UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE
CLUJ-NAPOCA
DOCTORAL SCHOOL: AGRICULTURAL SCIENCES ENGINEERING

HABILITATION ABSTRACT

RESEARCH ON THE PRODUCTION, PROCESSING AND UTILIZATION OF PLANT AND ANIMAL RAW MATERIALS FOR THE QUALITY AND ENERGY OPTIMIZATION

Domain: AGRONOMY

Author: Associate professor Mircea Valentin Muntean

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ABSTRACT

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The habilitation thesis summarizes the most significant scientific and academic results obtained after the doctoral studies. In accordance with the methodology for developing the qualification thesis, the qualification thesis is structured in three chapters: in the first chapter the academic and professional career is described, oriented towards three main directions: educational activities, research activities and institutional activity. In the second chapter, the most relevant research results are briefly presented, obtained through collaboration, both with departmental colleagues and following interdisciplinary collaboration with colleagues from the Faculty of Agriculture, the Faculty of Animal Husbandry and Biotechnology and the Faculty of Food Science and Technology. In the third chapter, the development plan of the academic career in the future is presented, with the following objectives: the development of teaching, learning and evaluation methods; attracting financial resources for research; the continuation of the research activity and its expansion to partners from the private sector.

In the first chapter, I presented in dynamics, the academic and professional evolution, after my integration in the collective of the Department of Mechanization of the Faculty of Agriculture in 1999 and in the Department of Technical Sciences and Soil Sciences in 2012 and currently.

Following the competition for the position organized by the Faculty of Agriculture in June 1999, I entered the position of university assistant professor in the Department of Mechanization. As a previous activity, I mention that from 2005 to 2009 I held the position of technologist engineer within the company S.C. Armatura S.A. from Cluj Napoca.

From 1999 to the present, we promoted the didactic degrees from assistant professor to university lecturer in 2016. The didactic activity started with the teaching of practical works and courses for students from the following specializations within the University of Agricultural Sciences and Veterinary Medicine: Agricultural Products Processing Technology, Food Products Control and Expertise, Food Products Engineering, Machinery and Plant Operation for Agriculture and Food Industry, Environmental

Engineering, Mountainology, Forestry.

During this period, I managed to perfect my didactic and professional activity through a rich scientific documentation, especially after enrolling and graduating from the doctoral studies at the Transilvania University in Brașov in 2005 with the theme "Optimization of the distillation process of raw cereal through automation the working regime of the machines". After completing my doctoral studies, I participated in specialization internships with the aim of accumulating new knowledge and practical skills, to improve myself in my field of activity. I also contributed to the organization and endowment of the material base of the taught subjects, to the creation of didactic and experimental installations for the most realistic exemplification of the taught notions, as well as to the modernization of the educational process with the students, respectively to the guidance of the Student Scientific Circles of the taught fundamental subjects .

The results of the didactic activity were realized through the publication of 10 didactic manuals, of which six courses (three as the first/single author) and four manuals of practical works (two as the first author) and two specialized books. I also coordinated 25 undergraduate papers for students from the Faculty of Agriculture and later 15 papers from 2012 for students from the Faculty of Food Science and Technology from the specializations Agricultural Products Processing Technology, Food Products Control and Expertise, Product Engineering Supply and Operation of Machinery and Installations for Agriculture and the Food Industry within the Faculty of Agriculture.

The research activity was carried out in parallel with the didactic activity. I was actively involved in the research activity carried out within the department as well as in the department, initially participating as a member in the research projects coordinated by Prof. Dr. Drocaș Ioan, Prof. Stănilă Sorin and Prof. Ranta Ovdiu. Within these research contracts, I gained experience regarding teamwork, managing research objectives and activities, and how to report the results obtained. This knowledge contributed to the possibility of coordinating 2 research projects as director or project manager, with the business environment. Total sums attracted as director/responsible for research projects are 118,250 RON.

