UNIVERSITY OF AGRONOMIC SCIENCES AND VETERINARY MEDICINE BUCHAREST

FACULTY OF BIOTECHNOLOGY

PhD THESIS

RESEARCH ON DEVELOPING BIODEGRADABLE POLYMERIC MATERIALS FOR ENVIRONMENTAL SUSTAINABILITY SUPPORTING

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SUMMARY

Key words: biodegradable, biopolymers, composite polymeric materials, renewable resources, environmentally friendly, food packaging, biodegradation, sustainability.

The PhD thesis entitled ***„Research on developing biodegradable polymeric materials for environmental sustainability supporting”*** is developed by PhD student Elisabeta Elena Tănase, under the scientific coordination of Prof. Univ. Dr. Ovidiu Popa, within the Doctoral School Plant and Animal Resource Management and Engineering from University of Agronomic Sciences and Veterinary Medicine of Bucharest. The experimental research conducted and presented in the PhD thesis were employed in modern laboratories from University of Agronomic Sciences and Veterinary Medicine of Bucharest and Research Institute of Auxiliary Organic Products (ICPAO), Mediaș.

The purpose of the PhD thesis aimed to develop biodegradable polymeric materials from renewable resources that are environmentally friendly, for their further use as food packaging materials, thereby replacing synthetic polymers that pollute the environment. To this end, I considered the following objectives:

- The realization of a literature study regarding the current „state of the art” about the polymers manufacturing from renewable resources and the identification of the main properties and limitations of their use in packaging.
- Choosing the polymeric matrixes to be used and the development of new recipes in order to realize composite polymeric materials with improved properties by adding fillers (renewable resources), and this led to a low production cost of the biopolymers.
- The development of the composite polymeric blends and the determination of their main physical-mechanical and chemical properties that are necessary for every polymeric material that is used for packaging design.
- The realization of the ecotoxicity biological tests (in order to determine if these new composite materials have a negative effect over plant development) and biodegradation tests (to determine the biodegradation rate of the polymeric blends in environmental conditions, by microorganisms action or by soil burial), in order to determine the ability of recycling by compost obtaining.

The PhD thesis consists of 224 pages, being structured on 10 chapters, 45 subchapters, a rich graphical illustration, with 173 figures, images and tables as well as a list of references with

217 book titles, scientific papers, technical papers from this domain and other sources of information.

This work comprises three typical parts for a PhD thesis namely the documentation part entitled ***„Literature review regarding polymers and biopolymers characteristics and their use in food packaging”***, an experimental research part entitled ***„Experimental research on the development and characterization of the composite polymeric materials”***, and the last part presenting the general conclusions entitled ***„General conclusions, author's contributions and valorisation of research results”***.

In order to achieve the goal of the thesis and establish the research plan, within the first part of the PhD thesis that is structured on three chapters I realized a state of the art literature review based on the existent literature in the field, in order to determine the properties of biopolymers made from renewable resources and ways to improve their properties by developing different polymeric blends (**Chapter I**, entitled ***„Literature review on biodegradable polymeric materials”***).

Chapter II, entitled ***„Mechanisms and techniques used in polymers biodegradation”*** describes the biodegradation process of the polymeric materials, process that can be achieved by different methods like biodegradation in biotic or abiotic conditions, soil or compost biodegradation, bioaugumentation or biodeterioration.

Chapter III, ***„Applications of polymers in food industry”*** describes the conventional polymeric materials and their properties, that are used in food packaging, compared to biodegradable polymeric materials and their properties.

Following the literature study and based on the resulted conclusions I established the research plan regarding the experimental research and investigations to be carried out, and then I established the writing structure of the thesis.

Therefore, in the second part of the PhD thesis, which comprises six chapters, are described the realized researches in order to determine the physical-mechanical, chemical and biological characteristics of the developed polymeric materials.

Chapter IV, ***„Materials, methods and apparatus used in the experiments”***, presents the materials that were used during the experiments, the methods of physical-mechanical, chemical and biological characterization of the developed polymeric composite materials and equipments that were used in the experiments.

Chapter V, ***„Development and characterization of PVA/starch based biopolymers”*** presents the polymeric materials development method (materials based on PVA and starch) and the determination of the main physical-mechanical, chemical and biological characteristics of the material, the chapter ending with the main conclusions of the experiments. The obtained results

demonstrated that some properties of the polymeric blends based on PVA and starch were improved compared to neat PVA (for example light barrier properties, transparency, hardness, density, etc.). Also, the results of the biological analysis performed on the developed polymeric composite materials showed that they had no negative effect over plant development and they can be successfully biodegraded both by microorganisms` action and by soil burial.

Chapter VI, ***„Development and characterization of PLA/cellulosic fibres based biopolymers”*** presents the polymeric materials development method (materials based on PLA and cellulosic fibres) and the determination of the main physical-mechanical, chemical and biological characteristics of the material, the chapter ending with the main conclusions of the experiments. The obtained results demonstrated that some properties of the polymeric blends based on PLA and cellulosic fibres were improved compared to neat PLA (for example lower energy consumption during processing, higher melting temperature, higher cristallinity degree, etc.). Also, the results of the biological analysis performed on the developed polymeric composite materials showed that they had no negative effect over plant development and they can be successfully biodegraded by the studied microorganisms action.

Chapter VII, ***„Development and characterization of PHB/cellulosic fibres based biopolymers”*** presents the polymeric materials development method (materials based on PHB and cellulosic fibres) and the determination of the main physical-mechanical, chemical and biological characteristics of the material, the chapter ending with the main conclusions of the experiments. The obtained results demonstrated that some properties of the polymeric blends based on PHB and cellulosic fibres were improved compared to neat PHB (for example lower energy consumption during processing, light barrier properties, etc.). Also, the results of the biological analysis performed on the developed polymeric composite materials showed that they had no negative effect over plant development and they can be successfully biodegraded both by microorganisms` action and by soil burial.

Within **Chapter VIII**, ***„The developed composite materials behaviour during thermal sterilization treatment”***, there are presented the results that were obtained after the polymeric materials based on PLA and cellulosic fibres and PHB and cellulosic fibres were sterilized by autoclaving.

The third part of the PhD thesis comprises the general conclusions of the obtained results, the implications for further research studies, author’s contributions and the dissemination of results, this part forming **Chapter IX**, entitled ***„General conclusions”***.

The PhD thesis ends with a full list of references.

The production of biodegradable polymeric materials is very important from an ecological point of view by reducing the accumulation of solid waste in the environment.

Biopolymers and biocomposites were described as sustainable materials compared to conventional synthetic polymers and composite materials, in terms the use of renewable resources as raw materials, their biodegradability and low ecotoxicity.