**ABSTRACT**

Food industry has evolved remarkably during the last decades due to the need to technify the production with the aim of reducing processing times and to increase industry profits, without this implying a decrease of the product quality. In this context, the use of spectrophotometric monitoring and treatment techniques for the optimization of production processes can represent a great progress for agri-food industry.

This doctoral thesis is focused on the study, design and development of non-destructive sensors based on spectrophotometry to monitor products and processes; as well as the application of treatment spectrophotometric techniques for the improvement of food production processes. This doctoral thesis is subdivided into three large blocks covering three types of food systems: animal tissue, plant tissue and colloidal systems.

In **block 1**, ***animal tissues*** were studied, in order to solve the increasingly frequent problems in meat industry. Firstly, the use of spectrophotometric sensors for the control of pork meat drying was analysed as a fundamental step to obtain cured ham, a product with high added-value. In this context, two techniques were used, infrared thermography and microwave monitoring. In the range of infrared, the study was carried out using a thermographic camera Optris PI® to follow the evolution of the emissivity at each stage of the drying process. This study, coupled to a thermodynamic model and some physicochemical determinations have shown that infrared thermography is a suitable technique able to monitor drying process, identifying each drying stage. On the other hand, in microwave range, permittivity was measured from 500 MHz to 20 GHz and it was demonstrated that the loss factor in -dispersion has a direct relation with the number of molecules on the meat sample surface.

Secondly, considering that freezing is one of the most widely used technologies to extend meat and meat products shelf life, a non-destructive and easy-to-use sensor in radiofrequency range able to detect if meat samples has been suffered freeze/thaw cycles has been developed.

Thirdly, an exhaustive study was carried out to solve the problems resulting from the strong technification and intensification in poultry industry, such as low-quality meats (PSE and DFD), the white striping and the deep pectoral myopathies, mainly produced because of the use of hypertrophic strains. For each of these problems, spectrophotometric studies were performed in the radiofrequency and microwave ranges and they were related to physicochemical and biochemical parameters, obtaining the relaxation parameters for ,  and -dispersions by using a logistic model. For each problem, sensors were developed in radiofrequency range, and in addition, for the myopathy studies, the developed sensors were able even to measure through the skin in whole chicken carcasses.

In **Block 2** ***plant tissues*** were studied. Firstly, the tissues that compose the mandarin were characterized spectrophotometrically. Due to this, a physicochemical and structural study were coupled with the permittivity obtained in radiofrequency and microwave ranges. As one of the most important results of this research, a tool based on the dielectric relaxation constant in the -dispersion able to predict the moisture of the samples was obtained. This research represents a first step in the development of sensors with different applications such as the detection of seeds in whole mandarins, diseases and/or contaminations of the fruits.

Secondly, the study of the application of pulsed electric fields as a pre-treatment to the osmotic dehydration of kiwifruit was carried out. This spectrophotometric technique, coupled with physicochemical determinations and a thermodynamic study, has demonstrated that the pulsed electric fields accelerate the osmotic dehydration process, mainly due to the cells plasmolyzation. In addition, the monitoring of the process was carried out with nuclear magnetic resonance, where the internal transports and the transformations that the plant tissue suffers were analysed. Finally, it has been possible to conclude that nuclear magnetic resonance is a suitable technique to quantify the water molecules according to their location in the tissue and to obtain sorption isotherms throughout the complete range of water activities.

Finally, **block 3** of this thesis focuses on the study of the third type of food system, ***colloidal systems***. Particularly, the stability of high-value bioactive compounds (-galactosidase) by its encapsulation in alginate-Ca(II) hydrogels with and without the addition of secondary excipients was studied. In this study, the behaviour of this colloidal system against thermal treatments and their transport kinetics were evaluated. Characterization, calorimetric and nuclear magnetic resonance studies were carried out as well as a deep microstructural analysis by small-angle X-ray scattering and scanning electron microscopy. It has been demonstrated that the addition of secondary excipients has enhanced the stability of the enzyme against heat treatments (freezing, freeze drying, vacuum drying, freeze / thaw cycles and storage). It has been studied the kinetic crystallization during beads freezing by nuclear magnetic resonance and finally, the degree of compactness of the rods that form the egg-box structure, its interconnection and size by small-angle X-ray scattering has been described.