Computer simulation of the maltose production in sweet potato during microwave cooking

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Sweet potatoes have the characteristic of becoming sweeter when they are heated, basically due to starch becoming gelatinized, and ?-amylase hydrolyzes the gelatinized starch resulting in the production of maltose, the main component of sweetness. Nowadays, the use of microwave (MW) cooking at home is a popular practice which in parallel is challenging because its characteristic high heating rate can affect the intrinsic chemical changes of sweet potatoes due to heat. To clarify this phenomena, experimental and simulated approaches for the MW cooking of sweet potatoes were evaluated.

The dielectric properties of sweet potatoes during MW heating were measured from 20 to 90 ? at 2450 MHz. A three-dimensional (3D) geometric model based on the actual structure and size of the MW flatbed oven and sample was constructed. Two commercial software packages, which are based on the finite element method, were used for the calculation by coupling the analysis of electromagnetic fields and heat transfer. The MW cooking of sweet potatoes was examined and the maltose production process was analyzed by simulation. A new kinetic model of maltose production based on the ?-amylolysis limit was proposed. The kinetic parameters of multi-reaction gelatinization, saccharification, and ?-amylase inactivation were determined successfully by a combination of simulation and experimental approaches.

The dielectric constant decreased with increasing temperature; whereas, the dielectric loss factor values were similar at 20–60 °C. However, at 60–90 °C, the values decreased sharply. The temperature change inside the sweet potato (temperature profiles and cross-section distributions) was compared with the experimental results. The simulated temperature results agree well to the measured results. From the simulated temperature profiles and kinetic parameters, the change in non-gelatinized and gelatinized starch, the active ?-amylase, and the maltose during cooking were simulated. Although the simulated maltose production occurs at positions where the temperature rises, at early stages, at later stages maltose production is suppressed by the inactivation of ?-amylase. Results could be used as tools to control the sweetness of sweet potatoes for the optimal design of products and cooking methods by MW technology.