Cherry Silverberry

Subjects: Agronomy

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The cherry silverberry (*Elaeagnus multiflora* Thunb.) is a lesser-known plant species with high nutritional and therapeutic potential. Cherry silverberry contains numerous biologically active compounds. The cherry silverberry is a shrub growing up to 3 m. Its drupe-like fruit is ellipsoidal, up to 1 cm long, and set on stems. It is red in color, juicy, and sour, and its taste resembles that of red currants.

cherry elaeagnus | chemical composition | biologically active compounds

1. Introduction

Bioactive compounds are widespread in the vegetal world. They exert protective effects on plants, as well as human and animal health. Bioactive substances can act as natural antioxidants, whose presence in the body may help prevent a wide variety of lifestyle diseases [1]. Plant species that are rich sources of bioactive substances have been extensively researched around the world [2]. Particular attention has been paid to lesser-known plant species such as kiwiberry, cornelian cherry, honeysuckle, hawthorn, chokeberry, rowanberry, elderberry, medlar, bilberry, seabuckthorn, and silverberry, which grow in different climatic zones and have been introduced to cultivation outside their natural geographic ranges. Novel fruits and berries are increasingly being introduced into local and global food systems [3][4]. Some of them can be eaten raw, while others require processing [5][6]. Neglected and underutilized edible plant species can also boost the livelihoods of small-scale farmers and local producers [7]. This group of plants includes *Elaeagnus multiflora* Thunb. (*Elaeagnaceae*), also known as cherry silverberry, cherry elaeagnus, and goumi. The cherry silverberry belongs to the genus *Elaeagnus* L. and the family *Elaeagnaceae* Juss., which also includes the more popular common seabuckthorn (*Hippophaë rhamnoides* L.) [8][9][10][11]. According to the literature [12][13][14][15][16][17][18][19], *E. multiflora* fruit, which is suitable for direct consumption and processing, can be classified as a “superfood” due to its high content of carotenoids, exogenous amino acids, macronutrients, micronutrients, unsaturated fatty acids, and vitamin C. Fresh and processed silverberries are a valuable source of lycopene, the most potent antioxidant among common carotenoids, which is renowned for its anticarcinogenic effects [18][19][20][21]. The cherry silverberry is native to China, Korea, and Japan [9]. In traditional Chinese medicine, the species is known as a phytosterol-rich plant [20][21][22][23][24]. The fruit, leaves, and young branches of *E. multiflora* can be used as phenolic antioxidant additives and dietary supplements [2][8][22][25][26][27][28][29][30][31][32][33][34][35][36][37][38][39] as well as natural remedies for cough, diarrhea, gastrointestinal disorders, itch, cancer, and bone diseases [8][12][19]. Cherry silverberry seeds are used in dietary therapy and as a functional food for cancer prevention [22][28]. According to Kim et al. [29], *E. multiflora* fruit extract can be applied as a whitening functional cosmetic material, due to the suppression of melanin biosynthesis. Cherry silverberries can be processed at home to prepare juice, compote, jam and jelly, herbal tea, wine, soup, sauces, desserts, candies, pudding, ice-cream topping, fruit leather, and other food products [2][9][11]. Today, this species is grown not only in China but also in the eastern United States and in Europe, including Poland [8][21]. As demonstrated by Bieniek et al. [9], the cherry silverberry thrives in the temperate climate of Poland, as it is easy to cultivate and resistant to diseases.

Elaeagnus multiflora is a thorny shrub, growing up to 3 m (**Figure 1**). The leaves are typical of the genus *Elaeagnus*—the upper part of the leaf blade is green, whereas its bottom is silvery. **Figure 2** presents the flowers and fruit with seeds of *E. multiflora*. The flowers are solitary or in pairs in the leaf axils, fragrant, with a four-lobed pale-yellowish-white corolla 1.5 cm long; flowering occurs in mid-spring. Since silverberry flowers give off a strong aroma, resembling that of cinnamon and vanilla, this plant can be used for flavoring cakes and other desserts [9]. Its drupe-like fruit is ellipsoidal, up to 1 cm long, and set on stems. It is red in color, juicy, and sour, while its taste resembles that of red currants. In Poland, silverberries ripen at the end of June or at the beginning of July [2]. This species is currently being introduced to Russia and the USA, while it has not yet been commercially produced in Poland. Since the 1990s, research has been carried out at the Department of Horticulture, University of Warmia and Mazury in Olsztyn (formerly: University of Agriculture and Technology), to select the most suitable biotypes for cultivation in Poland [2][8][9][26][35][36][37]. According to Lachowicz et al. [2], the cherry silverberry biotypes grown in north-eastern Poland constitute a highly interesting material and could be an excellent source of functional foods. This species also deserves special attention as a fruit plant for organic cultivation.

