

### 4.3. Streszczenie w języku angielskim (*Abstract*)

*Sambucus nigra* L., known as the black elderberry, is a species of the Viburnaceae family native to Europe and West Asia (Waswa et al., 2022). In medicine, the healing properties of its flowers and fruits are mainly used. They have a diaphoretic and antipyretic effect and are used to relieve the symptoms of common cold (Młynarczyk et al., 2018). However, in folk medicine elderberry leaves have also been used, mainly externally, for the treatment of wounds, burns and inflammatory skin conditions (Menendez-Baceta et al., 2014). So far, their activity and chemical composition have not been studied in detail.

The main aim of this study was to perform a phytochemical analysis and to investigate the biological activity of elderberry leaves extracts in relation to their traditional use in skin diseases.

In the first part of the work, four extracts of *S. nigra* leaves were prepared - aqueous and 70% (v/v) ethanolic at room temperature and at the boiling point of the solvent. They were subjected to qualitative and quantitative phytochemical analysis using UHPLC-DAD-MS<sup>n</sup> and HPLC-DAD methods, respectively. Subsequently, their antioxidant and anti-inflammatory properties were evaluated by studying the effect on radicals scavenging in *in vitro* systems (DPPH, H<sub>2</sub>O<sub>2</sub>, NO, O<sub>2</sub><sup>·-</sup>), inhibition of lipoxygenase activity, and reduction of secretion of reactive oxygen species (ROS) and inflammatory mediators (TNF- $\alpha$ , IL-1 $\beta$  and IL-8) by human neutrophils *ex vivo*. Phytochemical analysis showed that the extracts were dominated by phenolic acids and flavonoids. The 70% (v/v) ethanolic extract prepared at room temperature had the highest content of the major chemical compounds - isomers of caffeoyl-threonic acid, chlorogenic acid, quercetin and kaempferol derivatives. The results of *in vitro* tests indicated a strong antioxidant effect of the tested extracts, mainly against nitric oxide. *Ex vivo* studies showed that the extracts exert a potent and concentration-dependent inhibitory effect on the release of ROS and TNF- $\alpha$  by neutrophils isolated from blood stimulated with f-MLP and LPS, respectively (Skowrońska et al., 2022).

Based on the results obtained in the first step, the 70% (v/v) ethanolic extract prepared at room temperature was selected for further investigation. This extract had the highest content of main ingredients, exhibited a strong antioxidant effect *in vitro*, and demonstrated significant anti-inflammatory activity *ex vivo*, while having the lowest negative impact on cell viability. The extract was prepared on a larger scale and then fractionated using solvents of increasing polarity: dichloromethane, diethyl ether, ethyl acetate, and n-butanol. The composition of the extract, individual fractions, and aqueous residue was qualitatively assessed using the UHPLC-DAD-MS<sup>n</sup> method. Chemical compounds were isolated using column chromatography and preparative liquid chromatography methods. Eleven substances were obtained and identified using <sup>1</sup>H NMR spectra. These compounds belong to the groups of flavonoids, phenolic acids, lignans, and cyanogenic glycosides.

To verify the traditional use of elderberry leaves in treating wounds and inflammatory skin diseases, a basic research was carried out on the extract and its fractions. Their impact on the inflammatory response of cells present in the skin, the migration of keratinocytes to the site of injury, and the activity of enzymes involved in the skin repair processes were analyzed. Research has demonstrated that the extract and certain fractions can expedite wound closure by epidermal cells and decrease their secretion of chemotactic interleukin 8. Additionally, the extract and fractions exhibit anti-inflammatory properties on human skin fibroblasts, reducing the release of interleukins 6 and 8. The substances were found to inhibit enzyme activity, with the strongest effect observed on collagenase and lipoxygenase (Skowrońska et al., 2024).

In summary, the research presented provides partial justification for the use of elderberry leaves in folk medicine for treating wounds, burns, and inflammatory dermatological diseases. The work also involved developing three models for testing the inflammatory response on skin cells, which are now routinely used in the scientific work of the Department of Pharmaceutical Biology.

Additionally, a literature review was conducted on the use of natural products in treating burns and sunburn. Clinical trials and animal studies published between 2010

and 2022 on the effects of individual botanicals and their mixtures on the healing of burns and sunburn were compiled and evaluated (Skowrońska and Bazyłko, 2023).