

## Summary

### **Raw material and technological conditions in shaping the bioactive potential of products obtained from elderberry**

Black elderberry (*Sambucus nigra* L.) is a common species, the raw materials of which have been used for centuries in folk medicine and home food processing, and are currently increasingly used in the food, pharmaceutical and cosmetic industries. Numerous scientific studies indicate a high content of bioactive compounds, including, among others, phenolic compounds, which determine the health-promoting properties of elderberry. Fruits, flowers and other raw materials of elder are attributed to, among others: antioxidant, antiviral, antibacterial, cardioprotective and antidiabetic effects. The aim of the study was to assess the impact of selected environmental factors and technological conditions on the bioactive potential and physicochemical parameters of elderberry raw materials and products. The tested raw materials included flowers, fruits and leaves of black elder, which came both from the natural state (wild shrubs) and from commercial plantation (cultivated varieties), and were obtained in three harvesting seasons. Additionally, the fruits were harvested taking into account two stages of ripeness. The flowers and fruits were used to prepare „own” products, which included dried flowers, juices, syrups and alcoholic tinctures, with some products produced using different methods and in different variants. In addition, selected commercial products made from elderberry flowers and fruits were also analyzed. As part of the research carried out, selected physicochemical parameters (dry matter and extract content, pH, fruit weight, color parameters), antioxidant activity, total phenolic and anthocyanin content, phenolic and anthocyanin profile, ash and selected minerals content and sambunigrin content, as well as antimicrobial activity against selected bacterial strains were determined in the raw materials, extracts and products.

Based on the results obtained, it was observed that the type of raw material, its origin, variety and degree of ripeness, as well as the harvesting season and the technological processes and methods used, generally had a significant impact on the measured parameters and bioactive properties of elderberry raw materials and products. The leaves were characterized by a higher polyphenol content than flowers and fruits obtained from analogous locations and cultivars, while flowers showed the lowest antioxidant activity. The dominant compounds in flowers and leaves were rutin and chlorogenic acid, while anthocyanins such as cyanidin-3-glucoside and cyanidin-3-sambubioside predominated in fruits. The flowers had a higher content of most minerals than the fruits, with calcium dominating in the flowers and

magnesium in the fruits. The highest concentration of sambunigrin, representing potentially toxic cyanogenic glycosides, was found in leaves, significantly lower in flowers, and the lowest in fruits. Raw materials from cultivated varieties were characterized by higher antioxidant activity and total polyphenol and anthocyanin content compared to raw materials obtained from wild shrubs. In terms of fruit, the 'Haschberg' cultivar was rated highest, and for flowers and leaves – the 'Sampo' cultivar. Fully ripe fruits had higher weight, extract content, pH, antioxidant activity and total polyphenol and anthocyanin content, and at the same time lower sambunigrin content than less ripe fruits. Raw materials collected in the season with more sunny hours and lower total precipitation were characterized by higher bioactive potential and extract content in the fruit, which at the same time had a lower weight in relations to raw materials from the less sunny but more rainy season. The process of drying flowers significantly reduced their antioxidant activity and total phenolic content. Thermal treatment of fruit pulp (60/80°C) resulted in a significant increase in the bioactive potential and a darker color of the juices, however it led to a decrease in the efficiency of the juice pressing process and an increase in the sambunigrin level compared to cold-prepared juices. The pasteurization process contributed to an increase in the values of the measured parameters compared to unpasteurized juices. The elderberry juices obtained showed antibacterial activity against *Bacillus subtilis* and *Streptococcus mutans*. The influence of pasteurization conditions on the quality of juice was confirmed in an experiment in a model system, in which the effect of temperature and process time was analyzed using the response surface method. The pasteurization temperature had the most significant impact on the antioxidant activity, anthocyanin and sambunigrin content, with the most favorable values of these parameters recorded at 72,5°C. Among the elderberry products examined, juices had the highest bioactive potential, and at the same time, the „own” products were characterized by a higher antioxidant potential and the content of health-promoting compounds, in particular anthocyanins, than similar commercial products.

**Keywords:** elderberry, *Sambucus nigra*, antioxidant activity, polyphenols, anthocyanins, bioactive compounds, juices

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