Figure 1. *Elaeagnus multiflora* Thunb. with fruit.

Figure 2. Flowers and fruit with seeds of *Elaeagnus multiflora* Thunb.

2. Selection of Varieties and Cultivation Characteristics

The cherry silverberry has been cultivated as a fruit plant since 1974. The first variety of the cherry silverberry, Sakhalinsky pervyi, was bred in the Far Eastern Research Institute of Agriculture in Russia. In 1999, it was entered into the State Register of Breeding Achievements Approved for Use. Other varieties, including Moneron and Taisa (2002), Krilon (2006), Shikotan (2009), Yuzhnyi (2009), Kunashi (2011), Cunai (2015), and Paramushir (2016) were also registered in Russia (State Register of Breeding Achievements Approved for Use, 2016) [9].

A collection of *E. multiflora* was created at the M.M. Gryshko National Botanical Garden (NBG) of the National Academy of Sciences of Ukraine in Kyiv in 1980–1982. The primary material (seeds from free pollination) was imported from Sakhalin (Sakhalin Scientific Research Institute of Agriculture). At present, the *E. multiflora* collection includes 45 genotypes. Grygorieva et al. [22] analyzed the morphometric parameters of fruit in selected genotypes of cherry silverberry grown in the “Forest-Steppe of Ukraine” geographic plot in the M.M. Gryshko NBG. The results of this preliminary study have contributed to increasing interest in *E. multiflora* cultivation among farmers, which can be followed by the domestication and introduction of this species to the agricultural production system in Ukraine and other countries.

In Poland, research into *E. multiflora* was initiated in 1995 at the Department of Horticulture, University of Agriculture and Technology (presently: University of Warmia and Mazury in Olsztyn), when three-year-old plants were obtained from the Institute for Fruit Growing in Samokhvalovitchy in Belarus. [9]. At present, experiments involving several dozen seedlings are being carried out to select the optimal biotypes that could be grown in Poland and other countries [2][8][35][36][37]. Lachowicz et al. [8] noted considerable differences in the chemical composition and antioxidant activity of the *E. multiflora* varieties and biotypes selected at the University of Warmia and Mazury in Olsztyn. Lachowicz et al. [36] found that the fruit of biotypes Si1 and Si2 contained high concentrations of vitamin C, linoleic acid, and α-linolenic acid. The fruit of biotypes Si5 and Si4 was characterized by the highest content of glucose, fructose, and ash, whereas the fruit of biotypes Si0 and Si3 contained the highest levels of the remaining fatty acids as palmitic, oleic, stearic, and organic acids, exhibiting the highest antioxidant activity. Moreover, biotype Si0 had a high content of total polyphenolics, organic acids, and palmitoleic acid, and demonstrated higher antioxidant activity than the remaining biotypes. The above authors concluded that new biotypes of cherry silverberry grown in north-eastern Poland are highly promising and can be consumed raw or used in the production of functional foods.

Elaeagnus multiflora varieties ‘Sweet Scarlet’ and ‘SSP’ (seedlings obtained from Austria) can be purchased from Polish nurseries. ‘Sweet Scarlet’ is the earliest-maturing variety. The fruit begins to ripen in the first half of June; the berries remain on the stems for four weeks and, then, fall down. This variety has darker and sweeter fruit than other varieties. ‘Sweet Scarlet’ is an allogamous variety, which requires pollen from another variety for fruit setting. ‘SSP’ is an autogamous variety, with a slower growth rate than ‘Sweet Scarlet’. The fruit ripens at the beginning of July, and it has a sweet taste. Another *E. multiflora* variety is ‘Jahidka’, which produces much shorter shrubs (up to 1.5 m) and red oval fruit weighing 1–1.5 g that ripens in early July [31].

Elaeagnus multiflora is often confused with *E. umbellata* because both species have similar leaves and flowers. However, *E. umbellata* produces round fruit with short petioles, typically ripening in September [35].

