Title Mathematical modelling of wheat kernel drying with input from moisture movement studies using magnetic resonance imaging (MRI), Part II: Model comparison with published studies

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Abstract

The predicted moisture data, using the three-dimensional (3D) single wheat drying model (Part I) considering actual kernel geometry, were compared with two published semi-empirical thin-layer wheat drying models, and one published axisymmetric heat and mass transfer model for a single wheat kernel. The published axisymmetric model assumed a uniform initial moisture distribution within the whole kernel of ellipsoidal geometry and a single value of the water diffusion coefficient. Our model predictions agreed well with the observations obtained from the published models. Further, our model can predict the moisture distribution pattern within individual wheat components with drying time. Moisture and temperature distributions inside the wheat kernel and the effect of drying temperature on wheat quality were explained by calculating the Biot and Lewis numbers. High Biot numbers for moisture transfer (0.89×10^6–3.04×10^6 for endosperm and 1.98×10^6–3.37×10^6 for germ) indicated that moisture transfer inside the wheat structural components was governed by high internal resistance, whereas low Biot numbers for heat transfer (0.12–0.20 for endosperm and 0.02–0.10 for germ) indicated that heat transfer was controlled by external resistance and, hence, temperature within the wheat kernels was uniform at any given time during drying. Lewis numbers indicated that the rate of heat transfer was very high compared to moisture transfer in both the endosperm and the germ. Sensitivity analysis was performed for selecting proper model parameters which indicated that values of water diffusion coefficients in the germ and endosperm are the most sensitive parameters for a grain drying process.