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BIOCHEMICAL COMPOSITION OF BLACKCURRANT FRUITS IN A PLANTATION FROM JIBOU AREA

Szarita PASKUCZA[1], Rahela CARPA[2], Carla Andreea CULDA[3], Anca Livia BUTIUC-KEUL[2], Cristina DOBROTA[2], Octavian BERCHEZ[4], Teodor RUSU[1]

[1]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Agriculture, 3-5 Mănăştur Way, 400372, Cluj-Napoca, Romania
[2]Babes-Bolyai University, Faculty of Biology and Geology, Department of Molecular Biology and Biotechnology, 1 M. Kogalniceanu Street, 400084, Cluj-Napoca, Romania
[3]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Veterinary Medicine, 3-5 Mănăştur Way, 400372, Cluj-Napoca, Romania
[4]University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru Street, 410048, Oradea, Romania

Corresponding author email: k_hella@yahoo.com

Abstract

There is a plurality of studies highlighting the beneficial properties of blackcurrant, especially the anti-oxidant ones. These are mainly due to phenols, of which anthocyanins and flavonoids stand out, yet the mechanisms by which the active substances in blackcurrant act are not fully understood. Blackcurrant extract has a complex biochemical composition, it contains tannins, green volatile oils, terpenic carbides, B-complex vitamins, vitamin C, organic acids (citric, malic), pectins, sugars, anthocyanins, terpenes, oils fats, flavonoids (myricetol, cvercetol, camphor), pectin, calcium, iron, potassium, phosphorus, vitamin PP. The research was carried out between 2017 and 2020. By chemical and biochemical analyses, the content of blackcurrant fruits was monitored over time, as well as the presence of some chemical or biochemical compounds with sulphur, with harmful action on the human organism, in the extract. It was sought to know if the presence of sulphur springs would have an influence on the chemical and biochemical composition of blackcurrant fruits.

Key words*: antioxidant activity, blackcurrant fruits, polyphenols content, Ribes nigrum.*

INTRODUCTION

Blackcurrant (*Ribes nigrum* L.) is a shrub belonging to Saxifragaceae family, which grows up to 2 meters high. It can be found growing spontaneously of cultivated in mountain areas, in forests and bushwood, in colder temperate regions of Europe and Northern Asia. The white flowers are gathered in short clusters, gradually transforming into black baccae, with specific smell and taste. They are very valuable due to their content of polyphenols and vitamin C, intervening in the regulation of the intestinal microbiota, thus granting protection against anti-inflammatory degenerative disorders or even cancer (Butură, 1979; van Wyk and Wink, 2017; Vepštaitė-Monstavičė et al., 2018).

The blackcurrants are recognised as a rich source of polyphenols (especially anthocyanins, phenolic acid derivatives, flavonols and proanthocyanidins) useful for vascular and metabolic health. Among the large range of bioactive components of these fruits a main position is occupied by the anthocyanins, which are polyphenolic glycosides and belong to the flavonoid family. They also provide the natural colouring of the fruits. The minor compounds containing sulphur (as 8-mercapto-p-menthan-3-one) are contributing to the specific smell and aroma of blackcurrants (Castro-Acosta et al., 2016; Paunović et al., 2017; van Wyk and Wink, 2017).

The phenolic compounds, important bioactive compounds, split in two groups: phenolic acids and flavonoids (Quideau et al., 2011). Generally, they occur in nature as combined forms with sugars, organic acids and esters; while other phenols occur as aglycones. Phenolic acids are present in vegetal tissues mainly as hydroxyl derivatives of benzoic and cinnamic acids. They cause of the bitter and sour taste of different plants, to these adding their astringent properties (Parus, 2013). They represent substrates for biosynthesis reactions (e.g., caffeic acid is a precursor of lignin) (Quideau et al., 2011). Flavonoids form the largest group of polyphenolic compounds and are split into several sub-classes, according to their chemical structure: flavanones, flavanols, flavones, isoflavones, flavonols and anthocyanins (Ferreyra et al., 2012). These substances are the main antioxidants that confer protection against Reactive oxygen species (ROS), yielded by plants in large quantities under stress conditions. Also important in activating the enzymes involved in the cell metabolism and in the antioxidant systems are minerals and trace elements (Stern et al., 2008). The researchers concluded that high nutritional levels of K, Mg, and Ca reduce risk of stroke, hypertension, and osteoporosis (Larsson et al., 2008; Janz et al., 2013; Pavlovic et al., 2015). Microminerals, such as iron, are essential in many compounds performing oxygen transport and storage, representing cofactors for enzymes (Larsson et al., 2008). This mineral uptake in plants depends on the growth conditions, which imply cultivation techniques, stress (biotic or abiotic), and nutritional status (Niskanen, 2002; Staszowska-Karkut et al., 2020).

