ABSTRACT

In the last decade, the evolution of the market has forced food industries to maintain quality standards, conditioning companies to improve their methods and/or control techniques, as well as decreasing production costs. In this context, new non-destructive systems for on line monitoring, are necessary to obtain the needed information to maintain the quality of the product while reducing the production costs.

In this sense, this thesis studies the use of dielectric spectroscopy in the radiofrequency and microwave range, as a technique to obtain physical, chemical and structural properties of food during its manufacturing process. This information, together with phenomenological models proposed in this thesis, allow analysing control parameters in the production of food with complex structures.

First, a review of this methodology (dielectric spectroscopy) and examples of its application were made to obtain the needed basis for focusing the research for this thesis. The literature revision includes several studies showing the benefits of using dielectric spectroscopy in complex food products such as meats, vegetables, fruits, dairy products, etc. In all cases, the versatility and usefulness of the information provided by this technique has been demonstrated, allowing us to carry out non-destructive measurements and highly reliable, obtaining as a result the reduction of operating times and cost of production.

Secondly, the fermentation process was studied in brewing; the dielectric properties were analyzed during the fermentation step, together with various physical and chemical properties. The results showed that the γ-dispersion, induced by water mobility and water content, varies depending on the proportion of ethanol and sugar, as it interferes with the movement of water molecules. It is demonstrated that this technique can be used as a rapid, accurate and non-destructive method for monitoring the fermentation process.

In third place, a study and analysis of salting cheese process was made. The fluxes of water, chloride, sodium and calcium were analyzed during salting cheese in saturated brine using a thermodynamic model. Moisture, water activity, dielectric properties and volume were determined during treatment and after the repose time. Nonlinear irreversible thermodynamic model was developed to determine the transport of water and ions in the structure of the cheese, giving a phenomenological coefficient of $1.8 \cdot 10^{-5}$ $mol^2J^{-1}s^{-1}m^{-2}$. The model describes several phenomena that occur during the salting process. This model describes the effect of the mobility of charges on the ionic conductivity, which not only allows predicting the level of salt in the surface and inside, but also the output of calcium from the system, with the resulting structural changes.

Finally, a study and analysis of collagen gels at different concentration levels was made. It has been possible to detect two conformational levels of collagen in terms of its relationship with the water, through an analysis of the dielectric properties in the spectrum of the radio frequency and microwave range. It has developed an algorithm analysis based on Gompertz model for spectra, which enables, in a fast and reliable way, obtaining the parameters of relaxation frequencies of dispersions α, β and γ. The results showed the usefulness of dielectric properties as a control system in the formulation of gels.

In conclusion, the research conducted in this thesis centres on the study of different colloidal structures by thermodynamic modelling and dielectric spectroscopy in radiofrequency and microwave range. These studies show the viability of the technique for non-destructive and reliable monitoring of the manufacturing processes exposed in this work