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Aloe arborescens, *Aronia melanocarpa*, *Rosa canina*, *Sambucus nigra* –
immunostimulating properties and use in phytotherapy

Abstract

Natural herbal products can effectively support the functioning of the immune system, constituting an important element of the treatment and prevention of bacterial or viral infections. The study's main goal is to indicate, based on scientific research, the possibilities of using selected plant raw materials as immunostimulants. The work also aims to update the state of knowledge on the analysed properties of four selected plant species (*Aloe arborescens*, *Aronia melanocarpa*, *Rosa canina*, *Sambucus nigra*). The immunostimulatory properties of *Aloe arborescens* and *Sambucus nigra* have been confirmed by pharmacological and clinical studies. Therefore, it is not without reason that these plants are ingredients of popular and generally available commercial preparations. Similar activity of *Aronia melanocarpa* and *Rosa canina* has been found only based on *in vitro* or *in vivo* studies on experimental animals and clinical studies are needed to demonstrate the clear justification for using them as agents that increase the body's immunity.

Keywords: phytotherapy, medicinal plants, immune system, immunity

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Introduction

Many plant-derived agents affect the non-specific, antigen-independent immune system. By exhibiting multidirectional effects, they can regulate the physiological immune response. In phytotherapy, these plant materials include immunostimulants (preparations stimulating the immune system) and immunomodulators (agents enhancing or inhibiting the immune response). Clinically, immunostimulants, alongside immunosuppressants and immunoadjuvants, are one of the categories of immunomodulators. Specific components of immunostimulating plants can activate and strengthen the functions of the systemic and local immune system (Nawrot, Nowak, 2018; Behl et al., 2021). This action may be based, among

others on the activation of macrophages, responsible for the process of phagocytosis and the release of substances (TNF- α , interleukins), which perform extremely important functions in the immune system and exhibit several biological properties (e.g. stimulation of the activity of B, T and NK lymphocytes). Immunostimulating compounds include polysaccharides, which increase the number of lymphocytes and sensitize foreign substances to the effect of phagocytosis (opsonisation). The second group of such compounds are glycoproteins, which affect the proliferation and stimulation of B and T lymphocytes, as well as the phagocytic activity of leukocytes, or the synthesis of antibodies and interferon. As a result of ongoing research, more and more promising plants and their components with this type of effect are being discovered (Samochowiec, 2002; Hoffmann, 2016; Nawrot, Nowak, 2018; Róžański, Pietryja, 2021; Behl et al., 2021). In this context, four plant species whose various medicinal properties have been known for centuries enjoy considerable interest – *Aloe arborescens* Mill., *Aronia melanocarpa* (Michx.) Elliot, *Rosa canina* L. and *Sambucus nigra* L.

Aloe arborescens in the steady state in southern and eastern Africa, in Australia, on the Canary Islands, the Arabian Peninsula and on an island in the Indian Ocean. In Poland, this plant is grown in pots and greenhouses (Mederska, 2023). On the contrary, chokeberry is considered in North America and Asia, from where it was brought to Europe; it is also cultivated in Poland (Fijołek, 2016). In turn, *Sambucus nigra* and *Rosa canina* are shrubs native to Polish flora. Wild elderberry is a pathogenic species occurring in Central Europe, the Balkans and Asia. They often occur on the edges of forests, in thickets, on wastelands and near buildings. It is a nitrophyte. It is also planted in parks and gardens (Halarewicz, 2023). Wild rose is a species occurring in Mexico, South America, Siberia and Europe. In Poland, it grows commonly throughout the country, but least frequently in the northeastern part. It can be used on boundary strips, forest edges and roadsides, to protect slopes and thickets. From the collective packaging of fruits and plants, this variety was available in cultivation (Mederska, 2023).

This study aims to present the possibilities of using selected plant raw materials as immunostimulants and to update the knowledge on the immunostimulatory properties of *Aloe arborescens*, *Aronia melanocarpa*, *Rosa canina* and *Sambucus nigra*.

A brief description of the species analysed

Aloe arborescens Mill.

It is a perennial, evergreen succulent from the family *Asphodelaceae* Burnett (it can reach up to 5 m in height, growing as a strongly branched subshrub), with thick, fleshy and lanceolate

leaves, with prickly serrated edges; inside them, there is a water storage tissue filled with mucus. The leaves are arranged spirally and embrace the stem with a wide base; their colour is grey-green, covered with a blue bloom. The stem is straight, slightly woody and at its base grow numerous root suckers, used for vegetative reproduction. In pots, aloes bloom extremely rarely, while in natural locations or large-area cultivations, the plant produces a flowering shoot, at the top of which appears a racemose inflorescence, composed of many yellow-orange or red tubular-bell-shaped flowers (similar to *Aloe vera* Mill. – Fig. 1A-B).



