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STATIONARY DEEP-BED DRYING: DEVELOPMENT OF A NUMERICAL MODEL AND IMPLEMENTATION OF A CONTROL STRATEGY OF THE PROCESS

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Abstract. The objective of this work was to develop an integral deep-bed low-temperature drying simulation model for amaranth grain comprising an inferential strategy of control for the moisture content of the last bed layer, on basis of an improve of previous models (Pagano and Mascheroni, 2013; Crozza, Pagano and Smith, 2005; Canelli, Pagano and Crozza, 2005a,b). The model was characterized by four coupled partial differential equations representing the heat and mass balances, together other equations describing drying kinetics, physical and thermal properties of grain and air, and equilibrium relationships. The system was solved by two numerical methods (Crank-Nicolson of implicit finite differences and method of finite elements). The methods were respectively programmed in Simulink of MATLAB® Version 7.0 and COMSOL Multiphysics® Version 3.5a. Simulated values were compared with observed data in order to validate the numerical model. For this purpose, a laboratory scale deep-bed dryer was designed and built, and the temperature and moisture of the grain bed were experimentally determined during the drying process. The predicted temporal profiles of temperature and humidity for grain and air were close with experimental results at different bed depths (range: 0-0.18 m). Both numerical approaches were appropriated to describe the in-bin low-temperature drying process. After checking the validity of the simulations, an inferential loop control was incorporated into the MATLAB drying model in order to online infer the grain moisture content through secondary variables (inlet and exhaust air temperatures). The integral model for amaranth grain deep-bed drying simulation and control constitutes a very precise tool to predict the moisture content of the last layer of the bed, allowing prevent over drying.