

CORNELIAN CHERRY (*CORNUS MAS* L.) – CHARACTERISTICS, NUTRITIONAL AND PRO-HEALTH PROPERTIES

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ABSTRACT

The cornelian cherry *Cornus mas* L. belongs to the Cornaceae family (*Cornaceae*). It can be found naturally in the central and south-eastern regions of Europe. Its fruits are characterized by oval or oval-oblong shape, with colours ranging from light yellow to dark cherry. The taste of fruits is usually considered to be tart-sweet, sour and in some cases sweet-pineapple. All cultivars of the cornelian cherry have a high biological value, which is mainly connected with their antioxidant activity, as well as with their phenolic compound and ascorbic acid content. The main pro-health properties of the cornelian cherry are related to the large amount of anthocyanins. The basic raw material is fruits; however, leaves, flowers and seeds are also used as a source of active ingredients. The chemical composition of cornelian cherry fruits is diversified and depends to a large extent on the cultivar, as well as on cultivation, and the environmental and climatic conditions.

Keywords: polyphenols, anthocyanins, antioxidant substances, vitamin C

INTRODUCTION

In recent years, nutrition has been believed to play a very important role in preventing many diseases. Widespread pro-health awareness, as well as the constantly increasing consumer interest in healthy lifestyles and healthy diets, induces food manufacturers to search for little-known plant species whose edible parts have specific pro-health properties. One such plant is the cornelian cherry (*Cornus mas* L.), which was already being used universally in ancient times, as evidenced by excavations from that period, where objects made of cornelian cherry wood (exceptionally hard and durable) were found (Tarko et al., 2007). The cornelian cherry (*Cornus mas* L.) is a plant of vast natural range that has been known in garden cultivation for 400 years. Its fruits, flowers, leaves and bark have been known and appreciated in folk medicine for years, especially in Asia. According to historical

reports, Hippocrates wrote that cornelian cherry leaves can be used for preparing a decoction for treating stomach diseases, whereas Ovid provided the recipe for cornelian cherry jam in his poem ‘The Golden Age’. Even before the discovery of America, Native Americans would use cornelian cherry bark extracts for treating malaria. At the beginning of the 19th century, there were discussions in America concerning the reason why certain citizens had healthy white teeth, which was ultimately attributed to chewing cornelian cherry shoots (Gasik and Mitek, 2008).

Plant characteristics and occurrence

The cornelian cherry is a shrub or a small tree with a height from 3 m to 9 m. It belongs to the Cornaceae family (*Cornaceae*). There are approximately 50 species of cornelian cherry in the world (Kucharska,

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2012). Apart from the cornelian cherry, the most popular include: alternate-leaved dogwood (*Cornus alternifolia*), flowering dogwood (*Cornus florida*), kousa dogwood (*Cornus kousa*), wedding cake tree (*Cornus controversa*) and Japanese cornelian cherry (*Cornus officinalis*) (Kucharska et al., 2009).

In the natural environment, cornelian cherry grows in central and south-western Europe: from France to Crimea, in the Balkan Peninsula, Caucasus and Turkey. It is also cultivated in southern Sweden and England.

The cornelian cherry is relatively well adapted to unfavourable environmental conditions, as well as resistant to diseases and pests. It is a photophilous plant which blooms less and has fewer fruits in shady areas. It can also be found in mountains up to 1,400 m above sea level. It grows slowly and may live up to 300 years, and is very resistant to drought and frost. The cornelian cherry is among the earliest blooming plants in Poland – its flowers appear before the leaves are developed, whereas its intensive blooming period is in March.

It should also be noted that an important feature of the cornelian cherry is its fecundity – 10–15 t/ha of fruits, with plantation durability in commercial orchards of up to over 150 years, annual fructification, and also a lack of dangerous diseases and pests, and due to that the possibility of cultivation without chemical protection makes it an excellent raw material for food production.

