MODELING HEAT AND MASS TRANSFER DURING PORK LOIN COOKING IN AN ELECTRIC OVEN

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The meat cooking process involves heat to transform the raw muscle into safe, nutritious, and tasty food. This work aimed to model and validate pork loin roasting in a commercial electric oven. For that, pieces of pork loin were cooked in a controlled cavity with natural convection, and the transport phenomena were modeled using a system of partial differential equations. The model includes thermal radiation and heat convection between the food surface and oven ambient, and, inside the meat, heat conduction, moisture diffusion, and pressure-driven water flow. The 3D mathematical model was solved numerically by the finite element method and validated using experimental data of temperature and moisture content in the product during roasting at 180, 200, and 220 ºC, achieving good RMSE values. As expected, the oven temperature influenced the temperature and moisture content profiles during the roasting process. The time needed to reach the safe cooking temperature recommended for pork meat of 71.1 ºC at the center of the sample was shorter as the oven temperature increased, changing from around 16.33 min at 180ºC to 13.33 min at 220 ºC. In addition, the meat emissivity, convective heat transfer coefficient, permeability, and diffusion coefficient were estimated to feed the model for numerical simulations. The model provided detailed information about the product's transient temperature, moisture, and pressure distribution and demonstrated that dripping was the main mechanism behind moisture loss during meat cooking. A sensitivity analysis also indicated that the relative humidity inside the oven is a key parameter in the roasting process, impacting the meat moisture loss and cooking time. The present study is useful in understanding the physics of meat cooking and can be used for case studies since the mathematical model well describes the heat and mass transfer dynamics in the process. Thus, its use supports quality control during cooking, such as observation of temperature evolution and mass loss, and be coupled with quality kinetics to predict color, texture, microbial inactivation, and shrinkage.