Fig. 1. *Aloe vera* Mill. with yellow inflorescences – A, large-scale plantation of *Aloe vera* in Gran Canaria, Spain, 2022 r. – B, *Aronia melanocarpa* fruit, Germany, 2007 r. – C, false fruits of the *Rosa canina* (*hypanthium*) – D,

ripe elderberries of *Sambucus nigra* – E (A-B, D-E – Photo. A. Kucab, C – Source: commons.wikimedia.org – public domain)

The fruit is a multi-seeded capsule (Bełdowska, Guzewska, 1987; Senderski, 2017; Mederska, 2023).

The raw material used in medicine is fresh aloe leaves (*Aloe arborescentis recens folium*) and the juice obtained from them (*Aloe inspissatus succus*), which after drying takes the form of brown lumps called alona (Dymarska, 2016). Interestingly, species related to *Aloe arborescens* have similar properties (*A. ferox* Mill., *A. africana* Mill., *A. variegata* Forssk. and *A. vera*). To obtain the highest possible content of biostimulants (compounds with immunostimulating effects), the leaves should be obtained from specimens that are at least three years old and it is best to collect the lowest, the oldest ones. In addition, aloe should not be watered for about 2 weeks before harvesting, and after harvesting, the leaves are stored for several days in cold stores before further use, which allows for conditions conducive to biochemical changes (Fijołek, 2016).

Aronia melanocarpa (Michx.) Elliot

It belongs to the *Rosaceae* Juss family. It is a fairly tall shrub reaching 2–3 m in height. The leaves of chokeberry are dark green, elliptical or obovate in shape, set alternately on the branches. In autumn, they turn red. White, flowers gathered in corymbs bloom in May. The fruit is spherical, dark blue or almost black berries, covered with a downy coating, with slightly sweet and aromatic flesh (Fig. 1C) (Fijołek, 2016; Mederska, 2023).

The medicinal and food raw material is the ripe chokeberry fruit (*Aroniae fructus*) harvested in August or September. They can be used to make preserves or dried in a dryer, initially at a temperature of 30 °C, later increasing to 45 °C. Freshly harvested fruits require freezing because they have a tart aftertaste resulting from a significant amount of polyphenols (Sidor et al., 2019), which decompose at low temperatures (Kozłowski et al., 2023). Chokeberry fruits are used to produce juices, preserves, tinctures, fruit teas and dietary supplements. Dried fruits can be used to make an infusion that is rich in vitamin P (a mixture of organic compounds from the flavonoid group, supporting the action of vitamin C) (Kyle, Duthie, 2006).

Rosa canina L.

R. canina is a shrub with arching shoots, belonging to the *Rosaceae* Juss family. It grows up to 3 m high and has thick, hooked or sickle-shaped curved thorns. The leaves of this plant are

composed of 5–7 ovate or elliptical, pointed and serrated leaflets. The flowers are large, white or pale pink; they occur singly or are gathered in inflorescences. They have a characteristic rose scent and bloom from May to June. After this time, the flower base grows into a pseudo fruit – *hypanthium* (Fig. 1D), inside which there are fruits with hairs (achenes). This is the so-called apical fruit, it is red and ovoid, ripens at the end of September, at its top there are visible remnants of the calyx (Bełdowska, Guzewska, 1987; Halarewicz, 2023; Mederska, 2023).

The herbal raw material is the false fruit of the rosehip (*Rosae Fructus*). The fruit is collected in August and September, before the hypanthia are fully ripe when it is red but still hard; it can be dried with or without the seeds. It should be crushed and kept for the first 10 minutes at a temperature of about 100 °C to quickly destroy the enzymes that break down vitamin C, then dried at a temperature of about 50–60 °C (Mazerant, 1990). Examples of methods of preparation and use of the most commonly made remedies from rosehip fruit are presented in Tab. 1.

Tab. 1. *Rosa canina* L. fruit preserves

The form of the preparation	Recipe and application
infusion	Pour 3 heaping tablespoons of dry and crushed rose hips with 2 cups of boiling water, set aside for 30 minutes and strain, you can sweeten it with honey. Drink 200 ml 2-4 times a day, children - 100-150 ml several times a day.
decoction	Pour 1 tablespoon of dry and crushed rose hips with 2 cups of warm water, cook covered for about 5 minutes, set aside for 15 minutes, strain. Drink 1 glass 3 times a day.
tincture	Pour 0.5 cups of fruit with 300 ml of vodka or wine, digest for 14 days, filter. Take 1 tablespoon 2-3 times a day or 30 ml once a day.
intract	Pour 1 cup of fresh ground fruit with 500 ml of vodka (or wine) at 75°C, digest for 10 days and filter. Take as a tincture.

Source: own study based on Róžański, 2012; Senderski, 2017.

Sambucus nigra L.

It is a shrub from the *Adoxaceae* Trautv family. It grows up to 10 m high and spreads strongly. It has pinnately compound leaves arranged oppositely. White and small, radiant flowers are gathered in flat and wide umbels. They are characterised by an unpleasant smell, which is caused by the content of valeric acid and essential oil composed of over 55 different chemical compounds (Waszkiewicz-Robak, Biller, 2018). The plant blooms at the turn of May and June. At the end of August or in September, black-purple, shiny fruits appear, which berry-like drupes are (Fig. 1E) (Halarewicz, 2023).

