

Borage (*Borago officinalis* L.) – a valuable medicinal plant used in herbal medicine

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Summary

In Europe, the use of herbs in the treatment of various ailments had been natural for centuries. Nowadays, phytotherapy is a way to support typical pharmacotherapy of many diseases. Borage (*Borago officinalis* L.) is one out of more than 20 000 plants of therapeutic properties. The results of some studies indicate that *Borago officinalis* L. is commonly used adjunctively in disorders of the respiratory system, urinary tract, arthritis and skin problems. Biologically active compounds found in borage oil are used as additives in the treatment of atherosclerosis, as well as in the regulation of certain metabolic processes.

Key words: borage, adjunct treatment, diseases of respiratory system, urinary tract, arthritis, dermatology, central nervous system

INTRODUCTION

Borage (*Borago officinalis* L.) is an annual plant belonging to the family *Boraginaceae* (*Boraginaceae* Juss.) [1, 2]. It originates from Western regions of Mediterranean area. It grows in almost whole Europe and North America, mainly in Canada

and the USA. In Poland, borage is a rare plant, usually occurring as a garden weed [3, 4]. The plant reaches a height of 30 to 60 cm. Its stem is covered with hairs that secrete an intense smell resembling the aroma of fresh cucumbers while grinding [1]. On the tops of the shoots there are the star-shaped inflorescences which initially are pink, later turn blue, rarely white [2]. The fruit is a four-times schizocarpium borage. Only seed of borage oil can be used internally because the herb contains toxic pyrrolizidine alkaloids [1]. The herb and oil are recommended to use externally, although, it should be pointed out that borage herb is a raw material showing mild effects on the human organism.

CHEMICAL COMPOSITION OF *BORAGO OFFICINALIS*

Raw material used in phytotherapy is borage seed oil (*Oleum Boraginis*), borage herb (*Herba Boraginis*) and borage seed (*semen boraginis*) [1] as well as leaves. Seed oil is obtained by cold pressing, herb is collected at the time of flowering and dried in shade and ambient temperature. However, it should be stressed, that in modern phytotherapy the use of borage seed oil is only recommended [10].

The analysis with use of gas chromatography connected with mass spectrometry (GC-MS) allowed to mark 16 volatile compounds in the seed oil of *Borago officinalis* [5-9], among others: β -caryophyllene (26%), p-cymene-8-ol (19.7%), small amounts of nonadecane (0.7%) and hexanol (0.7%). There are also large amounts of oil monoterpenes (17.2%) and sesquiterpenes (26%). In addition, fatty acids have been isolated such as: γ -linolenic acid (10–28%), linoleic acid (35–40%) and α -linolenic acid (4–5%). In the extract from seeds the presence of rosemary acid in the amount of 1.65 mg/g dry weight has been noted [5-9]. De Haro et al. have shown that plants of this species blooming blue among all tested genotypes had a lower concentration of γ -linolenic acid compared with plants with white flowers [7]. In the seed oil of *Borago officinalis* (24.2%) oleic acid and erucic acids were also identified [8, 9].

Presence of linoleic acid and γ -linolenic acid (GLA) in borage oil seems to be of a great importance due to the fact that these compounds are classified as higher unsaturated fatty acids (Ω -6). Human organism is not capable to synthesize them, because does not produce appropriate enzymes. Therefore, supplementation of them is important [5]. The lack of these compounds leads to disorders in the construction and function of nervous system, infections, diseases of cardiovascular system and even cancer. The oil compounds included in borage are involved in the synthesis of eicosanoids, hence they can be used adjunctively in the treatment and prevention of atherosclerosis. In addition, they are also involved in the regulation of metabolism. However, too high concentration of these compounds leads to many disorders, including pro-inflammatory and allergenic reactions and also causes increased blood clotting.