Cultivation of Elaeagnus multiflora

The cherry silverberry has low nutritional requirements, and it thrives on dry, sandy, and poor soils. However, the species requires large amounts of sunlight. Cherry silverberry shrubs can grow in the same site for 25 years [9][40]. A symbiosis with nitrogen-fixing actinomycetes makes the cherry silverberry a pioneer soil-fertilizing species [9][40].

In commercial plantations, cherry silverberry shrubs should be planted at 4 × 2 m spacing, 5–8 cm deeper than in the seed bed (**Figure 3**). The species has similar fertilizer requirements to currants and gooseberries. *Elaeagnus multiflora* is highly resistant to drought. Due to its high-quality fruit, it is a promising fruit plant that can be recommended for organic cultivation. Most seedlings begin to bear fruit in the fourth year after planting [21][31]. According to Kołbasina [41], 5-year-old plants can yield 3–4 kg fruit per shrub, 10-year-old plants up to 15 kg, and 20-year-old plants up to 30 kg. Cultivation conditions, as well as climatic factors during the growing season, regardless of genetic factors, have a significant effect on the yield and qualitative characteristics of fruit [9][21]. *Elaeagnus multiflora* can be grown on a small scale and cultivated commercially with the use of combine harvesters [26].

Figure 3. *Elaeagnus multiflora* growing in the Experimental Garden of the University of Warmia and Mazury in Olsztyn (north-eastern Poland).

3. Biologically Active Compounds in *Elaeagnus multiflora* Thunb.

Cherry silverberry fruit is abundant in bioactive components that are responsible for its health-promoting properties [8][9]. These substances can be divided into primary and secondary metabolites. Primary metabolites are a source of nutrients, energy, and structural components in plants with limited bioactive properties, whereas secondary metabolites are metabolic products in plants that deliver a wide range of health-promoting effects. Primary metabolites include, among others, carbohydrates, organic acids, and amino acids. Secondary metabolites include, among others, vitamin C, biominerals, polyphenols, flavonoids, carotenoids, chlorophylls, and tocopherols (**Table 1**) [42][43].

Table 1. The basic chemical composition of cherry silverberry fruit.

Components	Contents	Ref.	Components	Contents	Ref.
Dry weight [%]	12.64–15.55	[9] [44]	Amino acids [mg/100 g FW]	89.68	[44]
Total saccharides [%]	5.34–6.30	[9]	serine	13.93	[44]
Monosaccharides [%]	1.54–1.96	[9]	phosphoethanolamine	13.93	[44]

Components	Contents	Ref.	Components	Contents	Ref.
Total free sugars [mg/100 g FW *]	781.44	[44]	alanine	13.16	[44]
fructose	370.34	[44]	β-alanine	13.16	[44]
glucose	401.96	[44]	aspartic acid	4.62	[44]
sucrose	5.80	[44]	phosphoserine	4.62	[44]
trehalose	3.34	[44]	cystine	4.45	[44]
Crude protein [%]	1.29	[44]	methionine	3.89	[44]
Soluble protein [g/100 g FW]	0.48	[44]	phenylalanine	2.85	[44]
pH	3.29	[44]	threonine	2.63	[44]
Crude ash [%]	0.46–0.62	[2] [44]	taurine	2.63	[44]
Biominerals [mg/100 g FW]	1353.70–1855.94	[17] [44]	tyrosine	2.17	[44]
potassium	1627.44	[44]	leucine	1.41	[44]
magnesium	140.28	[44]	isoleucine	1.16	[44]
sodium	56.70	[44]	valine	1.12	[44]
calcium	14.70	[44]	β-aminoisobutyric acid	1.12	[44]
iron	7.98	[44]	α-aminoisobutyric acid	0.62	[44]
manganese	5.53	[44]	ornithine	0.57	[44]
zinc	2.89	[44]	glutamic acid	0.51	[44]
copper	0.10	[44]	sarcosine	0.51	[44]
lithium	0.20	[44]	Polyphenolic compounds [mg/100 g DW]	417.02–1268.90	[2][8] [37]
nickel	0.12	[44]	phenolic acids	1.22–3.80	[2][8] [37]
Lipids [g/100 g]	1.40	[1][9]	flavonols	37.29–56.25	[2][8] [37]
unsaturated fatty acids account [%], of which	48.70–54.50	[1][9]	hydrolyzable tannins	3.07–10.60	[2][8] [37]