Blackcurrants are widely consumed in the world, usually in fresh, frozen, or processed form. It has been shown that currants possess positive effects in dietary management of various diseases (hypertension, osteoporosis, inflammation, cancer, and cardiovascular disease). Ascorbic acid, anthocyanins, and flavonoids are the most valuable compounds present in blackcurrants (Zdunic et al., 2016).

The biochemical composition of blackcurrants ensures the mineralizing, vitaminizing, bactericidal, hemostatic, diuretic, laxative, anti-inflammatory, depurative, immunostimulating, and phytonicidal effects of this plant.

MATERIALS AND METHODS

Chemical and biochemical analyses were performed on fresh blackcurrant fruit extracts, using distinct methods to establish the array of components. These analyses were performed in the research laboratories of the Faculty of Environmental Protection, University of Oradea.

The dry substance was determined by desiccating the fruits in stove at 105-110ºC, further weighing and proportioning. The sugar content of blackcurrant fruits is significant. It was assessed using the Schoorl method (Schrool and Regenbogen, 1917). Acidity was determined by potentiometric analysis. The detection of tanning and colouring substances (mg%) was performed with 1% vanillin solution in concentrated HCl and 1% $FeCl_3$ solution. The gauging of tanning substances was done by permanganatometric method Vitamin C (mg %) was determined by iodometric method, based on the oxidation of ascorbic acid with excess iodine. Than the sugar/acid parameter was calculated.

Spectrophotometry was involved, performing the Folin-Ciocalteu assay, for assessing the total phenolic content, expressed as mg of gallic acid equivalent (GAE)/g dry residue (Attard, 2013). Potentiometric method was used to determine the antioxidant activity, evaluated based on the capacity to capture free radicals. In the process, peroxy radicals are generated involving 2.2-azobis (2-amidinopropane) dihydrochloride. The results were expressed in gallic acid equivalents/g dry extract weight.

RESULTS AND DISCUSSIONS

The biochemical analyses were performed on blackcurrant fruits hand-picked on a plantation in Jibou town (Figure 1), situated in the vicinity of sulphur springs.

Figure 1. *Ribes nigrum* plantation

Each tested parameter was assessed in triplicate, for each studied year (2017-2020).
In this plantation the crop slightly decreased along the 4 years of the study (Table 1). The sugar content along the 4 years had slightly varied, the lowest content being recorded in 2019 (7.96%). The assessment of tanning and colouring substances (mg%) by permanganatometric method indicated a high content in each year included in the study (Table 1). The total content of tanning substances is variable from one year to another, registering a maximum of 73.29 mg% in 2017 and minimum of 69.58 mg% in 2020.

Table 1. Quality of blackcurrant fruits according to nutrient content for the period 2017-2020

Parameters	Year			
	2017	2018	2019	2020
Fruit average mass (g)	1.5	1.4	1.6	1.4
Crop (kg/ha)	18.22	19.58	17.36	16.47
Sugar content (%)	8.64	8.58	7.96	8.26
Titrated acidity (%)	1.58	1.49	1.53	1.47
Colouring substances (mg%)	69.58	72.34	71.96	72.67
Vitamin C (mg%)	23.56	22.69	23.18	23.36
Sugar/acid coefficient	4.81	4.74	4.59	4.82

Figure 2 shows the variation of the vitamin C content during the four years of study. It can be noticed the lower quantity of vitamin C in 2018, compared with the other years of study (Figure 2).