The cornelian cherry is currently becoming popular again, because the progress in its cultivation has led to the development of cultivars with a more attractive colour and larger fruits (with a smaller stone in the fruit weight). Due to the early period of blooming and long period of leaf discolouration in the autumn, the cornelian cherry is considered as an ornamental plant. It is also a honey plant. Ripe fruits are picked from mid-August to the end of October. Fruits of certain cultivars ripen at the same time, whereas the ripening period in other cultivars lasts up to three weeks (Bijelić et al., 2016).

CORNELIAN CHERRY FRUITS AND THEIR USE IN FOOD PROCESSING

The cornelian cherry fruit is a spherical or elliptical drupe, with an average length of 1.5–2 cm and

a weight of 1.6–2.6 g. There are also large-fruit cultivars whose weight may be up to 9 g. The differences in the weight of individual fruits are significantly greater, depending on the species. The smallest are the fruits of the wedding cake tree (*Cornus controversa*) with the weight of single fruit being approximately 0.07 g, whereas the largest are the fruits of the kousa dogwood (*Cornus kousa*), which grows mainly in China and Korea. The weight of a single fruit (these are spherical infructescences) can be up to 15 g.

The cornelian cherry seed connated with the flesh may constitute between 10% and 30% of the fruit weight. Stones may serve as a secondary raw material, e.g. to obtain oil rich in unsaturated fatty acids; however, its content is approximately 3–4 times smaller than in berry seeds (Piórecki, 2007).

Cornelian cherry fruits are juicy with a tart-sour taste and ripen gradually from September to October. The cornelian cherry begins to produce fruits in the third or fourth year after planting. During full fruit-bearing, 20–80 kg of fruits can be picked from one tree. The fruit capacity in well-managed cornelian cherry orchards amounts to 20–25 t/ha.

The most popular among cornelian cherry fruits are oval fruits, similar to olives and dark red, but there are also bottle-shaped and pear-shaped fruits, as well as pink or yellow fruits. Table 1 presents the characteristics of selected cultivars of the cornelian cherry.

Cornelian cherry fruits can be an attractive raw material for the food processing industry. There are many recipes, which are based on old 19th-century reports and formulas, for making processed cornelian cherry products, e.g. juices, jams, preserves, chutneys, syrups, liquors and wines (Biesowski, 2010). However, despite the valuable pro-health properties, these fruits are seldom used in the food processing industry at present. An important fact is that the similarity of cornelian cherry fruits to other stone fruit such as the cherry seems to support the possibility of using them in food processing. The large number of types of cornelian cherry and products that can be obtained from this raw material is a premise for conducting research that allows their chemical composition and suitability for food processing to be determined precisely (Bieniek et al., 2001). Thanks to the high content of organic acids, they can be used

Table 1. Characteristics of selected cultivars of the cornelian cherry (Biesowski, 2010; Kucharska et al., 2009)

Cultivar	Average fruit weight g	Fruit characteristics		
		shape	colour	taste/sugar content, %
Flava	2.7	oval	light yellow	pineapple/9
Florianka <i>Cornus mas</i> L. ‘Florianka’	4.0	oval	red	tart/10
Kresowiak <i>Cornus mas</i> L. ‘Kresowiak’	3.7	pear-shaped	red	sweet/15
Elena <i>Cornus mas</i> L. ‘Elena’	5.0	bottle-shaped	dark purple	tart-sweet/7.7
Szafer <i>Cornus mas</i> L. ‘Szafer’	3.0	conical	dark red	sweet/16
Podolski <i>Cornus mas</i> L. ‘Podolski’	3.1	oval-round	dark red	sour/10
Słowianin <i>Cornus mas</i> L. ‘Słowianin’	3.0	conical	dark red	sweet/13
Juliusz <i>Cornus mas</i> L. ‘Juliusz’	2.7	spherical-oval	red	sweet-sour/10
Elegantnyj <i>Cornus mas</i> L. ‘Elegantnyj’	5.0	oblong	dark red	sour/9.1
Jantarnyj <i>Cornus mas</i> L. ‘Jantarnyj’	3.5	oval	light yellow	sweet-sour/9.6

