

## **The use of hawthorn (*Crataegus* L.) for the production of concentrated plant preparations with a high content of biologically active compounds**

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### **Summary**

Products with health-promoting properties constitute a sought-after and systematically expanded segment of the food market. The requirements for producers by the market of food products with health-promoting features enforce the development of research on improving the composition, form and action profile of nutraceutical preparations, available in the form of powders, capsules and food enrichment agents.

The aim of the study was to assess the possibility of using hawthorn for the production of preparations in the form of a separated and concentrated fraction of polyphenolic compounds. Fruits, leaves and flowers of six species of hawthorn (*Crataegus* L.) were selected for analysis. In the first stage of the research, optimization of the extraction conditions was carried out in order to select the most appropriate solvent and process conditions guaranteeing the greatest recovery of polyphenolic compounds and antioxidants from the plant matrix. In the next stage of work, the isolation of polyphenolic compounds from hawthorn with the use of silica and polymer sorbents was carried out. The obtained preparations were assessed for the content of polyphenols, flavonoids, proanthocyanidins, quantitative and qualitative polyphenol profile (UPLC-MS / MS method), antioxidant activity (ABTS test, CUPRAC test, metal ion chelation test, test for capturing superoxide anion radicals and hydroxyl radicals) and physico-radical properties. -chemicals (pH, equilibrium humidity, water solubility). The cytotoxic activity against neoplastic cells was also assessed and the mechanisms of action were determined.

It was found that the most suitable solvent for the extraction of secondary metabolites from hawthorn is 50% and 70% aqueous ethanol. The extracts obtained with the use of these solvents, after 2 and 24-hour extraction, were characterized by the highest content of biologically active ingredients isolated from hawthorn fruits, leaves and flowers.

It was found that the preparations obtained from the RP-18 silica bed were characterized by the highest content of polyphenols, flavonoids and proanthocyanidins as well as the highest antioxidant activity. On the other hand, the preparations obtained from polymer beds were significantly less rich in the analyzed compounds. The preparations isolated with the use of the RP-18 sorbent were also characterized by the richest polyphenol profile in terms of

quantity and quality. The content of polyphenolic compounds was higher in preparations of fruits (2.5 times on average), leaves (2 times on average) and flowers (1.5 times on average) compared to polymer sorbents. On the other hand, the assessed physical and chemical parameters of the preparations were comparable within the tested deposits and indicated their high functional properties.

On the basis of the obtained results, a preparation from the fruits of *C. laevigata* x *rhaphidophylla* x *monogyna* and preparations from leaves and flowers of *C. monogyna*, characterized by high suitability for the production of nutraceuticals due to the content of polyphenolic compounds and antioxidant activity, were selected. In vitro studies of the antitumor activity of selected preparations showed the strongest cytotoxic activity against the U87MG glioma cell line. The mechanism of the cytotoxic action was to promote apoptosis and to suppress the proliferative and invasive potential of neoplastic cells. The demonstrated effects were related to the high content of flavan-3-ols and phenolic acids.

The results obtained as part of the doctoral dissertation show that the isolation of biologically active ingredients from hawthorn fruits, leaves and flowers, through the use of solid phase extraction, allows to obtain preparations with a high content of pro-health compounds, characterized by high antioxidant and anticancer activity, and at the same time desired physico-chemical properties. The obtained preparations may constitute a more attractive, in terms of technology and health, substrate for the development of nutraceuticals with targeted pro-health effects.