MICROWAVE HEATING: EXPERIMENTAL AND NUMERICAL APPROACHES FOR PROCESS EFFICIENCY

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In the food industry, the use of electrical-based processes such as electromagnetic fields techniques applied to bio-based materials are expected to increase in the following decades facing the energy efficiency of such low carbon foot print processes. This work focuses on various experimental and modelling aspects dedicated to microwave heating applications at lab scale in the framework of research and development activities at GEPEA (France) since 2005. Basic concepts of heat transfer related to the microwave heating of food products are presented in order to understand the thermal behaviour of the material during the treatment. The process parameters and product properties are detailed with the different mechanisms responsible for the temperature rise under microwaves in the case of tempering, thawing, cooking and pasteurization applications.
The work also presents some highlights on the use of advanced multiphysics modelling techniques to predict the heating behaviour of a food product undergoing a microwave heating treatment. Major applications of microwave heating of food products at 2450 MHz and 915 MHz are presented by including both thermal and non-thermal effects on biological materials. Future prospects are also discussed concerning the development of modelling tools such as digital twins to improve the process-product interactions at microwave frequencies.