for natural acidification of other fruit processed products. In the Balkans, fresh fruits are used for making cornelian cherry vodka, which is popular in this region. The fruits are also used in the Caucasian cuisine – dried and ground fruits are used for seasoning meat marinades and sauces for roasted game. Fresh fruits can be an ideal additive to cakes and desserts. Recently, attention has been drawn to the possibility of applying the pickling method for cornelian cherry fruits to obtain what are known as Polish olives. Roasted cornelian cherry seeds can also be used as coffee.

NUTRITIONAL PROPERTIES AND CONTENT OF BIOACTIVE SUBSTANCES

The nutritional value of cornelian cherry fruits depends on the cultivar, as well as on the soil and climatic conditions. The dry matter content of cornelian cherry fruits amounts to 14–28%. Its main ingredients

are sugars, mainly glucose and fructose. The total sugar content is 6–19%, including directly reduced sugars (2–12%) and saccharose (0–3%). The acid content calculated per malic acid may amount even up to 7%, but most frequently it is 2–4%. Fruit refractometric extract ranges from 12 to 21% (Piórecki et al., 2010).

Cornelian cherry fruits belong to a group of raw materials relatively abundant in vitamin C (Table 2). They contain significantly more vitamin C than other popular fruits (e.g. strawberries, lemons); its amount ranges from 34–100 mg/100 g fresh weight (Kucharska et al., 2009; Sosnowska et al., 2012).

The minerals which are present in the largest quantities include potassium, sodium, magnesium, iron, phosphorus and sulphur. The total ash content amounts to approximately 0.8%.

Cornelian cherry fruits have a high amount of polyphenols (Table 2, 3), including anthocyanins (Table 4), significantly higher than in other types of fruit. The total polyphenol content calculated per gallic acid

Table 2. Total content of vitamin C, anthocyanins and polyphenols, as well as antioxidant activity (DPPH, ABTS, FRAP) in selected Polish cultivars of cornelian cherry fruits (Kucharska et al., 2009)

Cultivar	Vitamin C	Anthocyanins	Polyphenol	DPPH	ABTS	FRAP
	mg/100 g fresh weight	mg/100 g dry matter		μmol T/g dry matter		
Juliusz <i>Cornus mas</i> L. ‘Juliusz’	50.83 ±1.40	27.52 ±1.03	261.70 ±5.30	10.85 ±0.26	18.87 ±0.32	21.17 ±1.97
Podolski <i>Cornus mas</i> L. ‘Podolski’	42.11 ±0.66	70.63 ±1.13	286.82 ±13.59	13.69 ±0.26	24.88 ±1.16	27.64 ±0.81
Szafer <i>Cornus mas</i> L. ‘Szafer’	75.05 ±1.32	160.51 ±5.94	464.12 ±12.85	19.01 ±0.56	38.96 ±1.03	41.08 ±1.71
Słowianin <i>Cornus mas</i> L. ‘Słowianin’	35.74 ±1.51	62.16 ±2.19	343.42 ±13.76	16.13 ±0.31	28.12 ±0.59	30.74 ±0.79
Kresowiak <i>Cornus mas</i> L. ‘Kresowiak’	51.78 ±0.33	79.93 ±1.54	286.45 ±1.11	16.30 ±0.54	28.51 ±0.24	25.24 ±0.46
Dublany <i>Cornus mas</i> L. ‘Dublany’	34.29 ±0.11	50.60 ±0.97	361.42 ±9.71	20.72 ±0.22	35.24 ±0.29	31.37 ±0.56

Table 3. Phenol composition of cornelian cherry fruit (Milenković-Andjelković et al., 2015)

