

## Elderberry-functional product (review)

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### Abstract

*Sambucus nigra* L. or black elder is a woody perennial plant native to Europe [3]. This has been used as a medicinal plant for many years. Even if all parts have their role in treating various ailments, the ones that have been studied the longest by scientists and used by consumers have been the fruits and flowers [1]. The protein content in elderberry fruits is 2.7-2.9%, in flowers approximately 2.5%, and in leaves we have a value of 3.3%, making elderberry a good source of protein [9]. Both flowers and fruits of *Sambucus nigra* are used as a traditional remedy for various types of ailments and diseases. They have a wide range of uses, but in particular they can treat the common symptoms of colds, fevers, coughs, nasal congestion, mucous secretions and flu, as well as for improving the immune system [8].

**Keywords:** elderberry, chemical composition, medicinal uses, *Sambucus nigra*, functional product

### 1. Taxonomy, geographical distribution

*Sambucus nigra* L. known as "elder, black elder or European elder" has gained popularity among people due to its positive and quite confident effects as antiviral and immunomodulatory. Elderberry has been used as a medicinal plant for many years. Even if all parts have their role in treating various ailments, the ones that have been studied the longest by scientists and used by consumers have been the fruits and flowers [1]. As early as 1651 in Europe, more precisely in France, elderberry was known among consumers. Also in the northern part of Africa and in some areas of Asia, with the aim of driving away evil spirits, to prevent or cure certain ailments. In America, with the first settlers, the knowledge about this plant, the American elder, was also spread, being easily found in the more unpopulated and deserted areas. Native Americans have a habit of using elderberries to treat rheumatic conditions and fever, as well as for other benefits to the body. Even though many of the known properties of black elder still do not have scientific validation, there is still a significant number of studies that confirm the important benefits brought by elder fruits medicinally or therapeutically [2].

*Sambucus nigra* L. or black elder is a woody perennial plant with flowers and dark blue fruits native to Europe and part of the family Adoxaceae (formerly Caprifoliaceae).



Figure 1. Fruits and flowers of *Sambucus nigra*

Also included in this family are vines, small trees whose fruits are orange to black, and various shrubs. For the classification of the species, certain characteristics of the fruits are taken into account, such as the size and color of the fruits, their arrangement, branching.

The genus *Sambucus* consists of about 30 species, most of which originate from the northern half. Given that elderberry fruit is preferred by birds, it can spread rapidly to warmer, wetter areas. The distribution area of the elderberry is vast, so it can be found at the edges of forests, along roads and railways, etc. [3].

Of the 30 species of the *Sambucus* genus, there are very few species that can be exploited and only two species are used for commercial purposes, namely *S. nigra* L. (black elder) and *S. canadensis* L. (Canadian, American elder) [4].

In Europe, the black or common elder (*Sambucus nigra* L.) is the most widespread species, and in North America it is the American elder (*Sambucus canadensis* L.). *Sambucus nigra* is a common species especially in western and central Europe, as well as in North Africa. The black elder is a deciduous shrub or small tree that can reach heights of up to 10m and likes sunny places, Scandinavia and Great Britain. The flowers it produces are cream-colored umbels and appear in late May-early June. After the flowers fall, the elder produces fruits that are green in the first phase and after ripening become dark in color (dark blue) arranged in the form of a cluster. Elderberries ripen towards the end of summer, and their size is about 6 mm. The flowers are hermaphrodite. The leaves are 20 cm long, branched with 5-7 leaflets [3]. The quality of freshly picked fruit can be seriously affected due to high perishability if exposed to high temperatures and not stored as soon as possible. So they must either be processed immediately after harvesting or stored for a limited period under refrigeration conditions (0°C–4°C) before processing. Freezing at -20°C is used if longer-term storage is desired or you can also opt for pressing the fruits to obtain juice or dehydrating them. Depending on the next processing step, the fruit can also be stored after dehydration in rooms with low humidity for a certain time [5].

Studies carried out so far have shown that both elderberry fruits and flowers have biological activities such as: antioxidants, antidiabetic and anti-inflammatory, already having a history in natural medicine in terms of reducing inflammation and diabetes symptoms, as diuretics and in the treatment of colds and of the flu [6].

Currently, *Sambucus nigra* is cultivated both for its ornamental value and for its fruits and flowers that can be used to obtain and prepare certain products, such as: juices, wines, jams, drinks or food colorings. Also, flower preparations, but especially fruit preparations, are used as nutritional supplements to relieve cold and flu symptoms and as an immunomodulator [7].