The main herbal raw materials used are flowers (*Sambuci Flos*) and fruits (*Sambuci Fructus*) (Mazerant, 1990). Their preparation for use and application are described in Tab. 2.

Tab. 2. The process of obtaining and medicinal use of raw materials from *Sambucus nigra* L.

Raw material/ After recovery and application	<i>Sambuci Flos</i>	<i>Sambuci fructus</i>
Collection	It begins when some of the flowers are still unopened; flowers with drooping crowns are no longer eligible for harvesting; on dry and clear days, entire canopies are cut down; the inflorescences should be carefully arranged in the basket.	It is harvested by cutting off entire umbels of ripe fruit (they cannot be overripe) and placing them carefully in flat baskets; fruits should be separated from the stalks and those that are green and unripe should be discarded; fresh fruit can be used to prepare juice, jam or tincture.
Drying	Entire canopies are unfolded/hung on ropes in dry, airy and shaded rooms; After drying, shake off the flowers themselves and throw away the flower stalks.	The fruits must be immediately transferred to a heated drying room; the initial drying temperature is approx. 30 °C, then a maximum of 55 °C (avoid burning); dried fruits are cleaned of stalks.
Storage	In tightly closed and dark containers.	In tightly closed and dark containers.
Application	For flu and colds (diaphoretic, antipyretic and expectorant effect), as an additional diuretic in inflammation of the urinary tract; with weakening and increased permeability of capillaries; the infusion is used externally as a rinse for angina or pharyngitis and for washing the skin with lesions.	In migraines, rheumatic diseases, severe neuralgia and colds; as a detoxifying agent (helps cleanse the body of harmful metabolites); seals and makes capillaries more elastic; also useful in the digestive tract inflammation.

Source: own study based on Senderski, 2017.

Elderberry bark also has healing properties (*Sambuci Cortex*), roots (*Sambuci Radix*) and leaves (*Sambuci Folium*) (Macků et al., 1989).

Review methods

A review of the literature on the immunostimulating properties of selected plant species was conducted using online databases – Google Scholar and PubMed. Scientific articles in English and Polish published in the years 1979-2024 were analysed, with particular emphasis on the latest publications. For each article, the abstract was first studied and then the full texts of studies consistent with the intended purpose were reviewed. These publications included both original and review papers. The description of biology, occurrence of individual plants, their properties and examples of methods of use in phytotherapy were made based on the bibliography of the subject and specialist websites.

Medicinal and immunostimulating properties of the analysed species

The healing properties of aloe are due to the extremely rich composition of substances found in it. Its immunostimulating effect is conditioned by the presence of the glycoprotein fraction

(protein and sugar compounds) and organic acids found in aloe gel. The glycoprotein fraction is a mixture of lectin-like substances, such as alloctin A and B (glycoproteins), responsible for stimulating the growth and division of B lymphocytes (producing antibodies) and T lymphocytes (releasing lymphokines). These cells participate in numerous immunological processes, related to the destruction of cancer cells, pathogenic viruses and bacteria, cells infected or changed as a result of the action of mutagenic factors. *In vitro* studies have isolated from aloe lectins S-1 and P-2, with immunochemical activity. They can agglutinate cells, which is possible due to the binding of polysaccharide fragments present on the surface of these cells with the active centre of the lectin. These lectins bind to α 2-macroglobulins, taking part in the nonspecific response. P-2 lectin has also been found to stimulate B cell mitosis and activate the complement system (Suzuki et al., 1979; Lamer-Zarawska et al., 2016; Nazeam et al., 2017). One study showed that aloe extract and its fractions significantly increased the viability of macrophages infected with the fungus *Candida albicans* (C.P. Robin) Berkhout (Farahnejad et al., 2011).

Another noteworthy and well-known component of aloe with a strong immunostimulatory effect is the polysaccharide acemannan (Fig. 2A), which can effectively activate and regulate immunity.

