ABSTRACT

Drumstick (*Moringa oleifera*) is an underutilized food commodity, despite of having potential, to be used as functional food ingredient in different food applications. The effect of air velocity and temperature on drying kinetics of the drumstick (*Moringa oleifera*) leaves in a forced convective dryer was investigated. The drumstick leaves were dried in the temperature range of 50-80°C, at different air velocity (D_v) of 0.5 and 1.3 m/s. Experimental data obtained for the samples for color, drying rate and drying time proved that samples dried at 70°C and air velocity of 1.3 m/s yielded the product superior in terms of both quality and energy efficiency as compared to other samples. Mathematical models were fitted to the experimental data and the performance of these models was evaluated by comparing the coefficient of determination (R^2), reduced chi-square (χ^2) and RMSE between the observed and predicted moisture ratio. Verma and Logarithmic model gave the best results for describing the drying kinetics of drumstick leaves. Activation energy for drumstick leaves dried with air velocity, 0.5 and 1.3 m/s was 12.50 and 32.74 kJ/mol, respectively. Effective moisture diffusivity also increased with increase in air velocity and temperature.

The drumstick leaves were blanched for 1-2 min at 80°C in order to minimize the color losses and were dried in electric convective type dryer at 70°C with an air velocity of 1.3 m/s to develop the dehydrated product. Finally, dried leaves were ground and sieved to form fine powder (200 µm) and packed in air tight polyethylene pouches until utilized. Sponge cake was formulated with replacing 0, 2, 5 and 10% of wheat flour with drumstick leaves powder (DLP). Results showed that batter viscosity and specific gravity increased with increase in DLP. Depending upon the replacement level, water absorption, dough development time and mixing tolerance index increased whereas, dough stability decreased. No significant difference was observed in moisture, fat and carbohydrate content, sponge weight and water activity of the sponge cake, but, significant decrease was observed in volume with increasing DLP. The hardness of sponge cake increased with increasing the replacement level. DLP incorporation significantly affected color of crust and crumb. SEM image analysis revealed that uniformity in structure was disrupted with increase in replacement level. DLP sponge cake with 2% replacement level had highest overall acceptability and was stable for a period of 15 days at room temperature (25°C).

The processing conditions were optimized for the extraction of bioactive compounds from drumstick (*Moringa oleifera*) seeds to determine their potential as a source of nutraceuticals. A central composite face centered design was applied to determine the effects of ethanol concentration (%), extraction temperature (ºC), extraction time (min) and particle size (mm) on total phenolic content, total flavonoid content, total antioxidant activity, ferric reducing power and hydrogen peroxide scavenging activity. A second-order polynomial
model was used for predicting the responses. The optimum extraction conditions were found to be ethanol concentration, 49.8 %, extraction temperature, 80ºC, extraction time, 45 min and particle size, 0.62 mm. LC–MS analysis under the optimum conditions showed 12 bioactive compounds. Major compounds were identified as 1Hpyrazol-4-yl methanol, 1-(2-methyl-5-nitro-1H-imidazol-1-yl)propan-2-ol, 1,4-naphthoquinone, luteolin-6-c-glucoside and hesperidin, which possess different biological activities.

The effect of different combinations of carrier agents (maltodextrin, gum arabic and whey protein concentrate) was investigated on the emulsion properties, encapsulation efficiency and oxidative stability of encapsulated drumstick oil powder (EDOP), produced by spray drying to increase its usage as an active ingredient. Feed emulsion characteristics were studied in terms of emulsion stability, droplet size, viscosity and surface charge. Obtained spray dried EDOP was characterized for physical and flow properties, microstructure and oxidative stability. EDOP obtained from the MD:GA emulsion showed higher encapsulation efficiency than MD:WPC. Microcapsules, obtained by MD:GA carrier agent had medium flow properties and better oxidative stability. Microstructure of EDOP with MD:GA showed no cracks, smoother appearance with continuous wall. EDOP with MD:GA had better stability and were stable at 45ºC, which confirms the protective effect of this carrier agent in encapsulating the drumstick oil.

The comparative effect of drying methods was observed on the physical characteristics and oxidative stability of spray and freeze dried microcapsules. Emulsions were prepared using drumstick oil and combination of maltodextrin (MD) and gum arabic (GA) in 1:3 ratio and were dried by spray drying (SD) and freeze drying (FD). Spray dried EDOP showed better encapsulation efficiency, physical, flow and thermal characteristics than freeze dried EDOP. Spray dried EDOP depicted smooth spherical shape without pores, whereas, freeze dried EDOP showed flake like porous irregular particles. TGA thermograms revealed that thermal stability of spray dried microcapsules was superior as compared to freeze dried microcapsules. FT-IR analysis confirms the compatibility of core material with carrier agent.