Borage herb contains changeable quantities of pyrrolizidine alkaloids (likopsamine, supinidine, amabiline, intermedine) having a toxic effect particularly on

liver parenchymal [1]. Their carcinogen activity based on the genotoxic mechanism of action has been shown in the studies carried out in animals [10]. However, the oil obtained from the ripe seeds of borage by cold pressing is devoid of these toxic compounds that do not pass to this oil during the production process. In the chromatographic studies, Gudej and Tomczyk noticed the presence of many phenolic acids (vanillic acid, *p*-coumaric acid, *p*-hydroxybenzoic, gentisic acid, caffeic acid, rosmarinic acid, chlorogenic acid), scopoletin and flavonoids (including quercetin, isorhamnetin, kaempferol) [4, 10, 11]. In addition, borage herb contains almost 20% mucous compounds, tannins (3-5%), mineral salts (including soluble silica 1.5–2.2%, calcium and potassium nitrate 3%), organic acids (ascorbic acid, malic, citric, acetic acid, lactic acid), saponins, allantoin (0.5–1%), vitamins, choline, bornesitol, cyjanogenic compounds (15 mg HCN/kg) and tocopherols [8, 12, 13].

Leaves of *Borago officinalis* L. contain organic acids, mucus, carotene, and a small amount of potassium nitrate [11]. However, it should be mentioned that full chemical composition of this plant has not been exactly determined so far.

ACTIVITY OF *BORAGO OFFICINALIS* L.

The results of recent studies show that *Borago officinalis* L. can be successfully used adjunctively in disorders of the respiratory system, urinary tract, in metabolic disorders, gout, arthritis and skin diseases and also relieving menopause discomfort.

Dietary supplements are used extensively all over the world. According to current definition, a dietary supplement is a product composed of nutrients and used as additional food. According to the definition of the Food Safety and Nutrition Act of 25 August 2006 (Dz.U.06.171.1225), the supplements are “foodstuffs, whose purpose is to supplement the normal diet, which are the concentrated sources of vitamins and minerals, or other substances with a nutritional or physiological effect (...)”. They are sources of vitamins, minerals or other substances that are produced and marketed in the form of tablets, capsules, powder or liquid. It is considered that they reduce the risk factors of many diseases [14]. Components of dietary supplements can be raw materials originating from animals and plants. However, the most commonly used are plant products and extracts.

Due to the fact that dietary supplements are foodstuffs, it is assumed that they do not need to meet the requirements of medicinal products. The properties of ingredients used for the production of supplements are different, some of them may cause the undesirable effects if they are consumed in too large quantities. It seems, therefore, that not only we can pay attention to the qualitative dietary supplements, but also on their quantitative composition and dose related to the safety of these products [15].

Due to the content of biologically active compounds, *Borago officinalis* L. is used for the production of the supplements. It is also a plant frequently added to food

[16]. Like ginseng and *Ginkgo biloba*, borage is used as natural medicament in the improvement of the intellectual processes. It is believed that the plant remedies in conjunction with conventional treatment and intellectual exercises based on the fluency exercises and activation of the memory records, improve memory in about 35% of people over the age of 90 [17]. GLA in the oil guarantees proper construction of the membranes of neurons which comes to the correct receiving and transmitting of nerve stimulus. Prof. Paulin Moszczyński argued that clinical studies have confirmed that borage oil (*Boraginis oleum*) supplementation relieves the symptoms of cerebral atherosclerosis in at least 30% of people [17]. In addition, an increase of the concentration and memory of direct events and reduction of the emotional changeability was noted.

Recently, it was reviewed that also the dried flower of borage can be valuable in the treatment of obsessive compulsive disorder (OCD) [18, 19]. Results of the study performed in 44 patients with diagnosed OCD in a six-week, placebo-controlled, double blind, parallel-group trial showed the beneficial anxiolytic effect (a significant reduction of anxiety with a 10 point reduction in the Hamilton Anxiety Rating Scale (6.5 point difference over placebo at endpoint)). It can be positive as comorbid, generalized anxiety, common in sufferers from OCD [18, 19].