Phenolic compound	Content, mg/g dry matter
Galic acid	0.62 ±0.10
Ellagic acid	2.11 ±0.13
Chlorogenic acid	0.85 ±0.11
Σ Phenolic acids	3.58 ±0.11
Quercetin-3-glucoside	0.20 ±0.04
Quercetin-3-galactoside	0.57 ±0.09
Rutin	0.81 ±0.12
Kaempferol-3-glucoside	1.11 ±0.20
Σ Flavonols	2.69 ±0.15
(+)-Catechin	3.91 ±0.68
(-)-Epi-catechin	2.11 ±0.71
Procyanidin B2	1.55 ±0.28
Σ Flavan-3-ols	7.57 ±0.42
Cyanidin 3-galactoside	3.27 ±0.12
Pelargonidin 3-glucoside	10.23 ±1.03
Delphinidin-3-galactoside	0.53 ±0.16
Σ Anthocyanins	14.03 ±0.67

amounts to 200–600 mg/100 g dry matter (Kucharska et al., 2009; Tarko et al., 2007).

Many authors commonly attribute the pro-health properties of cornelian cherry fruits mainly to anthocyanins, due to the biological function that they play in plants (Kucharska et al., 2007). It is believed that they protect chlorophyll against UV, as a result of which they reduce the risk of photooxidative damage to leaves. The concentration of anthocyanins is decisive for the colour of cornelian cherry fruits, which may vary from pink through red to almost black. The anthocyanins appearing in cornelian cherry fruits that are significant from the perspective of chemical values are glycosidic derivatives of cyanidin, delphinidin and pelargonidin. Glycosidic residue most often contains glucose and galactose, whereas xylose, arabinose and rhamnose are less frequent. According to the literature, the total content of anthocyanins calculated per cyanidin 3-o-glucoside in cornelian cherry fruits may amount to between 35 and 300 mg/100 g dry matter, depending on the fruit colour. A large difference in the content of anthocyanins was identified in various parts of the fruit. The content of anthocyanins in skin may even amount to 650–850 mg/100 g dry matter, and in flesh to 35–120 mg/100 g dry matter. It was identified that the type of aglycone and glycosidic residue

Table 4. Average content of anthocyanins in fruits of selected cultivars of the cornelian cherry, mg/100 g dry matter (Kucharska, 2012)

Cultivar	Anthocyanins					total
	Df 3-gal	Cy 3-gal	Cy 3-rob	Pg 3-gal	Pg 3-rob	
Dublany <i>Cornus mas</i> L. ‘Dublany’	0.34	15.11	5.43	35.57	8.22	64.68
Juliusz <i>Cornus mas</i> L. ‘Juliusz’	0.24	6.18	0.32	26.19	0.73	33.66
Podolski <i>Cornus mas</i> L. ‘Podolski’	0.56	26.09	2.47	43.31	1.47	73.89
Szafer <i>Cornus mas</i> L. ‘Szafer’	1.17	53.33	16.00	70.92	8.18	149.60
Słowianin <i>Cornus mas</i> L. ‘Słowianin’	0.40	22.45	2.28	36.24	2.19	63.56
Kresowiak <i>Cornus mas</i> L. ‘Kresowiak’	0.60	21.58	5.601	40.69	6.18	74.64

Df 3-gal – delphinidin 3-galactoside.

Cy 3-gal – cyanidin 3-galactoside.

Cy 3-rob – cyanidin 3-robinobioside.

Pg 3-gal – pelargonidin 3-galaktoside.

Pg 3-rob – pelargonidin 3-robinobioside.

referred to in Item 3 are decisive for the biological activity of anthocyanins.