During the teaching and research activity at the Faculty of Agriculture Cluj-Napoca and in collaboration with colleagues from the Faculty of Food Science and Technology, Animal Husbandry and Biotechnology, I published 74 scientific papers in specialized magazines from the country and abroad, of which 7 in ISI indexed journals (1 as main author, 1 as first author and 1 as corresponding author) and all 7 are published since the last promotion – cumulative FI 19,333; At the same time, I am the main author, corresponding author or co-author of 8 papers indexed by ISI proceedings and 58 indexed by BDI (of which 23 are first author). Based on the citations of scientific works (61 Google Scholar and 56 WOS), the Google Scholar Hirsch index is 7, and in the case of ISI Web of Science it is 3.

The second chapter, which presents the most relevant results obtained in scientific research after the defense of the doctoral thesis, is structured in five research directions.

In subchapter 2.1, with the title "*Methods for analyzing the physical properties of soils and the influence of climatic factors on obtaining fodder and the quality of certain varieties under drought conditions*", a study was carried out starting from the possibility of using a smart chemical sensor for the analysis specific soil parameters such as humidity, pH, soil respiration, enzyme activity, nutrient

requirements, etc., which aimed to optimize crops. After the analysis of the specialized literature, it was concluded that the optimization of the analyzes of specific soil parameters can be done with the help of a smart chemical sensor, but the calibration and recalibration must be performed in accordance with the specific data of the analyzed soils and can provide a unique measurement for different data interconnected to the analysis systems of soils. This chapter also presents a research on the analysis of the influence of climatic factors on some plant varieties and a study on the effects of the addition of botanical ingredients on bioactive compounds and the quality of non-alcoholic and craft beer.

In subsection 2.1.1. a research is presented in the specialized literature on the possibility of using a smart chemical sensor for the analysis of specific soil parameters. Among the soil properties that can be quickly determined are: moisture, pH, soil respiration, enzyme activity, air and gas in the soil, nutrient requirements, etc. Sensors that analyze these parameters can be resistive, capacitive, combined, electrochemical, ion-selective membrane sensors, respectively, and ion sensors.

In subsection 2.1.2. an experimental research carried out at the Jucu Teaching and Research Station was presented, the purpose of which was to determine the production capacity according to the soil moisture and the fuel consumption used by the working machines according to the two levels of hay production technology. The study was carried out on experimental plots with Festuca Arundinacea and spontaneous vegetation of the varieties Dactilys glomerata, Alopecurus pratensis, Festuca, Trifolium repens. Measurements were carried out in order to optimize fuel consumption, to determine the effective productivity of the aggregates, of the work qualitative indices such as: the working width of the aggregate, the uniformity of cutting the plants, the uniformity of the land, the loss of fodder when collecting the furrows, depending on the speeds of displacement.

In subsection 2.1.3. the production capacity, the content, the composition of the essential oil, as well as the content of polyphenols of the cultivars Origanum vulgare L. ssp. vulgare L. and Origanum vulgare L. ssp. hirtum (Link) Ietsw were analyzed in climatic conditions with higher than usual temperatures . These species were chosen for their antibacterial, antifungal, antioxidant, antiviral and flavoring properties that can change according to ecological and environmental conditions, even within the same species. The obtained results confirmed a phenotypic diversity and a pronounced variability of the quantitative traits in O. vulgare ssp. hirtum and O. vulgare ssp. vulgare both in the genotypes of each subspecies and in the significant differences between the subspecies regarding the content and qualitative and quantitative composition of the essential oil.

In subsection 2.1.4. aimed to assess the level of current information on the role of botanical ingredients on the final yield of bioactive compounds in specialty beer and how these molecules generally affect the sensory profile. At the same time, the estimated difficulties of implementing these ingredients are presented, taking into account the new processes and the relative cost. The addition of plants to the process of obtaining beer could improve the functional properties of the product, providing a unique aroma and, on the other hand, by adding variants in the field of craft beers and stimulating the production of craft beer. The study highlights the promising potential for the development and use of botanical ingredients as an additional source of bioactive compounds and increased antioxidant activity in the specialty beer segment.

