Evolution of the electrical conductivity of pound cake during baking by ohmic heating

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Ohmic heating (OH) is attracting more and more interest due to its many advantages, including high energy conversion efficiency with faster heating kinetics. Having a large number of actual and potential applications, OH seeks to meet the growing demand for new alternative heating technologies in the food industry. In the case of OH, electrical conductivity is a key property as it rules the conversion of electric power to warming power. It is estimated that the ideal electrical conductivity for use in OH is between 0.01 S m-1 and 10 S m-1 (Ramaswamy et al., 2014). In the case of baking, phase changes occurs such as starch gelatinization. The objective of this work was to follow the evolution of the electrical conductivity of a pound cake during baking using OH.
The baking was carried out in a prototype OH cell with an AC voltage of 220V and a frequency of 50 Hz. The degree of starch gelatinization was determined by DSC analysis at selected baking stages and was correlated to the electrical conductivity, which was determined using impedancemetry.
The results of this study showed that there is a negative linear correlation between the electrical conductivity and the degree of starch gelatinization in the center of a cake baked in OH. Increasing the degree of starch gelatinization in the center of the product from 4% at 60°C to about 48% at 76°C leads to a reduction in electrical conductivity from 390 µS/cm to about 89 µS/cm in the same range of temperatures. The reduction of the interstitial space and the availability of water linked to the swelling of the starch granules during gelatinization strongly and negatively impacted the evolution of the electrical conductivity. The increase in the porosity of the cake during baking also reduced the ability of current to flow through the sample.