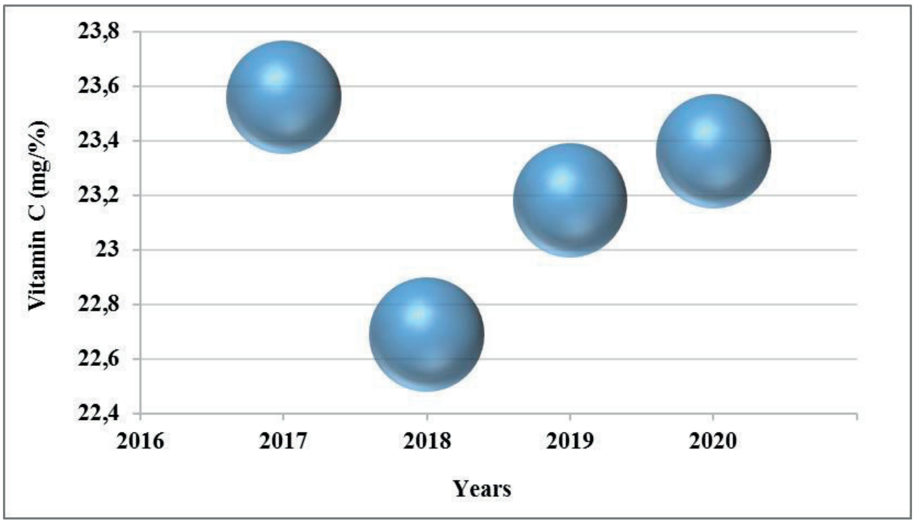

Figure 2. Content of vitamin C in blackcurrant fruits

The acidity detected by titration in the blackcurrant leaves during the timespan of the study was quite uniform and ranged between 1.47-1.58%. The sugar content was also rather uniform on the study period. The coefficient calculated for the ratio between the sugar content and acidity exhibited a slightly increasing trend in 2020 (Figure 3).
The total polyphenolic content reached values ranging from 0.492 mg/ml in 2017 to 0.552 mg/ml in 2020 (Table 2). Antioxidant activity is in relation with the polyphenol currant fruits contain. Within polyphenols, the most important are anthocyanins and flavonols, and it must be added that a synergistic action of different groups of phenolic compounds can be observed. The performed studies concluded that anthocyanins dominated in blackcurrants, while phenolic acids and proanthocyanidins dominated among the phenolic compounds in green and white currants (Maatta et al., 2001).
The phenolic compounds mentioned exhibit tones of blue, yellow, red, and purple and determine the colour of the currant fruits. Blackcurrant fruits may be regarded as genuine deposits of polyphenolic compounds, which provide antiradical impact, which can inhibit the carcinogenic process, if consumed fresh.

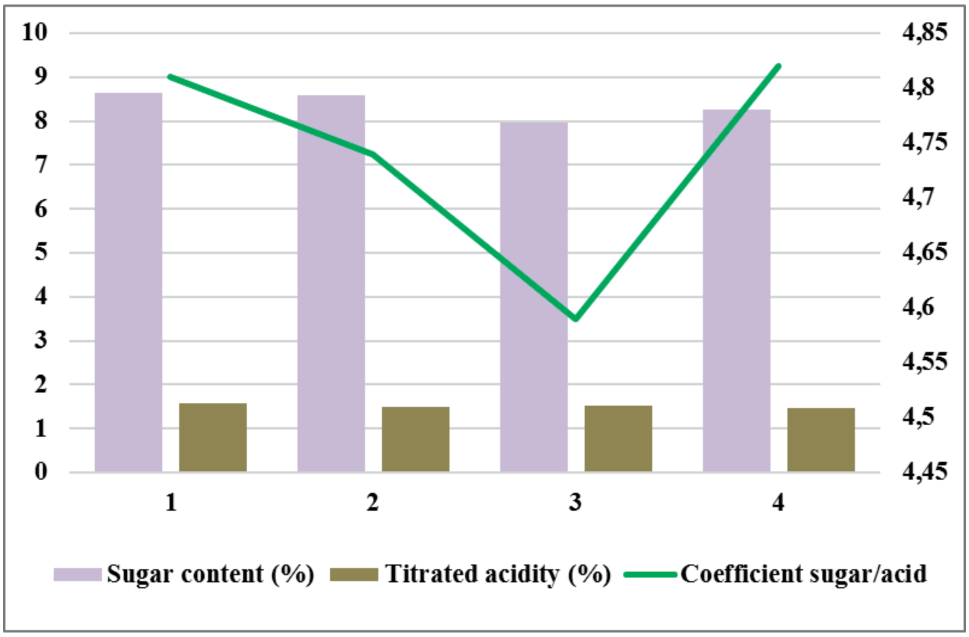

Figure 3. Content of sugar (%) and acidity in blackcurrant fruits (2017-2020 years)

Considering such properties, the antioxidant capability of fresh fruits correlated to the polyphenol content was aimed. As for the polyphenol content, the Folin-Ciocalteu method was used to assess it. The potentiometric method was applied to assess the antioxidant activity. The antioxidant activity of polyphenols translates in their aptitude to capture free radicals. The method implies generating peroxy radicals by using 2-amidinopropane dihydrochloride. The ability of fresh fruit extracts to capture radical peroxyls was expressed in gallic acid equivalent (GAE) µM gallic acid/g of dry residue. The dilution of the currant extract was 0.1.

