HEALTHCARE IMPORTANCE OF BLACKCURRANT (*RIBES NIGRUM*)

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Abstract. The blackcurrant is known as a crop plant in Europe from the 16th century. Its fruits, rich in carbohydrates, fatty acids, proteins and mineral substances, are used to prepare juice, syrup, jelly or marmalade. The fruits have a general tonic, vitaminizing and remineralizing effect, being recommended in cases of overwork, in anemic conditions, in cases of iron deficiency. The flowers are also used in perfumery. Leafs are used in the herbal medicine as diuretic, in heart diseases, rheumatism, or gout. The blackcurrant contains tannins, rutin, vitamin C, trepenic volatile oil. The fruits contain vitamin C, vitamins of B complex, organic acids (citric, malic), pectins, sugars, anthocyans, fatty oil, trepenes, flavonoids (myricetol, quercetol, campherole), pectins, calcium, iron, potassium, phosphorus, vitamin PP.

Keywords: antioxidant capacity, medical properties polyphenolic content, *Ribes nigrum.*

PLANT DESCRIPTION

Blackcurrant (*Ribes nigrum*) is a shrub belonging to *Ribes* genus, Grossulariaceae family, Saxifragales order, Magnoliopsida class, Magnoliophyta phylum, Plantae kingdom. It is an erect shrub, 1–2 meters tall and has glabrous branchlets (Figure 1). Leaves are petiolate and alternate on the stem. They have a cordate base, are palmately lobed, having five lobes, are broad, 3–5 cm long. The edge is serrated, the abaxial surface is glandular and pubescent, while the adaxial surface is puberulent when young, and then glabrescent. Flowers grouped in 5-10-flowered racemes with pubescent rachis and pedicels and pubescent, ovate or lanceolate bracts. Flowers are hermaphroditic, 5–7 mm across. Calyx with oblong, pubescent, recurved sepals; subcampanulate hypanthium with lobes spreading or reflexed. Petals ovate, half as long as sepals, white to reddish, nectary disc circular and prominent, green or purplish, covering ovary; stamens about equaling petals; filaments linear with white anthers. Fruits are black, globose, grouped in racemes, succulent, with sourish taste, 6–11 mm in diameter, each containing more seeds (Morin, 2008).

Blackcurrant grows in the boreal temperate regions from Eurasia, from England, France to the West to Manciuria to the Est. The northern edge of the range is Laponia, and the southern one in Armenia and the Himalayas. The main producers of blackcurrant and redcurrants are from Europe.

Blackcurrants, as the small dark berries of the shrub (*Ribes nigrum*) are called, are the subject of extensively grown fields in Europe and are used in a variety of products, although the primary product is juice. Blackcurrants have been extensively studied and it was observed that they have very high antioxidant capacities, due to high polyphenolic and vitamin C concentrations (Borges et al., 2010).

Fig. 1. Blackcurrant plantation

A range of therapeutic properties have been attributed to blackcurrant anthocyanins (Matsumoto et al., 2001). The antioxidant capacity of the fruits can be assessed by different methods, as the total phenolic content determined by Folin–Ciocalteu assay and total and individual anthocyanins by reversed-phase high-performance liquid chromatography (Gavrilova et al. 2011). The genetic parameters and genetic correlations were also determined for this economically important species. A fast and efficient method was developed for the rapid extraction of anthocyanins from *Ribes nigrum* L. (Kou et al., 2019).

Black currants are widely consumed throughout 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, diabetes and cardiovascular disease) (Da Silva Pinto et al., 2010). The ascorbic acid, flavonoids and anthocyanins are among the most valuable compounds present in both black and red currants. Besides these active compounds, the fruits present other important features, as good nutritional value, original flavor, appropriate size for a number of end uses, uniform ripening and resistance to pests and diseases. Based on these qualities, different breeding programs aim to develop new currant cultivars. Out of the species of *Ribes* genus, mostly subjected to this quest for new cultivars are *Ribes nigrum* and *Ribes rubrum*.

