for exactly 5 minutes. The pH was then reduced to between 2.5 and 2.8 by the addition of metaphosphoric acid (200 g/L). The solution was quantitatively transferred to a 50 mL volumetric flask and made up to the mark with distilled water. The prepared sample was filtered through a 0.45 µm membrane filter into vials and analysed.

The Agilent 1260 Infinity HPLC-DAD at 265 nm system was used for analysis. The mobile phase was composed of phosphate buffer and methanol with isocratic elution. The flow rate was 1.0 mL/min. Separation was performed on a Kinetex C18 100A column (150x4.6 mm;

5µm) at 25 °C. The volume of the injected sample was 20 µL. Identification and quantification was performed on the basis of comparison with the standard by the method of calibration curve. A calibration series was prepared by dilution of stock solution of L-ascorbic acid (1 g/L). The calibration points was 2; 5, 10, 20, 50, 100, and 200 mg/L. The analytic concentration in the samples were calculated using a calibration curve and converted to the amount of ascorbic acid resp. vitamin C in 100 g of fresh fruit. Each sample was prepared twice and averaged.

Results and discussion

The highest content of ascorbic acid was determined to be 104.2 − 249.1 mg/100 g of fresh fruit in monitored black currant cultivars in the year 2020 (figure 1). The level of ascorbic acid in red, pink, green and white currants were observed in the range 14.6 − 69.7 of mg/100 g of fresh fruit. The highest ascorbic acid content was determined in black currant cultivar ‘Ceres’ (EKO) 249.1 mg/100 g of fresh fruit, for the group of red, pink and green currants was recorded in cultivar ’Junifer’ (IPM) with 69.7 mg/100 g of fresh fruit. Cultivar ’Primus’ (IPM) showed the highest content of ascorbic acid with 62.4 mg/100 g of fresh fruit among white currants.

The content of vitamin C in the year 2021 moved in the range 25.5 – 139.8 mg/100 g of fresh fruit. Results are demonstrated on figure 2. For red, pink, green and white currants were observed in range 16.7 – 81.2 mg/100 g of fresh fruit. The highest vitamin C content was determined in black currant cultivar ‘Ceres’ (EKO) with 139.8 mg/100 g of fresh fruit. For the group of red, pink and green currants the highest Vitamin C was recorded in cultivar ’Junifer’ (EKO) with 81,2 mg/100 g of fresh fruit. Cultivar ‘Jantar’ (EKO) showed the highest content of vitamin C in white currant group.

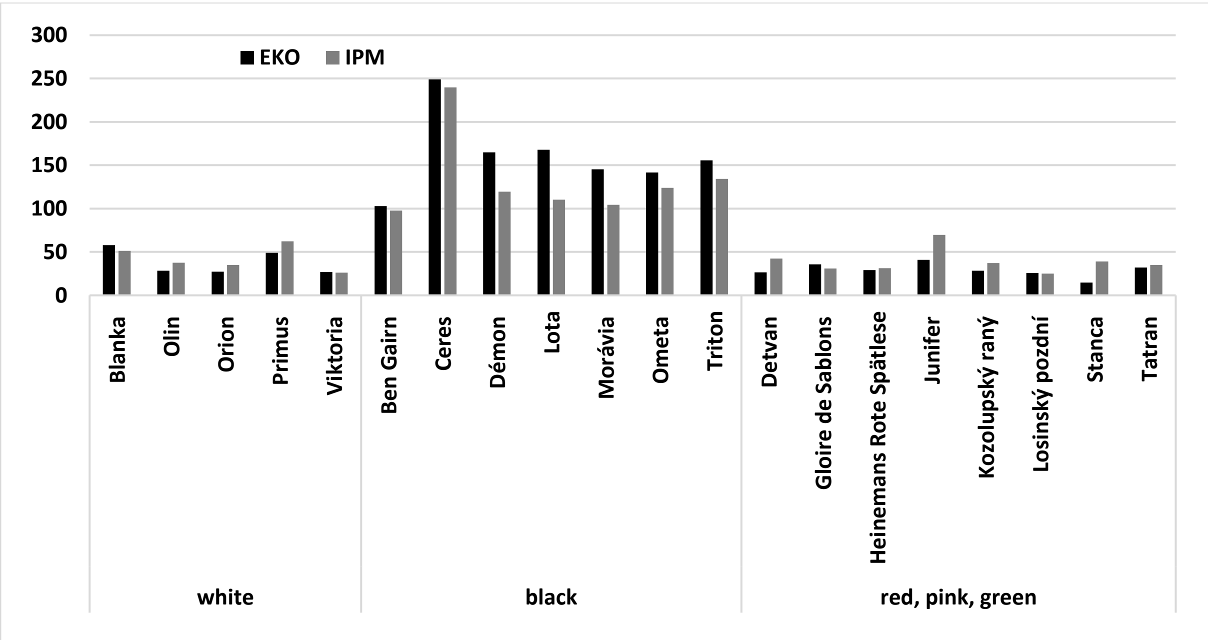

Figure 1. Ascorbic acid content in currants in 2020 (mg/100 g of fresh fruit)