Rheumatoid arthritis (RA) is one of autoimmune diseases. The symptoms of this disease are: morning stiffness, swelling (inflammation) of the joints comprising at least 3 or more joints, changes in wrists, metacarpus or in fingers, typical radiographic changes, rheumatoid nodules, and the presence of rheumatoid factor. In 1994, Leventhal et al. [20] published the results of the randomized double-blind study. The aim was to assess the effectiveness and adverse effects during the intake of plant oils containing essential unsaturated fatty acids used incidentally in relief of joint inflammation and tissue damages. The group of 37 patients was tested with all the symptoms of RA, along with inflammation of synovial membrane. During the treatment, borage seed oil containing 1.4 g/d GLA was administered in patients and cottonseed oil as a control. After 24 months, a reduction in symptoms of disease activity ($p < 0.05$) has been reported: the decrease of soreness of joints by 36% and reduction of swelling of the joints by 41% as compared with control group as a result of taking borage oil. The results of this study confirm that use of GLA is effective in the treatment of RA. No adverse effects were observed during borage oil intake. Also recent studies conducted on borage seed oil have positive results and may warrant further investigation [21]. Summarizing, there is moderate evidence that oils containing GLA (e.g. borage) can afford some benefit in relieving symptoms of RA [22].

Due to the high content of γ -linolenic acid, the products containing *Borago officinalis* can also be successfully used in the treatment of dermatological diseases. Atopic dermatitis (AD) is based on the genetic changes. This disorder appears spontaneously and there is no possibility to eliminate it permanently. Many specialists recommend the use of oil from *Borago officinalis*, as it is safe and accelerates the regeneration of the skin in patients with AD due to the content of

GLA [8]. According to published data concerning unsaturated fatty acids, they may be effective in relieving the discomfort associated with AD, however, not all results confirm their effectiveness. In 2003, Takwale et al. carried out a randomized double-blind study in order to evaluate the efficacy and safety of borage oil in AD treatment [23]. Capsules containing borage oil (920 mg) were administered in 84 patients twice daily for 12 weeks. After this time, it was found that the use of borage oil in children and adults with atopic dermatitis does not change the severity of symptoms as compared with *placebo* [23]. However, the authors suggest that in this case time of treatment might be too short.

Products rich in GLA are recommended to patients with skin problems. After prolonged use, the improvement in the appearance of skin and hair was noticed. Hence, borage oil is a common ingredient of cosmetics used in the care of dry and sensitive skin and skin with acne. It has anti-inflammatory, anti-abscess and black-head action, it prevents acne affecting the production of sebum both qualitatively and quantitatively [24].

Seborrheic dermatitis (SD) affects 1–3% of the population and is one of common inflammatory skin diseases. Mostly young people get sick, especially males, but it may also appear in infants. These diseases are difficult to treat due to its recurring nature. The etiology of SD is not known properly, although, it is considered that both internal (genetic predispositions, immunological disorders), and external factors (air pollution, skin irritation, poor hygiene of the body) are involved in its development. However, some patients require usually long-term and cumbersome treatment [25]. The study carried out in Sweden included a group of 48 newborns fully meeting the criteria of SD, in whom borage oil has been used in the treatment of local skin changes [26]. On these children, medically assisted treatment was applied using hydrocortisone, antifungal drugs and moisturizing preparations, without visible effects. In this study, borage oil was applied locally (to 5 ml) on the affected skin twice a day. After 10–12 days from first application the skin became free from the lesions, even in places in which the essential oil was not applied. Discontinuation of the treatment led to the relapse of the disease within a week, while the prophylactic use of essential oil 2–3 times a week protected the skin from disease relapse. During the treatment no side effects were observed. The authors of the study confirm that preparations containing GLA in its composition are an effective remedies against SD [26].

In The Institute of Gerontology in Germany the study assessing the parameters of the skin: epidermis water loss and metabolism of fatty acids in elderly people as a result of the consumption of borage oil was carried out [27]. The study group was composed of 29 volunteers – people aged 54 to 84 without any symptoms of diseases. *Borago officinalis* oil was administered in the form of gelatin capsules of 360 mg or 720 mg a day for two months. Before starting the treatment, 10 people were complaining on the itching of the skin. After a month of the oil intake only one person reported the presence of itching. After the treatment, this ailment has

passed on completely in all patients. The water content of the *stratum corneum* was assessed using the transepidermal water loss test (TEWL) – there has been a slight increase in the horny layer. After 2 months of supplementation with oil the improvement of the protective functions of the skin by 10.8% was observed. The dryness of skin has been reduced from 42% to 14% in persons using capsules containing borage oil. Studies have confirmed that use of oil leads to changes in the construction of the protective sheath of the skin. The changes concern the construction of lipid layer membrane of erythrocytes. The increase in the content of GLA to 70% and dihomog- γ -linolenic acid (DHGLA) to 18% as well as increase in the ratio of DHGLA to arachidonic acid by 23% and the decrease of the content of saturated and monounsaturated fatty acids were observed. These studies confirm the validity of the application of borage oil in order to improve the metabolism of phospholipids and the function of the skin [27].