BIOCHEMICAL COMPOSITION

Nutrient composition of raw ripe *Ribes nigrum* fruits per 100 g edible portion was reported as: water 81.96 g, energy 63 kcal (264 kJ), protein 1.40 g, total lipid 0.41 g, ash 0.86 g, carbohydrate 15.38 g, Ca 55 mg, Fe 1.54 mg, Mg 24 mg, P 59 mg, K 322 mg, Na 2 mg, Zn 0.27 mg, Cu 0.086 mg, Mn 0.256 mg, Vitamin C 181 mg, thiamine

0.05 mg, riboflavin 0.05 mg, niacin 0.3 mg, panthothenic acid 0.398 mg, vitamin B-6 0.066 mg, vitamin A 230 IU, vitamin E (α-tocopherol) 1 mg, total saturated fatty acids 0.034 g, 16:0 (palmitic) 0.02 g, 18:0 (stearic) 0.056 g, total monounsaturated fatty acids 0.058 g, 16:1 undifferentiated (palmitoleic) 0.001 g, 18:1 undifferentiated (oleic) 0.056 g, total polyunsaturated fatty acids 0.179 g, 18:2 undifferentiated (linoleic) 0.107 g, and 18:3 undifferentiated (linolenic) 0.072 g (USDA, 2011).

The total lipid content by weight in the seeds of the species in the *Ribes* family was found to range from 18.3% in goose-berries (*Ribes uvacrispa*) up to 30.5% in blackcurrants (*Ribes nigrum*), so the blackcurrant has the highest content (Tabart et al., 2011). Black currant seed oil was found to contain up to 19% by weight of another substance involving health benefits, γ-linolenic acid (γ-LA, C18:3, n-6) (Dobson, 2000). This value place blackcurrant as one of the richest natural sources of γ-LA known so far. Researches shown that these oils are promising for patients which are unable to break linoleic acid into the essential fatty acid fractions.

The fatty acids of 29 black currant genotypes were studied and it was assessed that α-linolenic, stearidonic, and γ-linolenic acid (GLA) vary in the whole amount between 11.1% and 18.7%, between 2.5% and 4.5%, and between 11.6% and 17.4%, respectively (Del Castillo et al., 2004). Goffman and Galletti (2001) found that the highest total tocopherol content was present in *R. nigrum* (mean, 1.716 mg/kg oil), which was followed by the content in *R. rubrum* (mean, 1.442 mg/kg oil), while the lowest content was in *R. grossularia* (mean, 786 mg/kg oil). The three species also differed noticeably in the tocopherol composition.

As for γ-linolenic acid, the reachest species in it was *R. nigrum*, amounting up to 15.8%, while *R. grossularia* and *R. rubrum* showed much lower mean levels, of 8% and 6.2%, respectively. The same source also indicates that the seeds of plants in *Ribes* genus, especially *R. nigrum*, represent a great source for gamma-linolenic acid and natural vitamin E. The first is an essential fatty acid for humans needed by pacients with δ-6-desaturase deficiency; serving as a precursor of prostaglandins, prostacyclins and tromboxanes. It also exhibits anti-inflammatory and even antitumoral properties. Tocopherols are natural antioxidants exhibiting cancer protective properties, as well as properties for prevention and treatment of cardiovascular conditions. Black currant seed oil represents also a good source of tocopherols (mean 1.143 mg/100 g of oil) and phytosterols (6.453 mg/100 g of oil on average) (Bakowska-Barczak et al., 2009).

There is a series of factors influencing the composition of blackcurrant. Not only the cultivar, but also latitude and weather were found to influence the sugars, fruit acids, and ascorbic acid content in black currant juice (Zheng et al., 2009).However, in all the fruits predominate anthocyanins as Delphinidin-3-glucoside, Delphinidin-3-rutinoside, Cyanidin-3-glucoside, Cyanidin-3-rutinoside, phenols, cyaniding and rutinoside (Leskinen et al., 2009).

There are high genetic correlations between total anthocyanin content, total phenolics and the antioxidant capacity, as well as between these parameters and the individual anthocyanins, which suggests that total anthocyanins, total phenolics or antioxidant capacity could be used for selection and result in genetic progress for the other traits.