Table 2. Characteristics of crude blackcurrant fruit extracts, during the research period (2017-2020)

Blackcurrant extract	Years			
	2017	2018	2019	2020
Dry residue (mg/ml)	6.76±0.15	6.28±0.15	6.96±0.15	6.67±0.15
Total polyphenolic (mg/ml)	0.492±0.005	0.612±0.005	0.527±0.005	0.552±0.005
Antiradical activity (%)	53.39±0.5	62.36±0.558	58.86±0.5	57.84±0.5
The ability to capture peroxyl radicals (µM GAE/g dry residue)	286.42±25.50	268.57±25.50	279.68±25.50	261.46±25.50
Dried blackcurrants at 60ºC	215.49±20.45	192.23±18.24	195.01±18.51	95.34±9.05

The anti-free radicals activity of the analysed extracts is directly correlated with the polyphenolic content, thus the capacity to capture the free radicals in the analysed extracts grows along with the increase of the polyphenolic content. The differences recorded in the research are mainly owned to the polyphenols content of blackcurrant fruits.

A higher content of polyphenols was observed in the year 2018 (0.612 mg/ml) (Figure 4).

Evaluation of the antioxidant activity of polyphenols was performed based on the ability to capture free radicals. The capacity to capture free radicals in dilution of 1/10 shows variations from 53.39 ± 0.5% in 2017 to 62.36 ± 0.5% in 2018. The extract of free radicals had the highest capability for free radical uptake corresponding to the extract from 2017, with an antiradical activity value of just 53.39 ± 0.5%.

The peroxyl radical uptake capacity of the analysed extract (by expressing the antiradical activity in the equivalent of gallic acid) varies widely during the research period from a maximum value of 286.42 ± 22.50 µMGAE/g recorded in 2017, to a minimum value of 261.46 ± 25.50 µMGAE/g recorded in 2020 (Table 2).

The antiradical activity of the analysed extracts is directly correlated with the polyphenolic content, consequently the ability to capture free radicals from the analysed extracts increases with increasing polyphenolic content. The differences registered during the research period are mainly due to the polyphenol content of blackcurrant fruits, the highest content being recorded in 2018 (Figure 4).

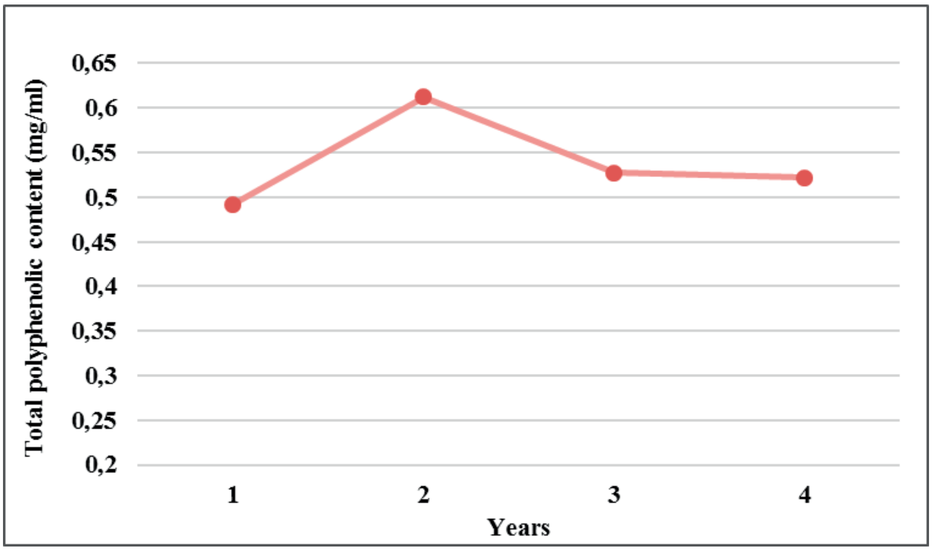

Figure 4. Total polyphenolic content (mg/ml) in blackcurrant fruits (2017-2020 years)

CONCLUSSIONS

The results obtained experimentally show that the antioxidant activity of blackcurrant fruit is directly proportional to the polyphenol content. According to the comparative analyses of blackcurrant fruits along the 4 years study period the total polyphenols varied slightly.

The priority to focus on is the ability to capture free radicals, because it reaches promising values, the highest being recorded in 2017, of 286.42±25.50 µMGAE/g.

