Use of Toroidal Cans in a Microwave Pasteurization Process: A Computational Study with Experimental Validation

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Canning is a highly preferred thermal processing approach with its versatile use and resulting long shelf life of food products. Heat transfer occurs by conduction for solid foods while convection is more dominant in liquid and solid-liquid mixture products. Due to the constraints in the process and geometry of the cans, the applied rotational and agitational processes are so far the only innovations in canning. Toroidal cans are the recent presentation to increase the heat transfer rates and reduce the process time while microwave (MW) processing has an increased applications in the food processing with its volumetric heating feature.

Therefore, the objective of this study was to apply toroidal cans (manufactured from polypropylene) in a MW application for an efficient processing.

For this purpose, toroidal cans with 73 mm diameter and 110 mm length were manufactured from polypropylene, and distilled water (low viscosity Newtonian liquid) and 0.5% CMC solution (high viscosity non-Newtonian liquid) were processed in a lab-scale 1 kW MW system. During this process, temperature measurements were obtained using fiber optic sensors, and this data were used to experimentally validate the mathematical model developed using Comsol v5.6 (Comsol AB, Stockholm, Sweden). Then, the validated model was used for various process design approaches for MW processing including rotational effects.

This study demonstrated an innovative process for canning with increased heat transfer and temperature evolution efficiency. This novel approach might be a possible sustainable process for future canning industry.

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