THERAPEUTIC PROPERTIES

Anti-inflammatory properties. The two main components of the flavonoids obtained from *Ribes nigrum* leaves, rutin and isoquercitrin did not show spasmodic or relaxing activity at experiments on rat stomach strip (Chanh et al., 1986). They did not exhibit capacity to inducing synthesis of prostaglandin-like substances and did not act on receptors of prostaglandin. They inhibited the biosynthesis and release of prostaglandin-like substances. It was also observed that total flavonoids were more active than rutin and isoquercitrin alone. The carrageenan-induced rat paw oedema test was applied to observe the anti-inflammatory activity of blackcurrant (using anhydroalcoholic extract of leaves), with positive result (Declume, 1989).

The anti-inflammatory activity of black currant extract and lyophilisate is comparable to the one of indomethacin and niflumic acid, but lacks the ulcerogenic potential of the letter ones (Garbacki et al., 2004; 2005).

Proanthocyanidins owe their anti-inflammatory activity to an inhibition of leukocyte infiltration triggered by a down-regulation of endothelial adhesion molecules.

Antiviral properties. Kurokarin (Japanese variety of *R. nigrum*) fruit extract was used to isolate the fraction D, comprised mostly by anthocyanins (Knox et al. 2001). It was further fractioned. The fraction E′ comprised 3-O-α-L-rhamnopyranosyl-β-D-glucopyranosyl-cyanidin and 3-O-β-D-glucopyranosyl- cyanidin, while the fraction F′ consisted of 3-O-α-L-rhamnopyranosyl-β-D-glucopyranosyl- delphinidin and 3-O-β-D-glucopyranosyl-delphinidin. The fractions D′ to G′ exhibited strong antiviral activity against influenza viruses A and B.

Subsequently the antiviral effect of E′ and F′ fractions combined was assessed. Anthocyanins in the fraction F′ was concluded that to not inactivate influenza viruses A and B, but manage to have an antiviral effect by inhibiting the virus adsorption to cells and also its release from the infected cells (Knox et al., 2003).

Suzutani et al. (2003) reported that Kurokarin fruit extract had a complete inhibitory effect on the attachment of HSV-1 to the cell membrane at a 100-fold dilution, as well as the plaque formation of HSV-1 and HSV-2, and varicella-zoster virus by 50% at a 400-fold dilution. This inhibition of virus replication is due to the inhibition of protein synthesis in infected cells at early stage of infection.

Anticancer properties. It was found that blackcurrant fruit juice contains cassis polysaccharide (CAPS), a polysaccharide-rich substance exhibiting macrophage-stimulating activity (Takata et al., 2005). Its Interleukin-1 beta inducing activity, promising for cancer therapy, was noticeably higher than at other fruit juice preparations. CAPS comprises rhamnose, mannose, arabinose, galactose, glucose and xylose. It was separated into a precipitable component (CAPS-h.m.) and soluble component (CAPS-l.m.) and the latter was revealed to play an important role in macrophage activation *in vitro*. Oral administration of blackcurrant juice and CAPS to Ehrlich carcinoma-bearing mice inhibited the growth of the solid tumor by 45% and 51% respectively.

One of the major anthocyanins in the anthocyanin-rich component of the aqueous extract of blackcurrant fruit skin is cyanidin-3-O-rutinoside (Bishayee et al., 2010). This component produced a potent cytotoxic effect on liver cancer cells, with stronger effect than two major aglycones of anthocyanins present in black currant, delphinidin and cyaniding. This action can be due to synergistic effects in this anthocyanin-rich fraction of the fruit skin. Bishayee et al. (2011) showed that here was a dose-dependent of the black currant skin extract on decreasing preneoplastic hepatic nodules in model of rat liver hepatocarcinogenesis. This action was confirmed by histopathological examination. The author sustained that the results, supported also by the identified composition of the black currant skin extract supported considering the blackcurrant bioactive constituents as chemopreventive agents for human liver cancer.