The use of botanical ingredients could represent the next step in the development of specialty beer, providing breweries with strategies for a range of distinctive products.

In subchapter 2.2., with the title "*Modalities of analysis of raw material distribution devices, qualitative parameters and quality indices for direct seeding machines and soil processing through a single pass*" some aspects related to technologies are presented of tillage, superior to the previous ones and economically feasible in terms of sustainable agriculture. These represent the aspect that the research in the field of agricultural machines, of the adaptations that the new technical innovations and trends apply to comply with the modern requirements in the growth and development of crops.

In subsection 2.2.1. qualitative parameters are analyzed for machines that use no-tillage technology in working conditions, making a modification of the Romanian SPC sowing machine to be used in this technology. The machine was used in laboratory conditions in the soil channel of the University of Hohenheim, Stuttgart and on an experimental site of the USAMV Cluj Napoca, on soft alluvial soil according to SRTS - 200, in the Someșului Mic (Someşan Plateau). The experimental research focused on the analysis of some indices such as seed sowing precision (distance between seeds per row), average depth of seed embedment, opening/closing of the sowing trench. The conclusions of the determinations were that the influence of the soil tillage system is related to the moisture conditions in which a seed was placed and depends on the presence of plant residues, fertilizers on the soil surface, the impact on the development of the root system during germination and emergence has an influence on on the development of the root system, on the height of the plant and on the production achieved in the conditions in which the machine that was adapted for no-till technology respected the major quality assessment indices at sowing and that places the seeds in good conditions and the closing of the furrow is done in optimal conditions.

In subsection 2.2.2. a research on the optimization of no-tillage cultivation technology for crops with a greater distance between rows is presented. The aim of this research was to investigate the soil preparation for three disc coulters (one flat and two corrugated) at different sowing speeds (3, 8 and 11 km/h). Tests to analyze the influence of disc harrows were carried out at the Institut für Agrartechnik of the University of Hohenheim, Stuttgart, Germany on a soil channel and the working equipment was adapted to allow a precise setting and monitoring of the rotation speed of the ploughshare. power and torque. For the experiments, the soil was prepared with a rotary harrow and the soil was compacted with a compactor cylinder, the soil channel having an irrigation installation. Following the analysis of soil compaction, several conclusions were drawn, the most important of which would be that direct seeding is a technology that can contribute substantially to reducing energy consumption as well as crop production costs, ensuring a sustainable development of agriculture and optimization of no-till technology for soil preparation can also be done using a disc geometry designed by the authors and experienced in the soil channel.

In subsection 2.3. with the title "*Research on the influence of the working parameters of spraying machines, the degree of coverage and the reduction of environmental pollution when carrying out phytosanitary treatments*" starting from Plant Protection as one of the most important branches of plant production, the modernization of phytosanitary treatment machines represents an important aspect in the optimization of the works that are carried out to increase the productivity of work, the realization of good

quality works with an effect on the increase of the harvest and the decrease of production costs.

In subsection 2.3.1. in the experimental research, it was studied how the air speed is changed at different distances from the fan circumference of the phytosanitary treatment machine for orchards of the ATOM 1000 type, making determinations at different heights at a distance between rows of 3 m. The experimental tests showed that the speed of the air flow air is not constant at the same distance from the fan circumference being greater to the right (the direction of rotation is clockwise) at all measured distances and the changes in air flow along the fan circumference are greater at shorter distances (0 .5-1 m) over longer distances; the measured speed of the air flow decreases with the increase of the vertical height, the maximum being located at a height of 1 m; the direction of rotation of the fan speed results in an asymmetric distribution of the air flow on both sides of the fan and it is necessary to carry out studies on the construction of the fan casing to correct the asymmetry of the air flow created by the fan.