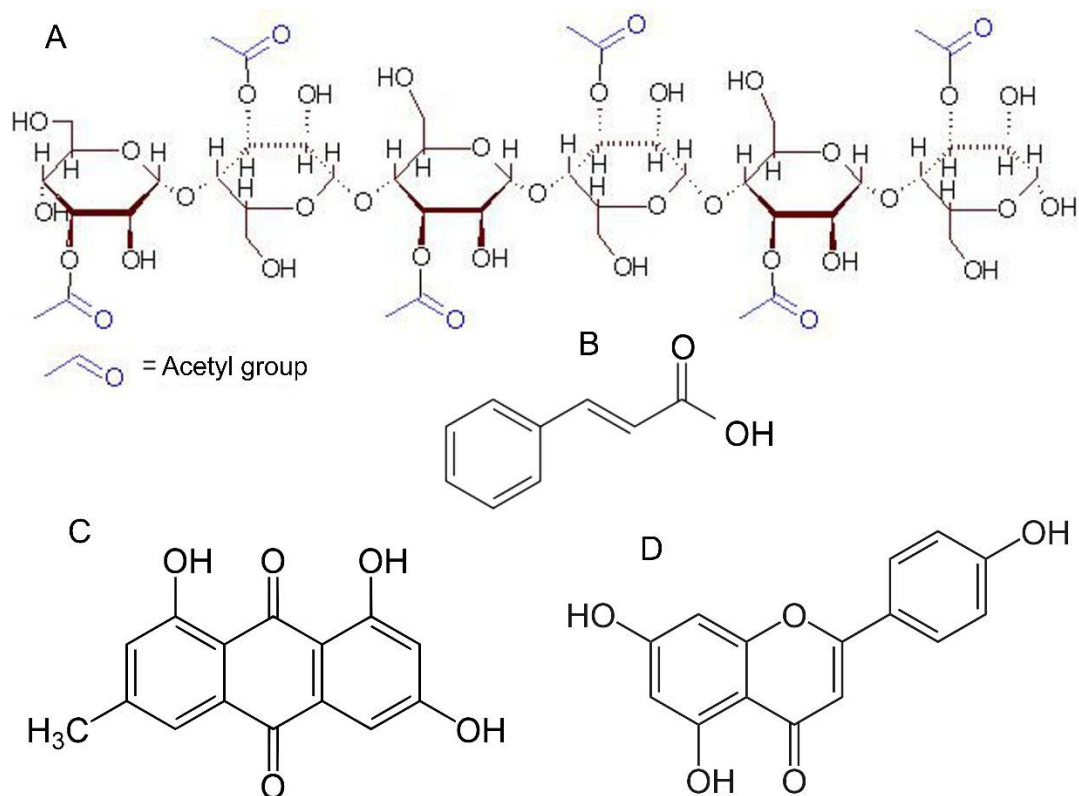


Fig. 2. Acemannan (C₆₆H₁₀₀NO₄₉) – a representative 6-sugar fragment – A, skeletal formula of trans-cinnamic acid (C₉H₈O₂) – B, emodin (C₁₅H₁₀O₅) – C, apigenin (C₁₅H₁₀O₅) – D

This compound, among other things, increases the level of cytokines (e.g. TNF- α and IL-1), increases the number of T and B lymphocytes, neutrophils and monocytes and also activates antigen-presenting cells – dendritic cells and macrophages. Activated macrophages, in turn, produce tumour necrosis factor (TNF α), which is a weapon against some types of cancers (Ebadi, 2006; Im et al., 2016; Aranda-Cuevas et al., 2020; Kim et al., 2023; Zhang et al., 2021).

The increase in immunity is also influenced by organic acids found in aloe, such as cinnamic acid (Fig. 2B), which induces the production and release of cytokines (e.g. IL-1, IL-6, IL-8). Through activated macrophages, it stimulates the production of antibodies by B lymphocytes and has a chemotactic effect on neutrophils (Wolska et al., 2019).

Numerous studies have also confirmed a number of anti-cancer properties of aloe, which result from the presence of substances such as emodin (6-methyl-1,3,8-trihydroxyanthraquinone – Fig. 2C), apigenin (4',5,7-trihydroxyflavone – Fig. 2D), quercetin (plant flavonol from the flavonoid group of polyphenols) and catechins (flavan-3-oles) (Wincek, 2017). Aloe reduces the risk of developing cancer under the influence of UV radiation. It can also accelerate recovery from infections – it prevents them and helps reverse the negative effects of taking synthetic antibiotics (Nowak, 2018). *A. arborescens* has many other directions of action. Among others, the antioxidant and antibacterial properties of the extract from the leaves of this plant have been confirmed (Maliehe et al., 2023). It can also be used externally – it accelerates the healing process of wounds or burns, eliminates pimples, relieves swelling and smoothest scars (Salehi et al., 2018; Tizazu, Bekele, 2024; Milind et al., 2024).

Aloe-based medicines have long been administered to people who are weakened, elderly, suffering from anaemia, or affected by devastating diseases. The therapeutic use of aloe extracts is mainly based on their bactericidal, antifungal and anti-inflammatory properties. In addition, aloe acts as a liver function support agent. As a source of biogenic stimulants, it has a beneficial effect on the functioning of the immune system. Aloe preparations are commonly used in conditions of reduced immunity, as well as increased susceptibility to infections (Nowak, 2018).

In official medical practice, commercial preparations containing extracts of *Aloe arborescens*, such as Biostymina and Bioaron C, have been used for many years. They are used to support the course of infections, especially in recurrent upper respiratory tract infections, as

well as for health prophylaxis. In the case of taking these preparations, fewer relapses of the disease and their milder course and faster completion are observed (Fal et al., 2016).