Antioxidant action of borage is not medically proven. It is known that borage oil has a limited antioxidant activity, although, in conjunction with oil from sea animals that includes higher unsaturated fatty acids their operation is significantly higher [8].

The juice and fresh herb are used externally in cosmetics in the form of rejuvenating and nutrients masks. It is believed that the juice is responsible for inflammation removal and promotion of the regeneration of the skin, however, the ointment from the fresh herb is effective in treatment of eczema and wounds [13]. The most common use of oil in cosmetology are capsules. The regular intake affect favorably the structure of hair and condition of nails. There have been positive steps to increase the flexibility, anti-wrinkle, firming, and also slightly exfoliating activity, due to the content of citric acid and malic acid.

In recent years, increasing interest in “functional foods” has been noted. The addition of herbs to food not only gives the taste, fragrance and aesthetic but also reveals the specified physiological action. The main goal is the improvement of health, well-being and reduction of the risk of diseases development [28]. Bioactive substances can be used in food including, among others, unsaturated fatty acids, vitamins, pre-and probiotics [29]. It can be received using conventional methods, as well as biotechnologically modified [30]. In Poland, several studies were carried out on the possibility of the implementation of borage oil to margarines and oil dressings. However, despite the greater availability of these products, they are targeted to more affluent customers, for example in USA and Japan.

The presence of certain substances responsible for the pharmacological activity is desirable and useful, but also the presence of toxic substances is hazardous. *Borago officinalis* L. next to desired pharmacological compounds also contains pyrrolizidine alkaloids with mutagenic and hepatotoxic activity. In particular, their consumption is prohibited for pregnant women due to their adverse effects on the fetus development [31]. Toxic action of these compounds was published by Roulet et al. [32]. They described the case of death of a newborn in 37th day of life. The interview with the mother of the child has shown

a large amount of the consumed herbal teas containing *Tussilago* during pregnancy. Subsequent analysis of the composition of consumed tea made using thin layer chromatography confirmed the presence of pyrrolizidine alkaloids in the amount of 0.6 mg.

Recently, a case report on status epilepticus in a patient who consumed borage oil for one week was published. Therefore, the use of the borage in some conditions should be considered cautiously [33].

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OGÓRZECHNIK LEKARSKI (*BORAGO OFFICINALIS* L.) – WARTOŚCIOWA ROŚLINA LECZNICZA STOSOWANA W ZIOŁOLECZNICTWIE

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Streszczenie

Przez lata w obrębie kultury europejskiej stosowanie ziół w leczeniu różnych dolegliwości było zjawiskiem powszechnym. Obecnie fitoterapia jest sposobem wspomagania typowej farmakoterapii różnych schorzeń. Wśród przeszło dwudziestu tysięcy roślin posiadających właściwości terapeutyczne jest również ogórecznik lekarski (*Borago officinalis* L.). Wyniki wielu badań wskazują, że *Borago officinalis* L. jest rośliną zielarską, która może być wykorzystywana do leczenia schorzeń układu oddechowego, dróg moczowych, chorób reumatoidalnych czy skórnych. Szczególnie biologiczne aktywne związki zawarte w oleju z ogórecznika lekarskiego mogą być stosowane pomocniczo w leczeniu miażdżycy jak i regulacji symptomów niektórych schorzeń metabolicznych.

Słowa kluczowe: ogórecznik lekarski, substancje biologiczne aktywne, leczenie wspomagające, układ oddechowy, drogi moczowe, choroby reumatoidalne, schorzenia dermatologiczne, ośrodkowy układ nerwowy