

ABSTRACT

The habilitation thesis entitled "**Research on the Advanced Characterization of Plant-Based Matrices with Applicability in the Development and Characterization of New Food Products Obtained through Innovative Technologies**" synthetically presents the most relevant scientific results obtained by the author after being awarded the title of Doctor of Agronomy (2014) at USAMV Cluj-Napoca.

The main research area focuses on advanced characterization of bioactive compounds from plant matrices in the context of their valorization in innovative food products, with an emphasis on their quality. *The thesis is structured into three main parts: A. Scientific and Professional Achievements, B. Career Development and Evolution Plan, C. Bibliographic References*

Section A presents the scientific and professional achievements, reflected through significant results obtained in academic activities, research projects coordinated as a project leader, and relevant publications. It is structured into three main research directions:

Studies on the advanced characterization of extracts obtained from various fruits with applicability in the food industry. Optimization of technologies for the valorization of alternative raw materials in various food products

Development and characterization of new food products obtained through the application of innovative technologies

The first main research direction (Chapter 1) This section consists of Studies on the advanced physico-chemical characterization and the application of chemometric techniques and IR spectroscopy on extracts obtained from various plant-based matrices with applicability in the food industry. It is structured into four subchapters.

Subchapter 1.1 This subchapter focuses on the comparison and chemometric classification of 22 apple genotypes based on texture analysis and physico-chemical quality attributes. The apples used come from highly diverse genotypes and origins. For instance, some are at different ripening stages, have distinct geographical backgrounds, belong to either "classic" or "modern" varieties, and are either well-known worldwide or newly developed local cultivars. Some apples represent ancient or ancestral forms of modern varieties, serving various purposes—either consumed as fresh fruit or suited for processing in the food industry.

Subchapter 1.2 This section presents the significant results obtained from Studies on the physico-chemical and antioxidant properties of *Sambucus nigra* L. and *Sambucus nigra* Haschberg during growth stages: from buds to ripe fruits. The aim of the study was to examine how genotype and maturity stage influence phenolic compounds, antioxidant capacity, and the mineral profile of the plants. These findings contribute significantly to profiling the bioactive compounds of new natural resources from the common elderberry shrub, from buds to fruit ripening. The chemical composition of the studied vegetative parts of *Sambucus* recommends it as an important source for nutrition and health.

Subchapter 1.3 This subchapter focuses on Quantitative analysis by HPLC and prediction using FT-MIR technique of individual sugars in plums harvested during fruit growth and development. Studying the dynamics of

sugar accumulation in plums harvested at different growth stages will open new ways to utilize fruits resulting from physiological drops. Additionally, a direct FT-MIR analysis method will provide significant contributions, as understanding individual sugar concentrations during plum growth is essential for selecting appropriate valorization pathways (e.g., direct consumption, juice production, fermentation, extraction of antioxidants, pigments, etc.). Furthermore, a direct method for determining sugar concentrations in various qualitative plum juice assortments will be useful in future genetic and breeding research, especially for monitoring sugar content in fruits obtained from new hybrids during development.

Subcapitolul 1.4 This section focuses on the advanced characterization of extractive products (alcoholic and aqueous extracts) obtained from plum fruits. It presents studies on the evolution of biochemical compounds (polyphenols, flavonoids, anthocyanins, chlorophyll, carotenoids, volatile compounds, starch, sugars) and physico-chemical indices during the developmental stages of plum fruits. A better valorization of plums, depending on variety and harvest time, can be achieved by identifying and quantifying volatile compounds, as well as understanding their accumulation dynamics during the ripening process.

The Second Main Research Direction (Chapter 2) This chapter focuses on the characterization of the nutritional composition of alternative plant-based raw materials and the optimization of technologies for their valorization in various food products. It is structured into two subchapters.

Subchapter 2.1 This section presents the results on the nutritional composition characterization and optimization of technology for obtaining alternative plant-based cocoa powder sources. The aim of this study was to replace cocoa powder with acorn powder to create an innovative product that does not contain nervous system stimulants. Additionally, aqueous extracts obtained from the resulting acorn powder were evaluated in vitro for total polyphenol content and antimicrobial and antiproliferative properties.

Subchapter 2.2 This subchapter focuses on the bioconversion of alternative plant-based raw materials to diversify and fortify new food products. It includes studies on the use of avocado seeds as an alternative to coffee to increase avocado consumption and reduce pollution and food waste. The study results showed that roasted avocado seed powder and the resulting beverage have antioxidant and anticancer properties. Additionally, studies were conducted on valorizing by-products from mango fruit consumption (peel and seed) to include them in biscuits. The goal was to expand the range of available products and obtain fortified products with bioactive compounds. Another study by our research team involved the superior valorization of hawthorn fruits harvested from Romania's wild flora to obtain hydro-alcoholic extracts suitable for use in various products. Consequently, tonic wines were developed and characterized as new types of beverages.

A collaborative study with my research team aimed to develop a product rich in bioactive compounds by creating and characterizing a new ingredient derived from sea buckthorn and blueberry by-products. This ingredient, in powder form and rich in nutrients, fibers, and vitamins, can be used in biscuit-type products. An important and highly applicable study focused on valorizing pine shoots at three developmental stages in a popular consumer product—jellies rich in phytochemicals.

The Third Main Research Direction (Chapter 3) This chapter focuses on Research on technological optimization, texture, and sensory characterization of innovative food products rich in bioactive compounds, and includes 4 subchapters.

Subchapter 3.1 This subchapter refers to Research on the functionality of muffins fortified with apple pomace: nutritional, textural, and sensory aspects. The aim of our study was to valorize apple pomace in bakery products like muffins. The objectives of this study were as follows: (i) to evaluate the functional properties of by-products and powders from apples, developed from this flour, (ii) to examine the antimicrobial potential and cytotoxic and anti-proliferative potential of apple pomace and its volatile compounds, (iii) to assess consumer acceptability and perform texture analysis of the muffins.

Subchapter 3.2 This subchapter refers to the influence of fenugreek flour (*Trigonella foenum-graecum* L.) on improving the techno-functional properties of wheat flour. The aim of this study was to characterize composite flours made from wheat and fenugreek to assess their suitability for bread production. For this purpose, physico-chemical, textural, microbiological, and sensory characterizations of bread made from wheat flour supplemented with fenugreek flour were conducted.

Subchapter 3.3 This subchapter refers to the manufacturing technology and quality control of baby purees obtained from ten different apple varieties and vegetable blends. The goal of this study was to develop purees from ten autumn apple varieties and a vegetable blend (carrots, pumpkin, and celery), which are ideal for children's nutrition.

Subchapters 3.4 and 3.5 These subchapters refer to patents: Nutritional bar composition based on dried seed germ flour from *Cucurbitaceae*, *Asteraceae*, and *Amaranthaceae* families *Compositions* for nutritionally optimized sugar products.

The author's entire professional period, carried out after defending his doctoral thesis, was marked by scientific achievements with applicability and impact in food engineering. The author's activity after defending his doctoral thesis resulted in: 2 specialized books and 4 chapters in books published by international publishers; 3 textbooks and teaching guides, 3 Patents, 37 ISI Web of Science indexed papers (14 ISI main author), 40 BDI articles, 8 research projects (2 as director/project manager), over 60 awards obtained at Invention Salons and 18 ISI award-winning papers. The author's international visibility is quantified by the Hirsch index according to Web of Science (13), (18) according to Google Scholar and (13) according to Scopus.

In the last part of the thesis the evolution and career development plans are presented, as well as the future directions of research.