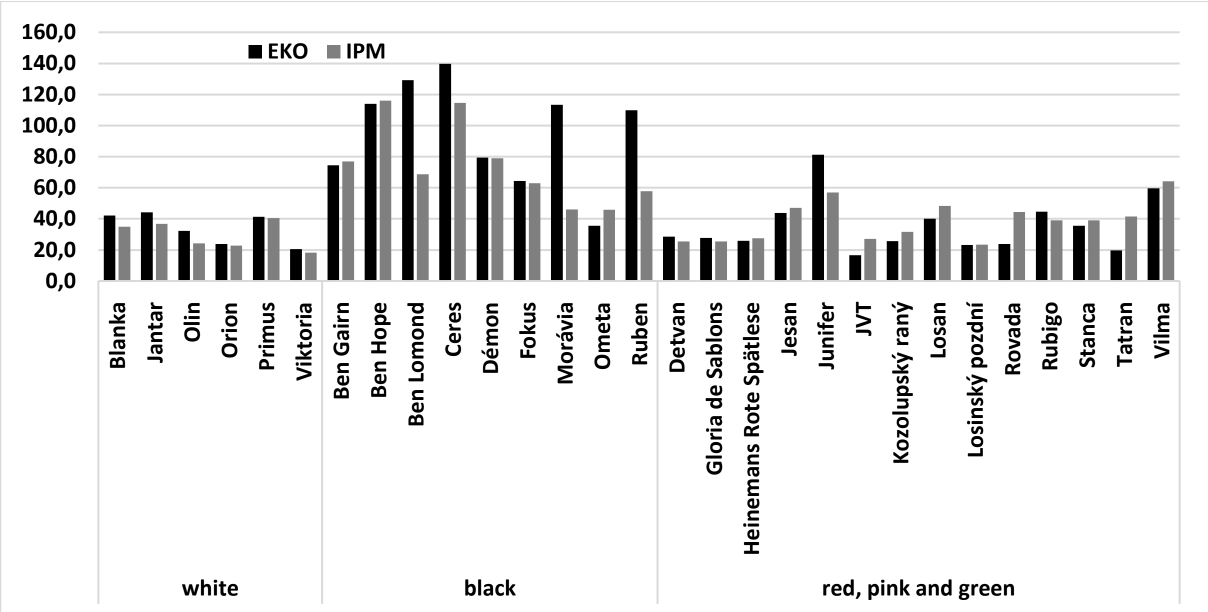

Figure 2. Vitamin C content in currants in 2021 (mg/100 g of fresh fruit)

Contents of ascorbic acid in gooseberries was recorded in range 9.0 – 37.8 mg/100 g of fresh fruit in 2020. Red gooseberry cultivar ‘Rolonda’ (IPM) showed the highest content of ascorbic acid 37.8 mg/100 g of fresh fruit. In the group of yellow and white gooseberries was recorded the highest content of ascorbic acid in cultivar ‘Dukát’ (IPM) with 27.5 mg/100 g of fresh fruit.

As far as vitamin C evaluated in 2021, its levels were in range 13.1 – 26.8 mg/100 g of fresh fruit. The highest content was determined in cultivar ’Karát’ (IPM) with 26.8 mg/100 g of fresh fruit from the group of red gooseberries. From the group of yellow and white group was the highest level of vitamin C determined in cultivar ‘Dukát’ with 22.8 mg/100 g of fresh fruit. Obtained results were documented in Figures 3 and Figures 4.

Cultivars of black currant grown in EKO production contained more ascorbic acid and vitamin C than cultivars grown in IPM in both year 2020 and 2021. This phenomenon was observed only in the group of black currants.