In conclusion, based on the comparative study of the free radical scavenging capacity in the analysed samples, along all the study years, blackcurrant fruits can serve as a source of products rich in polyphenolic content, with antioxidant properties.

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REFERENCES

Attard, E. (2013). A rapid microtitre plate Folin-Ciocalteu method for the assessment of polyphenols. *Open Life Sci*., 8, 48-53.

Butură, V. (1979). *Enciclopedie de etnobotanică Românească*. Ed. Științifică și Enciclopedică, București.

Castro-Acosta, M.L., Smith, L., Miller, R.J., McCarthy, D.I., Farrimond, J.A., Hall, W.L. (2016). Drinks containing anthocyanin-rich blackcurrant extract decrease postprandial blood glucose, insulin and incretin concentrations, *The Journal of Nutritional Biochemistry*, 38, 154-161.

Ferreyra, M.L.F., Rius, S.P., Casati, P. (2012). Flavonoids: Biosynthesis, biological functions and biotechnological applications. *Frontiers in Plant Science*, 3, 222.

Janz, T.G., Johnson, R.L., Rubenstein, S.D. (2013). Anemia in the emergency department: Evaluation and treatment. *Emergency Medicine Practice*, 15, 1-15.

Larsson, S.C., Virtanen, M.J., Mars, M., Männisto, S.J., Pietinen, P., Albanes, D., Virtamo, J. (2008). Magnesium, calcium, potassium and sodium intakes and risk of stroke in male smokers. *Archives of internal medicine*, 168, 459-465.

Maatta, K., Kamal-Eldin, A., Törrönen, R. (2001). Phenolic compounds in berries of black, red, green, and white currants (*Ribes* sp.). *Antioxid Redox Signal* 3(6): 981-993.

Niskanen, R. (2002). Nutritional status in commercial currant fields. *Agricultural and Food Science*, 11, 301-310.

Parus, A. (2013). Antioxidant and pharmacological properties of phenolic acids. *Postępy Fitoterapia*, 1, 48-53.

Paunović, S.M., Masković, P., Nikolić, M., Miletić, R. (2017). Bioactive compounds and antimicrobial activity of black currant (*Ribes nigrum* L.) berries and leaves extract obtained by different soil management system. *Scientia Horticulturae*, 222, 69-75.

Pavlovic, A.N., Brcanovic, J.M., Veljkovic, J.N., Mitic, S.S., Tošic, S.B., Kalicanin, B.M., Kostic, D.A., Đordevic, M.S., Velimirovic, D.S. (2015). Characterization of commercially available products of *Aronia* according to their metal content. *Fruits*, 70, 385-393.

Quideau, S., Deffieux, D., Douat-Casassus, C., Pouysegu, L. (2011). Plant polyphenols: Chemical properties, biological activities and synthesis. Angewandte Chemie Int. Ed., 50, 586-621.

Schrool, N., Regenbogen, A. (1917). Massanalytische Zuckerbestimmung. *Zeitschr. f. anal. Chem*., 56, 191.

Staszowska-Karkut, M., Materska, M. (2020). Phenolic Composition, Mineral Content, and Beneficial Bioactivities of Leaf Extracts from Black Currant (*Ribes nigrum* L.), Raspberry (*Rubus idaeus*), and Aronia (*Aronia melanocarpa*). *Nutrients*, 12 (2), 463.

Stern, B.R., Solioz, M., Krewski, D., Aggett, P., Aw, T.C., Baker, S., Crump, K., Durson, M., Haber, L., Hertzberg, R., Keen, C., Meek, B., Rudenko, L., Schoeny, R., Sloob, W., Star, T. (2007). Copper and human health: Biochemistry, genetics, and strategies for modelling dose-response relationships. *Journal of Toxicology and Environmental Health*, Part B, 10, 157-222.

van Wyk, B.E., Wink, M. (2017). Medicinal plants of the world. CAB International.

Vepštaitė-Monstavičė, I., Lukša, J., Stanevičienė, R., Strazdaitė-Žielienė, Z., Yurchenko, V., Serva, S., Servienė, E. (2018). Distribution of apple and blackcurrant microbiota in Lithuania and the Czech Republic. *Microbiological Research*, 206, 1-8.

Zdunić, G., Šavikin, K., Pljevljakušić, D., Djordjević, B. (2016). Chapter 5 - Black (*Ribes nigrum* L.) and Red Currant (*Ribes rubrum* L.) Cultivars, in: Ed. Simmonds Monique S.J., Preedy, Victor R., *Nutritional Composition of Fruit Cultivars*, 101-126, Academic Press.