Components	Contents	Ref.	Components	Contents	Ref.
α-linolenic acid [%]	17.50–20.80	[1][9]	stilbenes	0.91–1.71	[2][8][37]
linolinic acid [%]	21.80–25.90	[1][9]	polymeric procyanidins	861.36–1197.34	[2][8][37]
oleic acid [%]	19.30–22.70	[9]	Carotenoids [mg/100 g DW]	40.09–170.00	[2][8][37]
Organic acids [g/100 g DW **], of which	18.48–34.11	[2][36]	phytoene	0.93–0.97	[2][8][37]
malic acid account [%]	55–60	[2]	lycopene	39.16–169.00	[2][8][37]
quinic account [%]	11–15	[2]	β-carotene	0.21–0.31	[2][8][37]
tartaric acid account [%]	9–18	[2]	Tocopherols [mg/100 g DW]	2.00–9.93	[37]
Vitamin C [mg/100 g]	4.22–562.72	[9][44]	Chlorophylls [mg/100 g DW]	393.00 [38]	[2][37]

including ... fore, the ... ugars and organic acids. The average content of organic acids in the fruit of *E. multiflora* Thunb. biotypes grown in Poland range from 0.78% to 1.20% [9], or 18.48 to 34.11 g/100 g of dry weight (DW) [2][36], which implies that cherry silverberries are abundant in these compounds. A liquid chromatography analysis revealed the presence of seven organic acids in cherry silverberry fruit: malic, quinic, tartaric, oxalic, citric, isocitric, and succinic acid. The predominant organic acids were malic (55–60% of total organic acids), quinic (11–15%), and tartaric (9–18%) acids [2]. Kim et al. [44] identified four organic acids in cherry silverberry fruit and determined their total content at 294.44 mg/100 g of fresh weight (FW). According to Mikulic-Petkovsek et al. [45], citric and malic acids account for 30–95% of all organic acids in berries. Fruits that are low in citric acid include cherry silverberry as well as chokeberry, rowanberry, and eastern shadbush. Five organic acids with a total content of 167.8 g/100 g FW were identified in cherry silverberry leaves. Malic acid was the predominant compound (66% of total organic acids), followed by acetic (13.7%), citric (8.1%), lactic (6.3%), and succinic acid (5.3%) [17].

Another study demonstrated that cherry silverberry fruit contained 1.54–1.96% of monosaccharides and 5.34–6.30% of total sugars on a fresh weight (FW) basis [9]. Total sugar content was determined at 9.77 to 11.50 ° Brix by Hong et al. [46]. An analysis involving the high-pressure liquid chromatography with refractive index detectors (HPLC-RI) method revealed the presence of two sugars, fructose and glucose. Fructose accounted for around 57–59% and glucose for 41–43% of the total sugars in cherry silverberry fruit [2]. Kim et al. [44] identified five free sugars with a total content of 781 mg/100 g FW in cherry silverberry fruit. Fructose and glucose were the predominant sugars, whereas sucrose, maltose, and trehalose were detected in trace amounts [44]. Cherry silverberry leaves were found to contain five sugars: arabinose, fructose, glucose, maltose, and trehalose. Similar to the fruit, the predominant sugar in the leaves was fructose (46.9% of total sugars), followed by arabinose (27.2%) [17]. According to Mikulic-Petkovsek et al. [45], berries contain mainly fructose and glucose, and fructose accounts for up to 75% of the total sugars. However, some exceptions have been noted, such as kiwifruit, where sucrose represents 71.9% of the total sugars [45].

The sugar–acid ratio denotes the relative content of sugars and acids, which are responsible for the taste and aroma of fruit [45]. Sweet-tasting berries are not always rich in sugar, and they may be low in organic acids, mainly malic acid [45][47]. The sugar–acid ratio affects the perception of sweetness [48], and it ranges from 5.25 to 7.40 in cherry silverberry fruit [16]. In a study by Mikulic-Petkovsek et al. [45], white gooseberries and red, black, and white currants were the most acidic fruits with a sugar–acid ratio of around two. The sweetest-tasting fruits were black mulberries, brambles, and goji berries, with a sugar–acid ratio above 12.9 [45].