Also in this subchapter, the possibility of reducing environmental pollution and ensuring effective phytosanitary treatments in crops, which can be obtained through the constructive and functional modernization of phytosanitary treatment machines, was studied. In this sense, the variation of nozzle flow, liquid pressure and distribution uniformity for the EEP-600M phytosanitary treatment machine were studied, resulting in the flow and pressure on the nozzle being influenced by where the pressure hoses supplying the solution are connected to the section and the transverse uniformity and the flow of the nozzles can be improved by correctly connecting the pressure hoses that supply the solution to the sections.

The influence of the type of nozzle on the degree of coverage of plants when treated with phytosanitary solutions is presented in a research that aims to improve the degree of coverage using small amounts of active substances per hectare using a special double jet nozzle with the conclusions that jet nozzles double ensures the best degree of coverage on all parts of the plant, when moving at a lower speed.

In subsection 2.3.2. research is presented that looks at the optimization of precision spraying that could provide high coverage at lower chemical doses and coarse droplets, and in this way, the amount of product sprayed is reduced, due to the minimization of out-of-zone losses target and increased efficiency. The method of applying the protective treatments is hydropneumatic, and the experiments were carried out for 3 years between 2015–2017 in a vineyard near the city of Oradea, Bihor county, Romania. This study carried out in field conditions, verified the qualitative parameters of spray treatments in vineyards, under a pressure gradient (3, 5, 7, 9 bar) and height positions (0.8 m, 1.5 m, 2 .5 m) using water-sensitive paper. Based on the characterization of the volume median droplet diameter and spray coverages, it was determined that the best coverages and larger droplets tended to be deposited 1.5 m above the ground. By reducing drift, the amount of product sprayed is also expected to be reduced due to minimization of off-target losses. This can ensure the reduction of the negative impact on the environment.

In subsection 2.4. "*Research on the analysis of milk quality parameters starting from milking hygiene, the health status of dairy cows, feeding in order to sell milk at retail through dispensers*" Agriculture is closely related to other related fields without which an increase in the quality of life cannot be achieved through the products obtained from the processing of raw materials in these fields. Animal husbandry represents one of these fields that, together with the Food Industry, provides the products necessary for daily

food, fulfilling one of the basic requirements of human life.

In subsection 2.4.1. research carried out together with colleagues from the Faculty of Animal Science and Biotechnology for the increase of milk production starting from the improvement of the Romanian cattle breed through blood analysis from a hematological and biochemical point of view, the identification of errors in the feeding of lactating animals and which can produce metabolic and biochemical changes in lactating cows. A solution to improve the Romanian spotted cattle breed for milk production by crossing with specialized breeds such as Red Holstein was analyzed. To carry out the experiment, 2 batches of 50 cows were formed, which were kept in the same stables and had the same type of feed during the experiments. The females resulting from the crossings were individualized, recording certain characteristics on the computer files, including the production of milk and fat during lactation. The conclusions of the 18-month study revealed that the production of milk and fat is much higher compared to the experimental group for all lactations, the differences obtained being similar to the results of other authors.

Another aspect was materialized by another study regarding the evaluation of the health status of cows according to the hematological and biochemical profile of the blood in different stages of lactation. The aim of this study was to evaluate the metabolic and biochemical changes that occur during the colostrum period and regarding the number of lactations in cows. The biological material was represented by a total of 60 dairy cows from a farm in Sălaj County, Romania. The cows are all from the Holstein breed and did not show clinical signs of any specific pathology.

Blood samples were collected from the jugular vein of each cow and analyzed and the results showed that the hematological profile in cattle that suffered from reproductive problems compared to healthy breeds consists of changes in hematocrit, hemoglobin and erythrocytes under the influence of lactation and health and number of lactations and lactation rank influenced biochemical and hematological parameters.