## 2. Chemical composition of elderberry

Several factors influence the chemical composition of elderberry (*Sambucus nigra* L.), among which we can list: the species, degree of ripeness, climatic and environmental conditions, etc. [8]. The protein content in elderberry fruits is 2.7-2.9%, in flowers approximately 2.5%, and in leaves we have a value of 3.3%, making elderberry a good source of protein.

Amino acids present in fruits, leaves and flowers appear in free or conjugated form and there are 16 in fruit, of which 7 belong to exogenous amino acids (the human body cannot synthesize them, so they must be supplied in the diet) and relative exogenous amino acids (they can be synthesized in the body from other amino acids), instead in flowers and leaves there are only 9 amino acids [9]. Elderberry lipids are mainly located in the seeds.

The oil content in the seeds was estimated at 22.4% [10] and in the meal obtained from the seeds at 15.9% [11]. The fatty acid profile of total lipids is mainly composed of unsaturated fatty acids, namely linolenic (40.7 g/100 g oil), linoleic (34.3 g/100 g oil) and oleic acid (13.8 g/ 100 g oil et al.) , 2013). The oil derived from the seeds and the meal produced from the seeds are characterized by a very favorable omega 6/omega 3 ratio at 0.84 and 1.19 respectively [10,11].

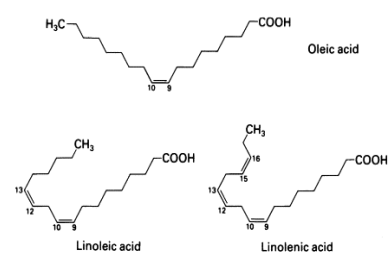


Figure 2. Unsaturated fatty acids [26]

Elderberries have a fairly high carbohydrate content of about 18.4%, of which 7.4% is dietary fiber. Fiber fractions present in fruits include pectin, pectic acid (polygalacturonic acid), protopectin (hemicellulose), and calcium pectinate.

The fruit sugar content is 6.8–11.5% in the fruit, of which more than 95% are reducing sugars in the form of glucose and fructose. They are present in elderberries in equal quantities, with the exception of sucrose which represents less than 0.33% of the fruit.

Also in elderberries we have water-soluble vitamins (complex B, vitamin C) and fat-soluble vitamins (group A vitamins), tocopherols). Vitamin C in fresh fruits is estimated in the range of 6–35 mg/100 g [8].

The minerals included in the composition of elderberries are 0.99%, namely: K, Ca, Fe, Mg, P, Na, Zn, Cu, Mn, Se, Cr, Ni, Cd [12,13]. In addition to lipids, carbohydrates, vitamins and minerals, elderberries contain compounds with high biological activity, polyphenols, such as flavonols, phenolic acids, proanthocyanidins and anthocyanins, which give the fruit its characteristic black-dark purple color [14]. The anthocyanin content of elderberries is variable. The most predominant anthocyanin content in *Sambucus nigra* is cyanidin 3-glucoside, depending on variety and fruiting, and the next anthocyanin is cyanidin 3-sambubioside [15].

Elderberry is also a good source of flavonols and phenolic acids. The predominant flavonols were quercetin, kaempferol and isorhamnetin. The component parts of elderberry such as leaves, flowers and fruits contain polyphenolic compounds. A higher content of flavonols is found in elder flowers (214, 25 mg/100 g) compared to fruits and than leaves (17.01 mg/100 g). In addition, elder flowers and fruits contain large amounts of phenolic acids. Several researchers have isolated from flowers nine phenolic acids, derivatives of caffeic and p-coumaric acid, and two phenolic acids without established structures [8, 11, 15].

Fruits especially berries, vegetables, chocolate, tea and wine are foods and drinks rich in phenolic compounds. These compounds are characterized by the fact that they have at least one aromatic ring made up of one or more hydroxyl groups attached to the carbon atoms of the aromatic ring. They can be classified as flavonoids and non-flavonoids [16, 22].

Flavonoids are polyphenolic compounds that have a common structure consisting of two aromatic rings (A and B) linked together by 3 carbon atoms forming an oxygenated heterocycle (ring C) and comprising 15 carbon atoms. They can be divided according to the type of heterocycle involved into 6 major subclasses: flavonols, flavones, isoflavones, flavanones, anthocyanidins and flavanols [17, 22]. The basic flavonoid backbone can have numerous substituents.

Anthocyanins (glycosylated polyhydroxy derivatives of 2-phenyl benzopyryl salts) are those water-soluble pigments that give many fruits, vegetables, and flowers their blue, purple, red, and orange colors [18,22]. As a rule, anthocyanins are found mainly in the skin, with the exception of certain types of red fruits, where they are also found in the pulp (cherries, blueberries, strawberries) [16, 22].

