# SUMMARY

of the doctoral thesis entitled:

## RESEARCH ON THE USE OF MICROENCAPSULATION TECHNIQUES IN THE FOOD INDUSTRY

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In recent years, the encapsulation of active compounds has become a process of great interest and significance, being suitable both for food ingredients and for chemical, pharmaceutical or cosmetic ones. Also the global demand for new, active and healthy products using natural compounds with antimicrobial activity as alternatives to current commercial preservatives is constantly growing. Since natural compounds with antimicrobial effect are difficult to apply directly to food products due to issues such as food flavor or bioavailability, recent advances in microencapsulation technology have the potential to provide stable systems for them, which can then be used directly in food.

The objectives of this doctoral thesis were to contribute to the development of packaging structures that preserve food, keeping it fresh and thus increasing its shelf life. In this work, I focused on the use of encapsulated natural antimicrobial agents such as essential oils as potential food preservatives to extend the shelf life of food products.

This thesis is organized in two parts: a theoretical part and a part where personal research is found.

The first part of the thesis contains the data taken from the specialized literature. This first part of the thesis is divided into three chapters.

In the second part of the thesis, the experiments and the obtained results can be found and it is structured in five chapters.

The first chapter is called "DOCUMENTARY STUDY ON THE USE OF ACTIVE PACKAGING IN THE FOOD INDUSTRY". This chapter presents the current state of research on the types of active packaging used in the food industry. Also presented is the legislative context on food safety in the European Union, as well as legislative frameworks on packaging and the use of active packaging in the United States.

The second chapter is called "DOCUMENTARY STUDY ON THE MICROENCAPSULATION TECHNIQUES USED TO OBTAIN ACTIVE PACKAGING IN THE FOOD INDUSTRY". In this chapter, the general aspects of the microencapsulation process and the methods used for the encapsulation of bioactive ingredients are presented.

The title of the third chapter is "DOCUMENTARY STUDY ON THE MICROENCAPSULATION OF SOME BIOACTIVE COMPOUNDS IN VARIOUS MATRICES". This section provides a literature review of the types of coating materials used in the microencapsulation process and the bioactive compounds that can be encapsulated. The correct choice of the encapsulation material is very important because it influences the encapsulation efficiency and can have a major impact on the encapsulation yield efficiency, shelf life and oxidation protection level and stability of the microcapsule. Microencapsulated active ingredients can be flavoring agents, sweeteners, colors, oils and vitamins or probiotics. Encapsulation of bioactive compounds in the food industry, is used to improve the nutritional properties or to extend the shelf life of some products.

In the fourth chapter entitled "EXPERIMENTAL RESEARCH ON THE "*IN VITRO*" ANTIMICROBIAL EFFECT ON SOME MICROORGANISMS INVOLVED IN FOOD SPOILAGE, THE ANTIOXIDANT EFFECT AND THE TOTAL POLYPHENOL CONTENT OF SOME ESSENTIAL OILS" the antimicrobial properties of some active ingredients used in the experiments were followed. For this chapter essential oils of sage, fennel and sea buckthorn were used as antimicrobial agents on organisms involved in food spoilage: Aspergilus niger and Penicillum expansum. Sage and fennel oils inhibited 100% the growth of A. niger and P. expansum fungi inoculated in the PDA culture medium when a concentration of 19 µl, respectively 14 µl was used. Following experiments on antimicrobial properties, sea buckthorn oil showed no antifungal activity even at concentrations of 300 µl, but it was shown to have antioxidant properties.

The fifth chapter of this thesis is called "EXPERIMENTAL RESEARCH ON THE STUDY OF THE PHYSICAL-CHEMICAL COMPOSITION OF THE NANOEMULSIONS OF SAGE, FENNEL AND BUCKCHIN ESSENTIAL OILS". In this part of the thesis, four nanoemulsions were obtained: sage nanoemulsion, fennel nanoemulsion, sage-buckthorn nanoemulsion and fennel-buckthorn nanoemulsion, which were characterized in terms of diameter. particles and zeta potential, total polyphenol content, antioxidant activity. The total content of polyphenols is an important indicator in the characterization of oils because phenolic compounds represent both antioxidant and antimicrobial activity. Two methods were used to demonstrate the antioxidant properties of the oils: DPPH and ABTS.

Chapter Six is entitled "EXPERIMENTAL RESEARCH ON THE OBTAINING OF FILMS FROM CHITOSAN, GELATIN AND FOR USE IN FOOD SYSTEMS". This chapter covers the production of films: chitosan-gelatin, chitosan-gelatin-clay, chitosan-pectin,

chitosan-pectin-clay, chitosan-gelatin-pectin, chitosan-gelatin-pectin for which the following properties were investigated: mechanical properties, analysis of film transmittance by UV-VIS spectrometry (transparency), chemical structure analysis. Following the results obtained in the experiments in this chapter, it was decided to continue testing with the incorporation of nanoemulsions in chitosan-gelatin and chitosan-gelatin-clay films.

Title of the seventh chapter "EXPERIMENTAL RESEARCH ON ENCAPSULATION METHODS OF ESSENTIAL OILS OF SAGE, FENNEL AND BUCKCHIN FOR USE AS BIOACTIVE AGENTS IN FOOD SYSTEMS". This chapter presents the encapsulation of nanoemulsions of sage, fennel and sea buckthorn essential oils in chitosan, gelatin and clay based matrices. Two methods were used for encapsulation: incorporation of nanoemulsions into films and encapsulation using the electrospinning method. After obtaining the films, the antifungal effect on inhibiting the development of food-degrading fungi from the genera Aspergillus and Penicillium was investigated. As with the oils tested as such and the nanoemulsions, the films also showed antimicrobial and antioxidant activity. With the electrospinning encapsulation technique, the amount of antimicrobial agents will be less compared to their encapsulation in films.

In the eighth chapter entitled "IN VIVO EXPERIMENTAL RESEARCH ON THE ANTIMICROBIAL EFFECT OF THE FILMS OBTAINED ON GROUND BEEF" physical-chemical and microbiological tests were carried out on the ground beef, which was packed in polyethylene terephthalate casseroles, based on the films with various oil emulsions studied in Chapter Seven. Following the results obtained in the physico-chemical analyses, it was observed that the product packaged in the polymer films in which the oils were embedded extended the shelf life of the ground beef stored in refrigerated conditions, compared to the control sample stored in commercial packaging.

The last chapter presented the conclusions of this doctoral thesis, the recommendations regarding direct personal contributions and the prospects for further research.

For the realization of this work, 249 bibliographic resources were consulted, which can be found in the specific section. Also, in the last chapter, the author's scientific contributions in the field of "Biotechnologies" are mentioned through the publication of full-length articles and participation in national scientific events.