In Russia and Ukraine, extracts are produced from fresh leaves of *aloe arborescens* in the form of an isotonic liquid macerate in ampoules. This extract is administered intramuscularly and subcutaneously and is used to strengthen numerous immune reactions and as an activator of renewal and regeneration processes. A single treatment includes up to 30 injections of 1 ml. In Poland, aloe extract is available in the form of ampoules, but it is not registered as a preparation intended for injection. However, it is recommended to take it orally. Dr. Henryk Róžański, a valued specialist in the field of herbal commodity science, claims that the effects of immunostimulation occur in children up to six years of age, while in adults, glycoproteins and enzymes present in aloe juice or macerate can be inactivated in the digestive tract. For this reason, he recommends parenteral administration of aloe preparations to adults. Similarly, aloe juices seasoned with alcohol (over 30%) or pasteurized - due to denaturation and decomposition of active substances – will not have an immunostimulating effect (Róžański, Pietryja, 2021).

To strengthen the body, various types of syrups can be prepared. Zbigniew T. Nowak, an expert in medicinal plants and a promoter of natural methods of supporting treatment, recommends, for example, a syrup made from 1 cup of thick chokeberry or blackcurrant juice (or syrup), 1/3 cup of well-blended aloe leaves and 3 tablespoons of honey. The syrup obtained by combining all the ingredients should be poured into a tight, sterile jar and stored in the refrigerator. Adults should take the product for 4–5 weeks, up to 3 times a day, 1 tablespoon each, about an hour before a meal. This syrup reduces susceptibility to infections and adds vitality, it is recommended during convalescence and in states of general fatigue (Nowak, 2018). There are certain contraindications to the use of aloe preparations – they are not recommended for use, including: in case of high blood pressure, gastritis, allergies or kidney diseases (Fijołek, 2016).

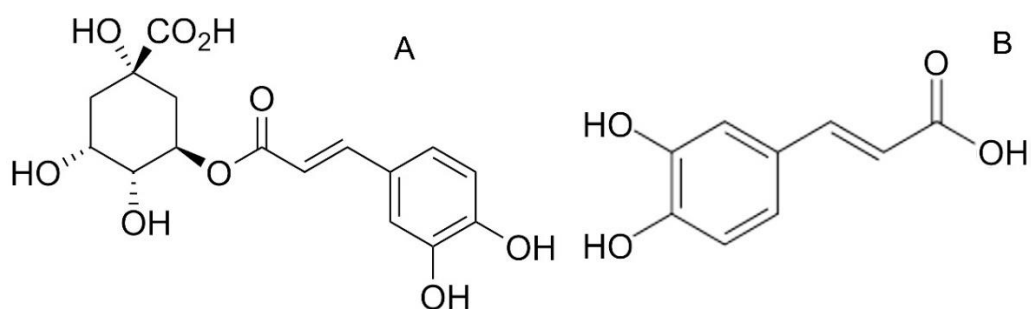


Fig. 3. Chlorogenic acid (C₁₆H₁₈O₉) – A and caffeic acid (C₉H₈O₄) – B

As for chokeberry, its fruits are rich in pectins, sugars, organic acids and microelements (iron, iodine, manganese, molybdenum, copper). The high content of bioflavonoids (with anti-exudative and protective effects on vitamin C), anthocyanins and flavonoids is also worth noting. Chlorogenic and caffeic acids present in the fruits (Fig. 3) have protective properties for the pancreas, liver and kidneys, and also show antibacterial effects (Salau et al., 2020; Rashidi et al., 2022; Xue et al., 2023; Pavlíková, 2023). They inhibit the development of bacteria resistant to some antibiotics. Chokeberry anthocyanins and flavonoids improve blood circulation and have anti-aggregation effects; they strengthen and seal blood vessels and alleviate symptoms of allergies and autoimmune diseases. Pectins have prebiotic and protective properties for the gastrointestinal epithelium. Pectins, anthocyanins, flavonoids and phenolic acids contained in chokeberries lower blood pressure, have anti-atherosclerotic and diuretic effects; they detoxify the body and reduce the level of lipids and cholesterol in the blood (Róžański, 2010a). Chokeberry juice stimulates the GALT and MALT systems and shortens the duration of infection (Róžański, Pietryja, 2021). Due to the high content of polyphenols, chokeberry also has immunomodulatory, antibacterial, hepato-, gastro- and cardioprotective, antidiabetic, anti-inflammatory and anticancer properties (Jurikova et al., 2017). These compounds have strong antioxidant and antiradical properties, and also reduce the impact of carcinogens on the body. It is also worth mentioning that black chokeberry proanthocyanidins (Fig. 4) are the strongest antimicrobial agents contained in these fruits (Sidor et al., 2019).

Scientists from Serbia conducted studies (in vitro and in vivo) based on which it was found that chokeberry extract stimulates pro-inflammatory properties in immune cells of the innate and adaptive response. They observed, among others, increased production of nitric oxide and interleukin-1 β in macrophages and dendritic cells; increased phagocytic activity of macrophages, increased number of T and B lymphocytes and stimulation of differentiation of T lymphocytes producing interferon- γ . The observed properties can be used in the fight against infections or cancers, in which an increased pro-inflammatory response is beneficial (Gajic et al., 2020). A team of German researchers demonstrated *in vitro* virucidal activity of black chokeberry juice against various enveloped viruses; among others, a significant reduction in SARS-CoV-2 infectivity was found (Eggers et al., 2022).