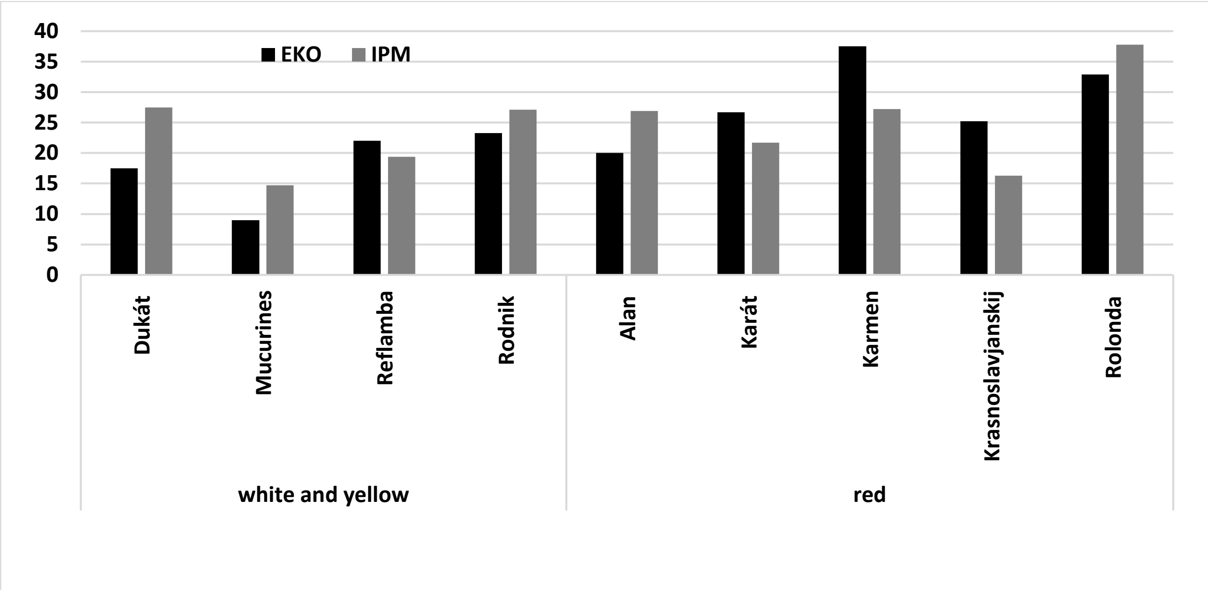

Figure 3. Ascorbic acid content in gooseberries in 2020 (mg/100 g of fresh fruit)

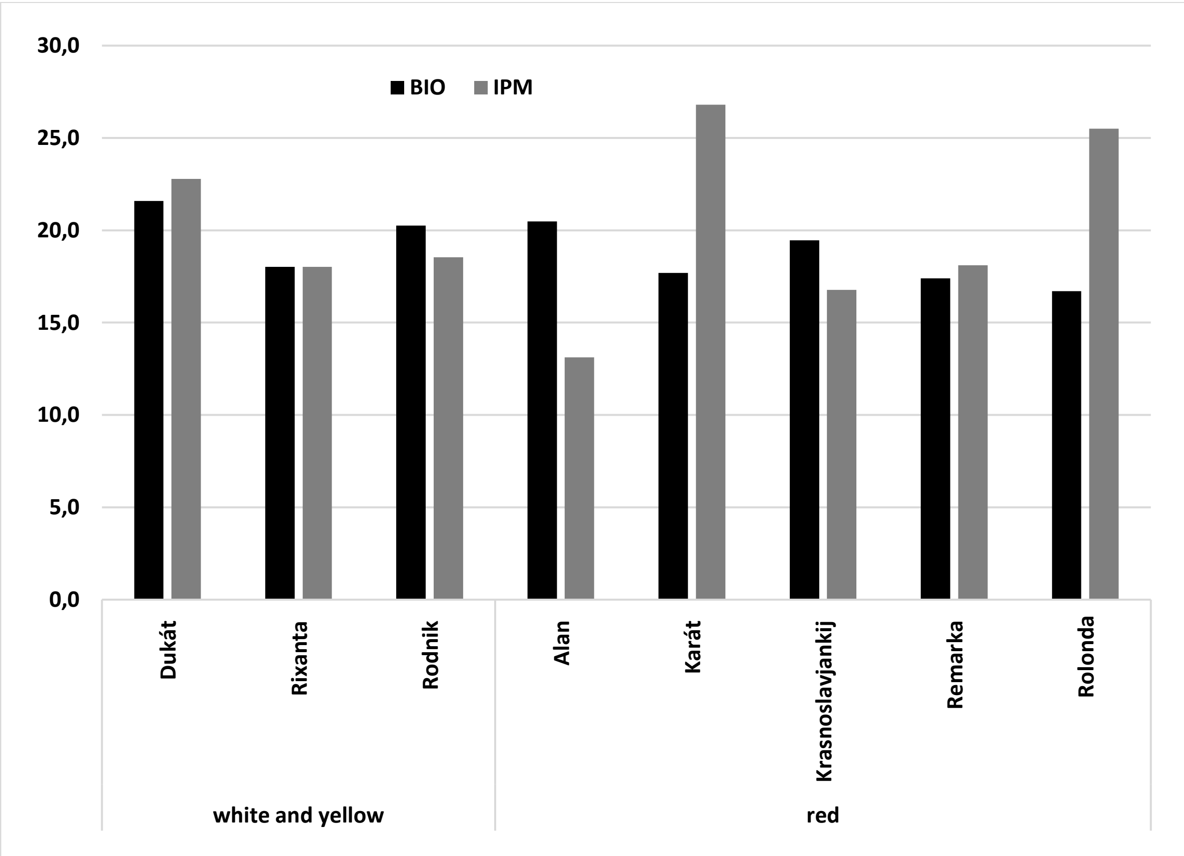

Figure 4. Vitamin C content in gooseberries in 2021 (mg/100 g of fresh fruit)

Conclusion

The higher antioxidant activity as well as higher ascorbic acid content 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). Fruits grown under the organic regime are forced to be more self-protected against diseases and pests and therefore contains more antioxidants than chemicals fruit protected substances. Black currant cultivars grown in EKO production contained more ascorbic acid and vitamin C than cultivars grown in IPM. Differences among white, red, pink and green currants, as well differences among gooseberry cultivars, grown in organic and IPM conditions are not distinct in our evaluation.

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