SEMI-EMPIRICAL MODEL FOR THE SIMULATION OF THIN-LAYER DRYING CHARACTERISTICS OF GREEN PEPPER

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Matured pepper upon harvest contains 70-80 wt % moisture (wet basis), and it should be dried to 10-12 wt % to maintain the quality of dried pepper on storage. Previous studies have shown that such an extent of drying can be achieved in a laboratory-scale bin-dryer in which a relatively thin bed of pepper is dried by passing hot air though the bed from below. Scaling up of this laboratory-scale dryer to a commercial-scale dryer requires that a thin-layer drying simulation model for green pepper be available. A search for the best, and yet simple, thin-layer drying simulation model for green pepper was the objective of this study.

To collect the experimental data required, about a 100 g of raw (green) pepper sample was dried in a drying oven (Yamato, Model DS-63) in 5 different experiments carried out at 50, 60, 70, 80 and 90 °C, respectively. Even though green pepper is dried always at temperatures well below 60°C to maintain the quality in dried pepper, the drying experiments of this study were carried out at temperatures higher than 60°C as well to ensure that the thin-layer drying characteristics of pepper were adequately modelled. The sample was spread on a #08 mesh such that a thin layer of the pepper was formed. Once the oven reached its set temperature, the pepper sample was placed inside it. At every 15-minute interval, the pepper sample being dried was taken out of the oven and its weight was measured. This procedure was repeated until the equilibrium weight is reached. The moisture ratio, *MR*, as a function of time, *t*, was calculated from the weight measurements taken.

The semi-empirical model, $MR = exp(- k_1 t - k_2 t^3)$, developed in this study is shown to best simulate the thin-layer drying characteristics of pepper which include both the constant-rate and falling-rate drying periods, for a wide temperature range. This model not only simulates the experimental data on *MR* versus *t* accurately in the full range of *MR*, but also adequately models the drying rate characteristics, expressed by *dMR/dt*, which is vital for the successful design and simulation of the commercial-scale dryer. It is important to note that the semi-empirical thin-layer drying models available in the literature, Lewis equation and Page equation, fail to simulate the thin-layer drying rate characteristics of pepper since these two models have been developed to simulate only the falling-rate drying characteristics. Thompson equation, developed to simulate the constant-rate and falling-rate drying characteristics, also fails perhaps owing to its purely empirical origin.

A closer look at the semi-empirical model developed in this study suggests that the rate of drying of pepper, simulated by the equation $dMR/dt = - k_1 MR - 3k_2 t^2 MR$, is basically the falling-rate model with the correction term $(-3k_2 t^2 MR)$ added to it to simulate the constant-rate drying period. It has been found in the experimental study that as the temperature reduces, the numerical value of the constant k_2 also reduces. Nevertheless, it is the presence of the term $(3k_2 t^2 MR)$, however small it is, that makes the model simulate the drying rate characteristics of pepper accurately in the full range of *MR* at high and low temperatures of the thin-layer drying of pepper. Further experiments will be carried out to determine these constants accurately for the simulation applications concerned.