In medicine and prophylaxis, chokeberry juice and syrups are mainly used, which have strong antioxidant effects and increase the body's immunity. Therefore, it is not without reason that these fruits are used to produce commercial preparations available in Poland, such as Bioaron and Bioaron C, the use of which is recommended for weakened organisms as a result

of infections, reduced immunity and upper respiratory tract infections (Lamer-Zarawska et al., 2016). Chokeberry-based products should be combined with aloe, *Rhodiola rosea* L. or echinacea (*Echinacea angustifolia* DC.), as well as with vitamin C, magnesium and zinc (Różański, Pietryja, 2021).

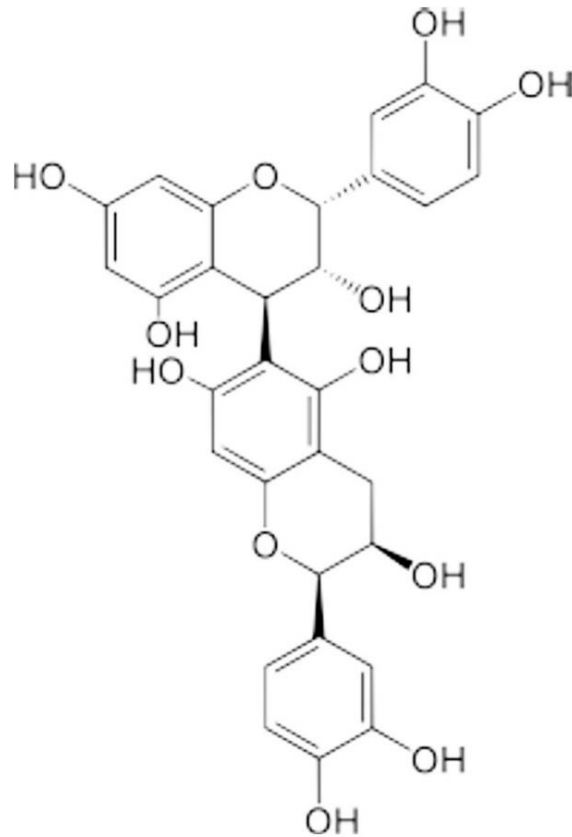


Fig. 4. Procyanidin B5 ($C_{30}H_{26}O_{12}$) discovered in chokeberry fruits (Da Silva et al., 1991)

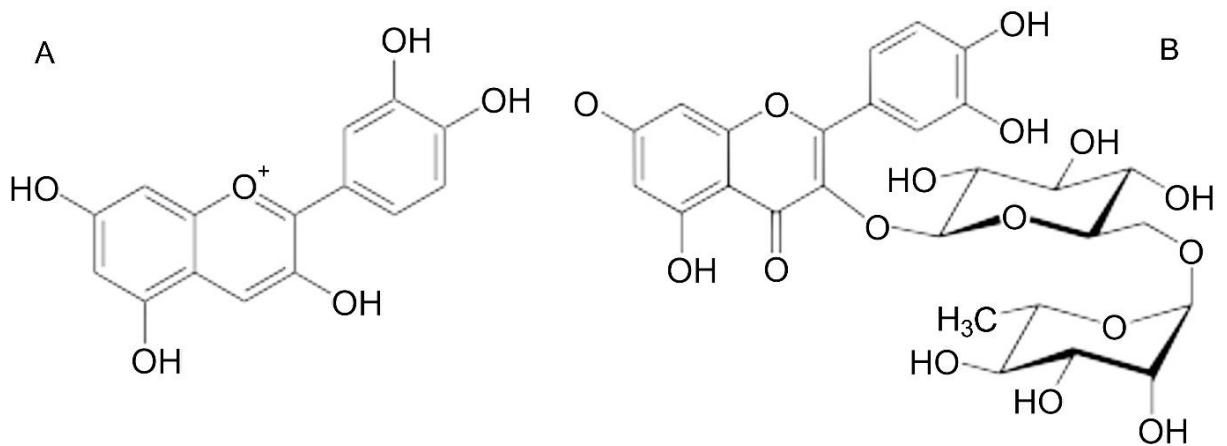


Fig. 5. Cyanidin ($C_{15}H_{11}O_6^+$) – A, rutin – rutoside ($C_{27}H_{30}O_{16}$) – B

Elderberry fruits also contain components with high biological activity – polyphenols, mainly anthocyanins (cyanidin glycosides – Fig. 5A), flavonols, phenolic acids and proanthocyanidins, as well as terpenes and lectins. Polyphenols, which are compounds with antioxidant properties, can significantly affect the course of numerous disease processes, counteracting oxidative stress. The main polyphenols in the fruit are chlorogenic acid (Fig. 3A) and rutin (Fig. 5B). They have a beneficial effect on blood pressure, lower glycemia, show anticancer potential and stimulate the immune system (Sidor, Gramza-Michałowska, 2015).