Several anthocyanidins have been reported, six of which are commonly found in fruits and vegetables: pelargonidin, cyanidin, peonidin, delphinidin, petunidin, and malvidin [16,22].

Phenolic acids belong to the category of non-flavonoids of dietary importance. These are secondary metabolites from plants and fungi. Phenolic acids are divided into two large groups: C6-C1 hydroxybenzoic acids derived from benzoic acid molecules and C6-C3 hydroxycinnamic acids derived from cinnamic acid molecules [19]. The most common hydroxybenzoic acid is gallic acid [20]. Hydroxycinnamic acids are more common than hydroxybenzoic acids and consist mainly of p-coumaric, caffeic and ferulic acids. Phenolic acids have been used as beneficial agents for various diseases, especially cardiovascular conditions. Phenolic acids have been shown to have antibiotic, antioxidant and anti-inflammatory properties and therefore can inhibit or prevent the development of infectious and inflammatory diseases [21,22].

### 3. Antioxidant activity

The diet that includes fruits, flowers and leaves of elder may represent a potential protective agent against the increase of oxidative stress in the human organism and the adverse effects caused by it, because elder is a rich source of polyphenols. Studies have shown that antioxidant activity is found in elderberry fruits, flowers and leaves [8].

Certain nutrients such as antioxidants, folic acid are found in large amounts in fruits and vegetables and are associated with a lower rate of cardiovascular disease according to observational epidemiological studies [23]. *Sambucus nigra* flowers usually have higher antioxidant activity than berries and leaves [24]. In other studies, the antiradical activity of aqueous extracts of elderflowers was determined in relation to the DPPH radical. Elderflower extract scavenged hydroxyl radicals (HO•) and 2,2-diphenyl-1-picrylhydrazyl radical (DPPH•) and inhibited lipid peroxidation in linoleic acid emulsion

(conjugated dienes and thiobarbituric acid reactive substances – TBARS) . Another very popular method for analyzing antioxidant activity is ORAC – oxygen radical absorbance capacity [8].

#### 4. Medicinal uses

In traditional medicine, both flowers and fruits of *Sambucus nigra* are used as a traditional remedy for various types of ailments and diseases. They have a wide range of uses, but in particular they can treat the common symptoms of colds, fevers, coughs, nasal congestion, mucous secretions and flu, as well as for improving the immune system. Elder flowers, due to their flavonoid content, can mainly have diaphoretic, antipyretic and diuretic properties. Due to the content in the compounds that have the properties of vitamin P, they close the capillary walls, improve their flexibility and prevent the infiltration of red blood cells and plasma outside the vessels.

In addition, elderflower has anti-inflammatory and antibacterial properties, so it is used as a gargle for sore throats or as a compress to treat conjunctivitis. They are most commonly used as infusions, obtained from dried flowers, for internal or external use. Elderberry has, like elderflowers, the same properties but in addition acts as a laxative and antidote, so elderberries are often used as an ingredient in various herbal mixtures to treat constipation or to help with weight loss. Elderberries also have moderate analgesic effects and can be used as an adjunct analgesic for migraine, sciatica and neuralgia.

In addition to the flowers and fruits, the other component parts of the elderberry such as: the bark, roots, stems and leaves of the elderberries are good for health, being used especially as medicine or food by rural populations. For example, elder bark is known for its diuretic and weight-loss properties, while elder leaves help increase resistance to infectious diseases. Today, medicines for colds, flu and other infectious diseases are developed using black elderberry fruit or flower. They are used as ingredients in food supplements in the form of syrups, drops, tablets, capsules, pills, aerosols, emulsions or suspensions [24].

#### 5. Conclusions

1. Elderberries have received increased attention due to their high content of anthocyanins, which are widely used and may provide nutritional benefits.

2. Anthocyanins, as well as other flavonoids, have antioxidant, anticancer, immunostimulating, antibacterial, antiallergic and antiviral properties; therefore, their consumption can help prevent several degenerative diseases such as cardiovascular disease, cancer, inflammatory diseases and diabetes [25].

3. Numerous studies indicate that the fruits and flowers of *Sambucus nigra* are highly nutritious and rich in bioactive compounds.

4. Elderberry has been shown to have mainly antibacterial and antiviral properties, can reduce sugar and lipid concentration, and even has antidepressant and antitumor properties.

5. Considering the increasing demand for natural, organic and health-promoting foods, it can be said that elderberry (a natural food component) fits perfectly into this trend and has a good chance to increase its role as a beneficial component of a healthy diet [24].

**Compliance with Ethics Requirements.** Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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