One of the particularly interesting active compounds of the cornelian cherry from the group of polyphenols, and to which a lot of attention has recently been drawn, is ellagic acid, present in plants in pure form and (more frequently) in ester combination with glucose, thus forming hydrolysable tannins (ellagitannins) (Kwiatkowska, 2010). The sources of ellagic acid and ellagitannins include oak, walnut and chestnut wood, also berries, as well as certain seeds and nuts (Aguilera-Carbo et al., 2008). Cornelian cherry fruits are also a good source of ellagic acid: its average content amounts to approximately 8 mg/100 g dry matter. For comparison, strawberry and raspberry fruits have 0.7–4.3 and 3.7–4.7 mg respectively.

The presence of the following iridoids was identified in cornelian cherry fruits: loganic acid, which constitutes 88–96% of the total content of iridoids, as well as loganin, sweroside and cornuside (Deng et al., 2013; Perova et al., 2014).

Cornelian cherry fruits are also a source of fat which is used in the cosmetic industry (Kucharska et al., 2009). It has been determined that cornelian cherry seeds may contain up to 4.5% of fat, whereas its flesh may contain up to 0.35% of fat. The main fatty acid is linoleic acid (Table 5). In dwarf cornel (*Cornus suecica*) seeds, approximately 9% of oil was identified per dry matter, whereas in fresh flesh it was approximately 0.55%. The proportion of main fatty acids, including oil, was as follows: linoleic acid 71.7 mol%, oleic acid 23.2 mol%, whereas other acids (e.g. palmitic, stearic and indene) constituted 5 mol% (Kucharska et al., 2007a).

Cultivars of the cornelian cherry have a high biological value, connected with their antioxidant activity, as well as their phenolic compound and ascorbic acid content. The test results indicate a great diversity of chemical composition and antioxidant activity of cornelian cherry fruits, which is related to genetic and environmental variability (Kucharska, 2012).

Table 5. Fatty acid content in selected cultivars of cornelian cherry, mol% (Kucharska, 2012; Kucharska et al., 2007)

Cultivar	Palmitic	Stearic	Oleic	Linoleic	Linolenic
Dwarf cornel <i>Cornus suecica</i>	2.0	1.0	23.2	71.7	1.1
Bolestraszycki <i>Cornus mas</i> L. ‘Bolestraszycki’	4.6	6.2	16.4	70.7	2.1
Florianka <i>Cornus mas</i> L. ‘Florianka’	3.5	3.9	15.8	75.0	1.8
Golden Glory <i>Cornus mas</i> L. ‘Golden Glory’	4.2	3.5	16.2	74.8	1.3
Macrocorpe <i>Cornus mas</i> L. ‘Macrocarpa’	3.9	4	16.3	74.2	1.6
Słowianin <i>Cornus mas</i> L. ‘Słowianin’	4.3	5.1	16.7	72.2	1.7
Szafer <i>Cornus mas</i> L. ‘Szafer’	4.2	4.8	15	74.5	1.5
Average	3.8	4.1	17.1	73.3	1.6

PRO-HEALTH PROPERTIES OF CORNELIAN CHERRY

The ingredients contained in cornelian cherry fruits demonstrate beneficial properties mitigating the symptoms of influenza and angina, as well as astringent and anti-inflammatory properties in gastrointestinal disorders. They relieve pain and fever, and are used in the form of decoction or fresh juice in diarrhoeas, gripes and intestinal diseases (Karlłowicz-Bodalska et al., 2017).

The anthocyanins present in the cornelian cherry have antioxidant and anti-inflammatory properties. Many authors researching the qualitative composition of anthocyanins in various cornelian cherry fruits reported that the delphinidin-3-o-glucoside, delphinidin-3-o-galactoside, cyanidin-3-o-galactoside, pelargonidin 3-o-galactoside or delphinidin-3-o-rutinoside present in them have an inhibiting effect on: oxidation of fats and cyclooxygenase activity (EC 1.14.99.1), which may explain the beneficial effect of cornelian cherry fruits on the treatment of inflammatory conditions in organisms or the inhibition of the proliferation of cancer cells (Gasik and Mitek, 2008; Vareed et al., 2006).