In scientific research, it is concluded that the extract of black elderberry fruit (such as Sambucol and its preparations) activates a healthy immune system by increasing the production of inflammatory cytokines (Barak et al., 2001; Barak et al., 2002). The mechanism of action of the extract is probably based on the presence of flavonoids, which stimulate the immune system to increase the production of cytokines by monocytes (Baraniak, Kania, 2014).

Black elderberry preparations are often used for upper respiratory tract infections. The results of experimental studies have confirmed the antiviral and antibacterial effects of elderberry flowers and fruits. However, no clinical studies have been conducted on the properties of black elderberry flowers in the treatment of colds or flu. However, the subject of such studies were black elderberry fruits (Mahboubi, 2021). Both in vitro and clinical studies have shown that elderberry fruit extract is effective in alleviating the duration and severity of flu symptoms, in several of its strains (Zakay-Rones et al., 1995; Zakay-Rones et al., 2004). It has been proven that a standardized liquid extract of black elderberry fruit has antimicrobial activity against some pathogenic Gram-positive and Gram-negative bacteria and inhibits the spread of pathogenic human influenza viruses (Krawitz et al., 2011). A study on mice confirmed the beneficial effect of black elderberry fruit juice on stimulating the immune response and preventing infection caused by human influenza virus type A (Kinoshita et al., 2012). Another study found an inhibitory effect of elderberry fruit extract in the early stages of the influenza virus cycle, with a much stronger effect in the post-infectious phase. Both the direct activity of the extract by blocking viral glycoproteins and the indirect effect through increased expression of IL-6, IL-8 and TNF were confirmed (Torabian et al., 2019). In light of the above studies, the use of black elderberry fruit in the prevention and treatment of influenza and colds is fully justified (White, Foster, 2018).

In modern herbal medicine, elderberry flowers are commonly used in the form of decoction, infusion, syrup and tinctures. Decoctions and tinctures are made from the fruit; in addition, juice can be prepared from them. Ready-made preparations containing standardized fruit extract in the form of syrup, or in the form of capsules or lozenges are also available

commercially. The manufacturer's recommendations should be followed when dosing them. To make an infusion, pour a glass of boiling water over 1 tablespoon of flowers and leave covered for 15 minutes. It is recommended to drink this infusion 2–3 times a day, about ½ glass each (mainly as a diaphoretic and antipyretic agent); it can also be used externally to rinse the mouth and throat. To prepare a decoction, pour a glass of cold water over 1 tablespoon of flowers or 1–2 tablespoons of dried fruit, heat to a boil and slowly cook for about 5 minutes under cover, set aside for 15 minutes. The dosage is similar to that of an infusion. A decoction of the fruit is used, among others, as a detoxifying agent, diuretic or as mild painkiller (Senderski, 2017; White, Foster, 2018).

Rose hips are also a valuable medicinal raw material used primarily as a general strengthening drug. Their therapeutic effect is based mainly on the high content of vitamin C (Fig. 6A) and flavonoids and folic acid (Fig. 6B) cooperating with it. It is worth mentioning that in the presence of bioflavonoids, the physiological activity of ascorbic acid increases by 50–400% (Cendrowski et al., 2012).

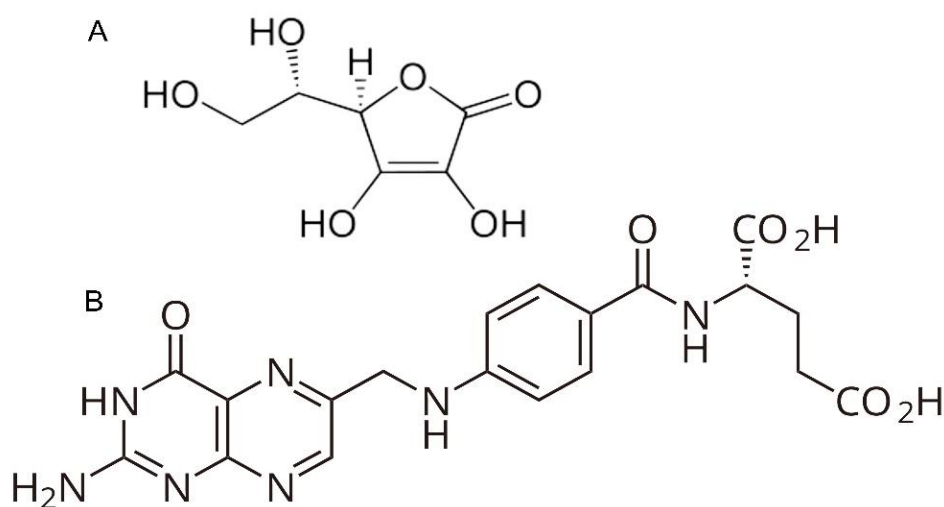


Fig. 6. Vitamin C – ascorbic acid ($C_6H_8O_6$) – A, folic acid ($C_{19}H_{19}N_7O_6$) – B

The raw material is traditionally used for bacterial infections, which are often accompanied by fever, as well as for digestive tract ailments. It is worth emphasizing that properly dried raw material should be free of stalks and have a natural red colour (Bełdowska, Guzewska, 1987; Senderski, 2017).

