

**Development of an innovative analytical system based on  
a comprehensive study of the composition of amino acids  
and dipeptides in multicomponent agri-food and medical matrices**

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## Abstract

This dissertation is dedicated to the optimization of testing methodologies for amino acids in diverse agri-food and medical matrices, with a particular emphasis on chromatographic techniques such as GC-MS, HPLC/DAD, and UHLC/MS/MS. The current state of the art includes well-developed analytical methods such as high-performance liquid chromatography (HPLC), gas chromatography (GC), UV/VIS spectrophotometry, infrared (IR) spectroscopy, and classical Kjeldahl and Dumas methods. However, each of the aforementioned methodologies has specific limitations in terms of sensitivity, specificity, and testing capabilities for different matrices. In response to these challenges, the paper identifies the optimal conditions for each method. The work included the selection of appropriate extraction conditions, the evaluation of the suitability of sorbents, and the optimization of chromatographic procedures. The objective of the experiments was to develop an analytical system that allows for the accurate and efficient study of amino acids and proteins in complex matrices. The objective of the research was to optimize separation and analysis methods, thereby increasing the efficiency and precision of measurements. In addition to the study of conventional agri-food matrices, particular attention was devoted to the adaptation of testing systems for the analysis of amino acids in waste matrices derived from the tanning industry. Derived from the tanning leather manufacturing process, shavings and trimmings were regarded as raw materials from which complete collagen value could be extracted. The resulting protein is suitable for utilisation as a raw material in the food and cosmetic industries. Additionally, novel food products from the novel food products sector were examined as part of the ongoing research. The findings of this research may have implications for the food and dietary supplement industries. The results obtained are of particular significance, particularly in light of the growing interest in healthy and safe protein products and vegan alternatives to animal protein. In recent years, there has been a notable increase in public awareness of healthy eating and the impact of diet on overall health, as evidenced by numerous surveys, including the "Dietary Behavior of Poles" survey conducted by CBOS in 2024. The improving economic situation has resulted in an increased demand for quality products, including dietary supplements and medicinal products. In countries with a high level of economic and social development, including Poland, the effects of an aging population and declining birth rates are becoming increasingly evident. The aging society is increasingly paying attention to healthy nutrition to maintain good physical condition and prevent age – related diseases. This phenomenon gives rise to an increased demand for technologies that facilitate the monitoring of nutrients, as well as research into novel food products, including functional foods and pharmaceutical preparations. The analytical system developed as part of this research project is intended to provide support to the agri-food and medical industries by offering tools for precise analysis of amino acids and proteins in a range of matrices.