In subsection 2.4.2. the study carried out as a result of the research and consultancy project no. 1756/12.02.2015 in which the microbiological contamination was analyzed on the technological flow of obtaining milk as a raw material from milking to its retail sale in dispensers. The research was carried out over a period of 5 years in which milk samples taken from existing dispensers in 4 locations in the counties of Cluj, Salaj and Alba were analyzed. These samples were analyzed within the Milk Quality Foundation in Cluj-Napoca. The aim of these researches is to follow the composition of the milk and check the hygiene from a microbiological point of view in the entire chain from farms to the consumer, which ends up being sold through milk dispensers. The conclusions of the study were that ensuring raw, hygienic milk in accordance with food safety requirements requires dairy farmers to comply with food and animal health measures, milking hygiene, rapid cooling and marketing using state-of-the-art equipment. Regular microbiological controls of raw milk assess product safety and reduce food safety risks.

In subsection 2.5. "*Research on the processes and technologies for obtaining products from agriculture and the food industry*" are represented by research on energy consumption, changes in quality parameters as a result of athermal processing processes and transformation of raw materials from agriculture and the food industry, and are analyzed the possibilities of reusing vegetable and fruit by-products to obtain innovative products with the help of usual equipment and techniques.

In subsection 2.5.1. a research is presented on the by-products generated by food producers that are considered household waste and the possibility that they can be reused to obtain innovative products. To this end, the research focused on the waste from local small processors who sell juices from apples, oranges, carrots, celery and beets and who dispose of the obtained residues as household waste. The research focused on efficient approaches to valorize these fruit wastes into by-products, analyzing the traceability of bioactive compounds through the process and finally identifying various affordable and sustainable methods of transforming them into consumer products using affordable machinery and equipment. overall dimensions. Their processing included a J80 ULTRA juicer, a 2000W PU 05 electric screw press, a Hendi dehydrator and a laboratory grinding mill. Analyzes were carried out to determine phenolic substances, anthocyanins and non-flavonoid phenolic compounds, and the following conclusions resulted from the statistical analysis: it is possible to obtain affordable, low-tech solutions that could generate sustainable added value for suppliers through the development of innovative functional products from residues resulting from the processing of vegetables and fruits; the used equipment reaches the value of 4000 euros which would be amortized in 2 years of use.

In subsection 2.5.2. a research on changes in quality parameters and volatile profile during cold storage of leafy vegetables is presented. Fresh, ready-to-eat foods are generally free of additives and require little or no processing before consumption. The shelf life of ready-to-eat plant foods is limited and is caused by physiological ageing, biochemical changes and microbial spoilage stages. Temperature is the most important environmental factor influencing the quality of minimally processed plant foods. Consequently, a good knowledge of the time-temperature relationship in the cold chain is essential to evaluate the effect of the actual cold chain on the quality loss and shelf life of these products, and the quality losses consisting of color changes (discoloration, yellowing), texture (loss of crispness or juiciness), flavor (off-flavors) and water loss can be prevented.

In subsection 2.5.3. Research on grain grinding energy consumption and the influence of hammer type and humidity on grinding are presented. Cereals that are administered in feed must have a certain degree of grinding depending on the breeds of animals for which the feed is prepared. In the grinding process with the help of hammer mills, they are used to achieve the crushing of grains using the crushing effect of the hammer and the grain. The degree of grinding of animal feed grains in the case of hammer mills can be determined depending on the type of raw material used, its moisture content, the size and type of hammers used, the mesh sizes of multi-grinding sieves, engine speeds . Grain grinding energy is influenced by all these parameters. The experimental research analyzed the influence of humidity, the size of the sieve meshes and the constructive type of hammer used in hammer mills on the fineness of the grind obtained from wheat and corn. The MB 7.5 type hammer mill equipped with 4 types of sieves with different mesh sizes was used for the experimental research. The experimental results showed that the specific energy consumption of grinding corn grains decreases with the decrease of humidity and the increase of grain sieve diameter. The crushing capacity of the mill is higher when the humidity is lower and the diameter of the mesh of the sieve is larger and to obtain a certain type of grinder, the humidity of the material must be chosen according to the degree of grinding required and the type of hammers used does not significantly influence the quality

and quantity of the grindstone.