The pharmacological and health-promoting effects of rosehips are related to the content of a number of active ingredients, as shown in Table 3.

Tab. 3. Activity of substances contained in fruits of *Rosa canina* L.

Active substances	Action
vitamin C combined with anthocyanins and flavonoids, carotenoids, manganese and copper	immunostimulating
oxalates, polysaccharides, malic, citric and succinic acid	nourishing, strengthening, antiscorbutic and slightly laxative
anthocyanins, bioflavonoids	strengthening and sealing blood vessels
saponins, polyphenols and organic acids	detoxifying
organic acids, pectins	prebiotic
vitamin C, malic and succinic acid, anthocyanins, flavonoids	diuretic
flavonoids, galactolipids, phytosterols and catechins	anti-inflammatory and anti-exudative
flavonoid glycosides	gentle calming effect

Source: own study based on Róžański, 2010b.

The immunostimulating effect of rosehips is confirmed by numerous studies. One example is the experiment conducted by Turkish scientists, which aimed to determine the immunostimulating effect of *R. canina* fruits on haematological and non-specific immune parameters of sturgeon (*Acipenser gueldenstaedtii* Brandt & Ratzeburg) infected with *Mycobacterium salmoniphilum* (Whipps et al.) Gupta et al. A significant increase in the activity of lymphocytes, monocytes, cytokines and phagocytes was observed in fish fed with fruit, which showed that the immune response to infection was significantly stimulated (Duman, Şahan, 2018). It has also been proven in other experiments that rosehip extract has antioxidant and selective cytotoxic effects on cancer cells, including prostate and lung cancer cells (Kilinc et al., 2020) and colon cancer cells (Jiménez et al., 2016; Turan et al., 2018).

The use of rosehip fruit is indicated in many ailments, e.g. in the case of vitamin deficiency and increased demand for vitamins (during increased physical and mental effort, infectious diseases, cancers, impaired digestion and absorption, intensive menstruation), in allergic, rheumatic, vascular diseases, hypertension, inflammation of the intestines, stomach and urinary and reproductive systems, colds, liver diseases, as well as during convalescence (Beldowska, Guzewska, 1987; Róžański, 2010b). Rosehip products are commonly used primarily due to their strengthening effect, which results from the presence of many valuable active substances that act synergistically in the human body.

Summary

This study presents selected plant species in terms of their biology, presents examples of methods for obtaining medicinal raw materials from them and using them in phytotherapy, with particular emphasis on the use of their immunostimulating activity. The information contained

in the publication shows how much potential is shown by plants that we also have in our immediate surroundings, almost at our fingertips.

The results of studies conducted so far on selected plant species confirm their effectiveness or potential in the prevention or treatment of diseases associated with weakened immune systems. The immunostimulating properties of *Aloe arborescens* and *Sambucus nigra* have been confirmed by pharmacological and clinical studies. In the case of *Aronia melanocarpa* and *Rosa canina*, only *in vitro* or *in vivo* studies have been conducted on animals, therefore clinical studies are needed to prove the clear justification for using these plants for immunostimulation.

Conflict of interest

The authors declare no conflict of interest related to this article.

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Aloe arborescens, *Aronia melanocarpa*, *Rosa canina*, *Sambucus nigra* – właściwości immunostymulujące i wykorzystanie w fitoterapii

Streszczenie

Naturalne produkty ziołowe mogą skutecznie wspierać funkcjonowanie układu immunologicznego, stanowiąc istotny element leczenia i profilaktyki infekcji bakteryjnych lub wirusowych. Głównym zamierzeniem opracowania jest wskazanie na podstawie badań naukowych możliwości zastosowania wybranych surowców roślinnych jako środki immunostymulujące. Dodatkowo starano się uaktualnić stan wiedzy na temat właściwości czterech wybranych do analizy gatunków – *Aloe arborescens*, *Aronia melanocarpa*, *Rosa canina*, *Sambucus nigra*. Przeprowadzono wnikliwą analizę artykułów naukowych dostępnych w bazie Google Scholar i PubMed, korzystano również ze źródeł bibliograficznych oraz specjalistycznych stron internetowych.

Właściwości immunostymulujące *Aloe arborescens* i *Sambucus nigra* zostały potwierdzone badaniami farmakologicznymi i klinicznymi. Dlatego też nie bez powodu rośliny te są składnikami popularnych i ogólnie dostępnych preparatów handlowych. Podobną aktywność *Aronia melanocarpa* i *Rosa canina* stwierdzono jedynie na podstawie badań *in vitro* lub *in vivo* na zwierzętach doświadczalnych. Dlatego też potrzebne są dalsze badania kliniczne, aby wykazać wyraźną zasadność stosowania ich jako środki podnoszące odporność organizmu. Opracowanie porusza niezmiennie aktualną i ważną problematykę, ponieważ stany obniżonej odporności i towarzyszące im infekcje zdarzają się na ogół bardzo często.

Słowa kluczowe: fitoterapia, rośliny lecznicze, układ immunologiczny, odporność

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