Investigation of Pound Cake Baking in the Case of Ohmic Heating for an application in 3D printing

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Considering food material composition of most bakery products such as the presence of fat, 3D printed foods of such matrices are mostly not able to retain their structure/shape after the baking step, which is necessary to cook/solidify the product. Ohmic heating (OH) offers new limits to the food industry due to its volumetric principle of heating with minimum temperature gradient. It also comes several advantages such as, high-energy conversion efficiency, and possible high heating rate. The insertion of this technology in the printing head of 3D printer would yield pre-cooking with high throughput printing. The research concerning the application of OH in the baking industry is scarce and the mechanisms of cake making using OH are poorly understood. The objective of this study is to adjust a pound cake recipe and investigate the baking process by ohmic heating, using conventional oven baking as a reference.

Experiments were first carried out in the batch process, where, different OH process parameters (heating rate, power input and holding time) were tested and their effect on the physico-chemical properties of batter and cakes (specific volume, porosity, starch gelatinization, texture) were analysed. Alongside, the effect of leavening acid type with different levels of baking powder (BP) on batter and cake properties were also studied. Results indicated very clear significant differences in the appearance cakes between the two methods of baking, in which OH cakes were crustless. Time of baking was reduced by 50 - 60% when OH was used, and as heating rate increased from 3.2°C/min to 6.4°C/min, crumb firmness of OH cakes were significantly reduced. On the other hand, increasing BP amount significantly increased batter specific volume and porosity, but dropped as BP level approached maximum (4.52%).

Overall, study helped to explore the process parameters of cake baking by OH and highlights the need to identify the optimum amount of BP to attain the desired product qualities. Perspectives concern the application of this technology for continuous baking of cereal matrices, aiming at its implementation in 3D printing.