In subsection 2.5.4. research is presented on the effect of irradiation with gamma ionizing radiation (0.7–2.7 kGy) on the sensory quality of parsley compared to conventional post-harvest treatments. The effects of this treatment should be compared with biochemical and microbiological ones and the effect of product texture and flavor in accordance with consumer preference. Ionization treatment of food is a physical process that uses ionizing radiation from radioactive isotopes cobalt, cesium or accelerators - called irradiation sources - to ensure food safety and extend shelf life. The ionization process causes changes in food, including contaminating organisms, due to chemical reactions between constituent atoms or molecules. In the food industry, the following are accepted as sources of ionizing energy: gamma rays from radionuclides, energized electrons generated by particle accelerators and X-rays emitted by them. The experimental research used fresh parsley that was minimally processed following a procedure described in a previous paper. The samples were gamma irradiated at IRASM – multipurpose industrial irradiator at the National Institute of Nuclear Physics and Engineering Horia Hulubei, Măgurele, Romania. The irradiator was a type SVST Co-60/B loaded with 100 kCi. The actually absorbed doses were: 0.7 ± 0.1 kGy; 1.4 ± 0.1 kGy; 2.0 ± 0.2 kGy; 2.7 ± 0.3 kGy, determined for the 2.7 kGy dose with an ECB dosimeter. The samples were irradiated in 4 batches. A sensory analysis was performed and following the interpretation of the obtained results it was concluded that irradiation can be applied to minimally processed parsley to significantly extend the shelf life when thermal or chemical methods are excluded and Irradiation with higher doses led to flavor changes. Freezing did not affect the taste or smell scores of the sensory analyses, which were significantly higher than for dried parsley, and the flavor was preserved.

Also in this chapter, a modern aspect of food processing was analyzed for the purpose of quality and energy optimization regarding the high pressure processing (HPP) of solid or liquid foods.

High pressure processing is a new food preservation technology that has begun to be widely implemented in the meat, fruit and vegetable beverage sectors, mainly due to its ability to inactivate tissue enzymes, pathogenic and spoilage microorganisms, keeping in at the same time, the nutritional and sensory characteristics of food products.

Applying overpressure to foods with a high moisture content reduces their volume by 15%. The product returns close to its original volume upon decompression. Fruit and vegetable products, mainly purees, juices and beverages account for approximately 40% of the global HPP food market. The main parameters that characterize HPP processing are the pressure value, the working temperature and the holding time of the processed food in the container. The values of these parameters differ depending on the purpose pursued, as a result great importance is given to the research of the way of working, the parameters and factors that influence the different applications of the technology as well as the optimization of working conditions through HPP. The quality of high-pressure pasteurized foods is very similar to that of fresh foods. The quality of food products during the shelf life is influenced to a greater extent by the subsequent distribution and storage or packaging temperatures, rather than by the pressure treatment itself. HPP uses intense pressure (approximately 400 - 600 MPa) in refrigeration or mild process temperatures (< 45°C), preserving most foods with minimal effects on taste, texture, appearance or nutritional value. Pressure

treatment can be used to process both liquids and solid foods with a high moisture content. Although lethal to microorganisms, pressure treatment does not break covalent bonds and has minimal effect on food chemistry. On the other hand, HPP provides a means to preserve food quality while avoiding the need for excessive heat treatments or chemical preservatives. High pressure processing is also referred to in current literature as hydrostatic high pressure processing (HHP) or ultra high pressure processing (UHP).

The third chapter of the habilitation thesis briefly presents the development plan of the didactic and research activity, through which I want to continuously improve the teaching-learning methodology; to contribute to the development of research in the agronomic field specialized in engineering aspects; to continuously develop the research methods applicable in this field through interdisciplinary and/or inter-university collaborations, in order to attract funds for the development of Unitary Processes and Operations laboratories and Measurement and Control Devices; to initiate trans/multi/inter disciplinary projects within national and international competitions, as well as attracting private funding sources for research; to develop partnership relations with private production units or economic partners; to increase my external visibility by publishing scientific articles in prestigious ISI indexed journals by coordinating doctoral students; to participate in international conferences abroad, as support for creating links with research teams from other university or research centers in the EU.