Antimicrobial properties. *Ribes nigrum* bud essential oils exhibited powerful antibacterial activity against pathogens as *Acinetobacter baumanii, Escherichia coli, Pseudomonas aeruginosa* and *Staphylococcus aureus*, as proved by the very low minimum inhibitory concentration values observed when applied on their strains (Oprea et al., 2008). Lengsfeld et al. (2004) observed that galactans, with high molecular weight 1,3-linked with side chains possessing 1,4-galacturonic acid, along with galactose and arabinose residues were provide the antiadhesive qualities of seed extracts. These polymers blocked *Helicobacter pylori* surface receptors, hindering their interaction with specific binding elements on the gastric epithelia. The juice and extracts (aqueous and methanol) of the polyphenol – rich pomace of *Ribes nigrum* exhibited efficient antibacterial activity against both Gram positive *Bacillus subtilis* and *B. cereus*, and Gram negative bacteria *Escherichia coli* and *Serratia marcescens*, except for the water pomace extract which was very much less inhibitory to *B. cereus* and the methanol pomace extract likewise to *Serratia marcescens* (Krisch et al. 2008).

The juice, water and methanol extracts of the polyphenol–rich pomace of *Ribes nigrum* exhibited anti-fungal activity against*Candida glabrata, C. guilliermondii, C. inconspicua, C. lipolytica, C. norwegica, C. parapsilosis, C. tropicalis*and *C. zeylanoides* (Krisch et al., 2002).

Antiosteoarthritic properties. Garbacki et al. (2002) suggested that the prodelphinidins fractions, which represent the major compounds isolated from the leaves of *R. nigrum*, may be effective when used as an additive agent in the prevention of osteoarthritis. The trimer of gallocatechin (GC-GC-GC) presented the higher stimulation of the production of type II collagen and proteoglycans, while the dimer and gallocatechin-epigallocatechin markedly reduced the synthesis of prostaglandin E(2). The inhibition of prostaglandin E(2) synthesis was confirmed by the *in vitro* test on purified COX enzymes.

Traditional Medicinal Uses. Blackcurrants are used as a remedy for cold and flu and the juice is used to stop diarrhea and stabilize digestion. The raw juice is diuretic and diaphoretic and an excellent beverage for febrile diseases. Boiled, sugar-added juice is used to treat inflamed sore-throats. Lozenges are also prepared from it.

An infusion of the leaves is cleansing and diuretic. The infusion is also used in the treatment of dropsy, rheumatic pain and whooping cough, and as a gargle for sore throats and mouth ulcers. It has also been used externally on slow-healing cuts and abscesses.

An infusion of the young roots is useful in the treatment of eruptive fevers. A bark decoction is useful for treating calculus, dropsy and hemorrhoidal tumors.

Cosmetic uses. The leaves of blackcurrant represent the source for a yellow dye and the fruits for a violet dye. The seed oil can be utilized in skin and cosmetic preparations.

Wounds were surgically induced on rats and mice and ointments prepared from 8 species in Ribes genus were applied once daily. Considering the significant reduction in the wound area, it was concluded that *R. nigrum* stands for a good candidate for developing a wound healing agent (Kendir et al., 2019).

Linnamaa et al. (2010) performed a placebo-controlled trial on 313 pregnant mothers. They were randomly distributed to receive blackcurrant seed oil (151) or olive oil, the placebo (162), with the aim to reveal if the dietary supplementation with blackcurrant seed oil influence the prevalence of atopy at 12 months of age. The result showed a lower incidence of atopic dermatitis at mothers consuming seed oil than the ones in the placebo group. Additionally, the dietary supplementation studied was well tolerated, thus constituting a potential support in the prevention of atopic symptoms, from an early stage of life.

Also from *Ribes nigrum* was isolated a protein, an arabinogalactan, proven to significantly stimulate the cellular dehydrogenase activities of human skin cells as well as the proliferation rate of keratinocytes at 10 and 100 µg/ml (Zippel et al., 2009).

CONCLUSIONS

Blackcurrants have been widely studied and it was concluded that they have very high antioxidant capacities, due to high polyphenols and vitamin C concentrations.

Moreover, it is known to have several therapeutic properties, including anti-inflammatory properties, antiviral properties, antimicrobial properties, anticancer properties as well as cosmetic uses and other traditional medicinal uses.

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