Vareed et al. isolated from kousa dogwood (*Cornus kousa*) flavonoids (kaempferol 3-O-rhamnoside, kaempferol 3-o-glucoside and myricetin-3-o-rhamnoside), which are also attributed similar biological activity (Gasik and Mitek, 2008; Vareed et al., 2006).

In the cornelian cherry, the main fraction responsible for anti-inflammatory activity is glycosidic iridoids, which demonstrate antigenotoxic activity without causing any toxic effects at the same time (Deng et al., 2013; Karlłowicz-Bodalska et al., 2017).

The total polyphenol content in cornelian cherry fruits is additionally correlated with the antioxidant activity. The confirmed hepatoprotective activity of the cornelian cherry fruit extract may stem from the presence of certain antioxidants, which have a stabilising effect on the cell membranes (Somi et al., 2014). It has been determined that the cornelian cherry fruit extract increases the sensitivity of cells to insulin activity, without the need to release a higher amount of it. The application of cornelian cherry fruit extract proved to be effective in hypoglycaemia (Narimani-Red et al., 2013). Cornelian cherry fruits are also attributed anti-atherosclerotic properties (Lotfi et al., 2014).

The literature sources state that ellagic acid, present in cornelian cherry fruits, has immunostimulating,

immunomodulatory, antimicrobial, antioxidant and anticancer properties. It inhibits the damaging effect of UVB rays, protects skin against degradation and has anti-inflammatory properties (Sepulveda et al., 2011). The antioxidant activity of ellagic acid contained in cornelian cherry fruits is comparable, and even stronger than the effects of vitamin E (Kwiatkowska, 2010). The newly discovered biological activities of ellagic acid include the effects related to the prevention of eye, kidney, heart and joint diseases caused by a high glucose content in blood (Sepulveda et al., 2011).

Fatty acids obtained from cornelian cherry seeds demonstrate antimicrobial activity against Gram-positive and Gram-negative strains, respectively: *Staphylococcus aureus* and *Escherichia coli* (Mamedov and Craker, 2004). The alcoholic extract from cornelian cherry seeds and leaves is characterised by higher antibacterial activity against *S. aureus* and *E. coli*, *Pseudomonas aeruginosa* and higher antifungal activity against *Candida albicans* than the extract from the bark and fruits of this plant (Krzyściak et al., 2011). Medicinal preparations from fresh fruits of *Cornus mas* L. are characterised by significant selective antibacterial activity against *S. aureus* and *P. aeruginosa*. The identification of new medicines with strong antibacterial activity against these species is highly significant for solving the problem of common resistance to antibiotics (Kyriakopoulos and Dinda, 2015). Moreover, the strong antimicrobial activity of extracts from cornelian cherry leaves and fruits against Gram-positive and Gram-negative bacteria, as well as yeast-like fungi, has been determined. These extracts, rich in phenolic compounds, characterised by strong antiradical and antibacterial activity, can be used as additives to food and medicines (Milenković-Andjelković et al., 2015). Leaves, bark and shoots are also valuable raw materials for production of pharmaceutical preparations. Leaf infusions are recommended as a diuretic and choleric agent, whereas bark infusions are recommended as a strengthening and stimulating remedy. Moreover, cornelian cherry leaf extract reduces the concentration of lipid peroxidation products and, like the flower extract, it demonstrates potential cytotoxic activity at the same time (Mikaili et al., 2013).

To sum up, we may notice that in recent years, many researchers have begun to pay particular attention to cornelian cherry fruits, describing not only their

quality and taste benefits, but also their pro-health properties. The chemical composition of cornelian cherry fruits is diversified and depends to a large extent on the cultivar, as well as on the cultivation, environmental and climatic conditions, which is one of the important aspects to be taken into consideration when using cornelian cherry preparations in health prophylaxis.

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