Vitamin C (ascorbic acid) is yet another bioactive substance that plays a very important role in fruit. Vitamin C has antioxidant, anticarcinogenic, anti-inflammatory, and antisclerotic properties; it lowers blood glucose levels and reduces the risk of cardiovascular diseases [49][50]. Cherry silverberries are abundant in vitamin C, although the content can vary depending on variety, genotype, growing conditions, weather, and ripeness [9]. In the work of Sakamura et al. [24], vitamin C concentration decreased in successive stages of fruit ripening. In contrast, in *Rubus sieboldi*, *Ribis nigrum*, pears, peaches, and papayas, the content of L-ascorbic acid increased with ripening [24]. In a study by Kim et al. [44], cherry silverberries grown in Korea contained 131.35 mg/100 g FW of ascorbic acid and 431.37 mg/100 g FW of dehydroascorbic acid, and the total content of vitamin C was determined at 562.72 mg/100 g FW. These results indicate that cherry silverberry fruit is an excellent source of vitamin C. In a study conducted by Bieniek et al. [9], the concentration of vitamin C in the fruit of cherry silverberry grown in Poland ranged from 4.22 to 7.70 mg/100 g FW. Vitamin C levels reached 15.8–33.1 mg/100 g in cherry silverberry fruit grown in Ukraine [51] and 27.8 mg/100 g in the fruit grown in Pakistan [52]. In other fruit, vitamin C concentrations were 30 mg/100 g in elderberries, 35–90 mg/100 g in blackcurrants, and 16–32 mg/100 mg in raspberries [53].

Cherry silverberries are also abundant in biominerals, mainly potassium (1627.44 mg/100 g FW), magnesium (140.28 mg/100 g FW), sodium (56.70 mg/100 g FW), calcium (14.70 mg/100 g FW), iron (7.98 mg/100 g FW), manganese (5.53 mg/100 g FW), zinc (2.89 mg/100 g FW), copper, lithium, and nickel (0.10–0.20 mg/100 g FW) [44]. According to Polish Standards [54], 100 g of cherry silverberry fruit provide approximately 65% of the recommended daily intake of potassium, 33–43% of magnesium, 53–79% of iron, 26–32% of zinc, and 240% of manganese, for healthy middle-aged adults [54]. Bal et al. [55] found that seabuckthorn is also a rich source of potassium, whose content was determined at 1012–1484 mg/100 g FW in fruit flesh and at 933–1342 mg/100 g FW in seeds. Cherry silverberry leaves can be used as functional food additives [8], and they have been found to contain 14 minerals with a total content of 1353.70 mg/100 g FW [17]. Similar to the fruit, 100 g of cherry silverberry leaves provided 33% of the recommended daily intake of potassium, 36% of calcium, 35–63% of iron, 22% of copper, 18–24% of magnesium, around 250% of manganese, and around 180% of selenium [54]. Other elements, including Li, Na, Al., Fe, Co, Ni, Cu, Zn, and Ge, were detected in trace amounts [17].

Free and bound amino acids and their derivatives are yet another important group of biologically active compounds. According to Kim et al. [44], cherry silverberries are abundant in amino acids, whose total content was determined at 89.68 mg/100 g FW. The content of serine, alanine, phosphoethanolamine, and β-alanine exceeded

10 mg/100 g FW, whereas aspartic acid, cystine, methionine, phosphoserine, threonine, glutamic acid, glycine, valine, isoleucine, leucine, tyrosine, phenylalanine, taurine, sarcosine, α-aminoisobutyric acid, β-aminoisobutiryc acid, and ornithine were detected at concentrations below 5 mg/100 g FW. In turn, cherry silverberry leaves contained 7 essential amino acids, 10 non-essential amino acids, and 11 amino acid derivatives, with a total content of 943 mg/100 g FW. The following amino acids were identified at concentrations higher than 50 mg/100 FW: threonine, valine, isoleucine, leucine, phenylalanine, glutamic acid, alanine, and tyrosine. Lysine, aspartic acid, serine, cystine, histidine, proline, glycine, tyrosine, arginine, phosphoserine, sarcosine, α-aminoadipic acid, β-aminoisobutyric acid, y-aminoisobutyric acid, and anserine were detected at concentrations below 20 mg/100 g FW. Trace amounts of carnosine, β-alanine, cystathionine, and α-aminoisobutyric acid were also identified in cherry silverberry leaves [17]. The content of amino acids was similar in medlar leaves, but it was 10 times higher in ripe medlar fruit [56]. Amino acid concentrations in Saskatoon berries were estimated at 490 mg/100 g [57]. According to Zhang et al. [58], the content of free amino acids in fruits is determined mainly by ripeness, growing conditions, position on a plant, genotype, and the applied analytical methods.

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