ABSTRACT

Radiofrequency drying is a novel approach that solves many issues currently faced by the tea industry. By keeping this point of view, a research study had been undertaken on drying kinetics of the three most famous distinctive types of tea, viz. CTC (Cut-Tear-Curl), Orthodox, and Green tea using the novel radiofrequency dryer (27.12 MHz, 25 kW). The drying conditions varied three different RF power ratings (15, 20, and 25 kW) and three different tea bed thicknesses (0.08, 0.10, and 0.12 m) during the study. The non-fermented Green tea leaves and fermented CTC and Orthodox tea leaves were dried. For comparison purposes, these three types of tea were also dried in a tray dryer at 75°C. The time taken by CTC tea in the RF dryer was 90 min, 60 min for Orthodox tea, and 150 min for Green tea, whereas drying time in the tray dryer for different types of tea varied from 120-240 min. The drying time required in the tray dryer at 75°C was approximately double. During the drying process, the fermented leaves were dried from 65-70 % (wb) to around 2-4% (wb), and non-fermented tea leaves were dried from 78-82% (wb) to around 2-4% (wb). The physical, thermal, and dielectric properties of tea were measured during the drying process at different moisture contents. The true density and porosity of tea increased with the decrease in moisture content. The thermal conductivity and volumetric specific heat capacity of tea leaves decreased with a decrease in moisture content of all three types of tea. Bulk density increased, and true density decreased with an increase in moisture content. Maximum bulk density for CTC was noted to be 545 kg/m^3, and that for Orthodox and Green tea, it was found relatively the same, i.e., 400-435 kg/m^3. At high moisture content, specific heat was high and vice versa. Thermal conductivity and diffusivity were decreased linearly with moisture content. While on the other hand, thermal resistivity was increased with a decrease in the moisture content for all three types of tea. For dielectric properties, a decrease in moisture content of all three types of tea resulted in a decrease of both dielectric constant and loss factor. The time required for CTC tea at 25 kW RF power at 0.08 m tea bed thickness was found to be 80 min. For Orthodox tea, the time required for drying was 60 min, while for Green tea, it was found around 150 min for the same tea bed thickness. The drying characteristics of all three tea were evaluated using different drying curves. The drying mechanism during the falling rate zone was determined for all drying curves. The calculated constant drying rate was higher than measured in all experiments, which clarified that the falling rate zone was capillary controlled. The drying data values were fitted into eleven theoretical, empirical, and semi-empirical thin layer drying models to study tea drying kinetics. Midilli model gave the best fit for all three types of tea when statistically tested with the lowest chi-square and RMSE values. The liquor colour and aroma index were measured using Hunter lab colorimeter and Electronic nose. The liquor colour and aroma index was better for short bed thickness (around 0.08-0.085 m) and between 15 to 16.5 kW RF power levels. The liquor colour values 'a' and 'b' were found slightly the same at low power levels (15 and 20 kW) for CTC and Orthodox tea. At any particular drying time, the highest RF power rating showed higher instantaneous moisture diffusivity, $D_{L(inst)}$, values when compared with values at lower power ratings for the same tea bed thickness at the same time. Moisture ratio and drying rate were predicted using a suitable ANN model design for all three types of tea. During the drying process, the power absorbed in different time intervals was a little high during the initial drying stages. The energy required in different dryers was calculated in MJ per kg made tea. RF dryer required less energy than the conventional hot air drying method used for the comparison.

Keywords: CTC; radiofrequency drying; aroma index; mathematical modeling, ANN modeling