Experimental study and modelling of a continuous ohmic heating system for starch matrices for 3D food printing application

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Ohmic heating (OH) involves the circulation of an electric current through an electrically conductive product, which will heat up by the Joule effect. The advantage of OH is its energy efficiency; it can reduce cooking times and gives a particular appearance to the product because of its ability to heat more uniformly. This work consists of developing a 3D printing nozzle using this technology applied to cake batter. The device consists of electrodes between which the batter flows. Heat exchangers, in which cold glycol water circulates in countercurrent, are used to cool the electrodes and facilitate the flow of the product, preventing clogging of the nozzle due to gelatinization. A numerical model was developed to help the design optimization. For validation purposes, numerical results have to be compared with experimental data. An experimental methodology was developed to have the temperature cartography at the nozzle outlet. The materials used are a cutting blade and a thermal camera. The blade quickly cuts the cooked product at the nozzle outlet to flatten the surface and the IR camera placed directly below takes a thermal image of the surface. The results show the expected heterogeneity of heating. The batter is hotter in the center of the product and colder at the edges due to the cooling of the electrodes and the specific design of the nozzle. Numerical results qualitatively agree with the experimental data.

Keywords: Ohmic heating, temperature profile, IR camera, 3D printing