ABSTRACT

The synergistic blends of sunflower (SO) and sesame oils (SEO) (51:49) were exhaustively characterized for thermal and oxidative stability by Rancimat, thermogravimetry (TG), and differential scanning calorimetry (DSC). The temperature dependent kinetics of lipid oxidation was described using Arrhenius equation (ln k vs. 1/T) and activated complex theory (ln k/T vs. 1/T) to calculate the kinetic parameters *viz.* activation energies, activation enthalpies, and entropies that varied from 91.80 to 99.57 kJ/mol, 86.94 to 95.35 kJ/mol, -30.57 to -4.78 J/mol K, respectively (R^2> 0.90, p< 0.05). The optimized blend (SSOB) consisted of 50.8 and 49.2% of SO and SEO, respectively, and showed highest synergism (115%) and Rancimat IP (100 °C) than SO (13.2 *vs.* 6.1 h). SSOB possess nutritionally stable composition of ω-fatty acids than SO (ω-9, 34.5 *vs.* 28.7%; ω-6, 50 *vs.* 52%) and superior thermal stability (onset temperature, 387 *vs.* 212 °C; oil induction time, 21.6 *vs.* 15.7 min) as measured by gas chromatography and TG/DSC, respectively. Spray dried microcapsules of optimized oil blend were fabricated using modified starch (MS) and protein isolates (PI) (70:30 w/w) as wall matrices. The best microcapsules (ME: 93%) ($D_{[3,2]}$: 0.63 µm; $D_{[4,3]}$: 28.9 µm) (oil blend = 25 %) (MS : PI =3:1) revealed close match of oxidation onset temperature (293 vs. 347 °C), satisfactory retention of MUFA (35.1 vs. 34.5%), PUFA (44 vs. 50 %) and calculated oxidizability (4.83 vs. 5.52) vs. oil mix. FTIR confirmed minimal interactions between oil and wall components while SEM revealed semi-spherical microcapsular morphology with insignificant surface fissures.

The best formulation of microcapsule was further optimized for the spray drying process conditions based on seven major response parameters using response surface methodology (RSM) and multilayer perceptron (MLP) artificial neural networks (ANN). The optimum ME (%), PV, color (L*), moisture (%), porosity (%), hygroscopicity (%) and BD were obtained as 92.61 %, 12.82 meq / kg oil, 87.04, 3.66 %, 52.07 %, 4.49 % and 404.83 kg/m^3 at inlet temperature 170.3 °C and feed rate 2.9 mL/min. The developed neural network (MLP ANN) was able to predict efficiently different physico-chemical parameters studied for the microencapsulated vegetable oil blend (MESSOB) with a R^2 values ranging between 0.75-0.98. The overall relative error during training (0.75) and testing (0.55) obtained were also satisfactory. Adsorption isotherms of MESSOB were determined by static gravimetric technique at 15, 30 and 45 °C. The data obtained were fitted to five different sorption models. A non-linear least square regression analysis was adopted to evaluate the model constants. The experimental sorption data were best fitted to four parameter Peleg model. The monolayer moisture contents found from GAB model were in the range of 2.83-3.99 kg H_2O per kg dry solids. Net isosteric heat of sorption was evaluated using the Clausius–Clapeyron equation and differential entropy decreased with increasing moisture content. Gibbs-free energy decreased with increasing equilibrium moisture content. The spreading pressure increased with the rise in water activity for all temperatures.

The storage stability of MESSOB in terms of MC (%), ME (%), PV, p-AV, FFA (%) and CI of MESSOB packed in aluminium laminated low density polyethylene (ALLDPE) were studied along with their change kinetics under ambient (30 °C, 75 % RH) and accelerated (40

°C, 90 % RH) conditions. Based on Rancimat analysis, the shelf-life determined of MESSOB and oil blends at 30 °C was 214 and 192 days respectively. In frozen dessert formulation, based on similarity value, it can be concluded that 30 % milk fat replacement with vegetable oil powder in frozen dessert has no significant difference with control ice cream in terms of sensory attributes. In comparison to the control ice cream, the optimized frozen dessert has 83.6 % higher DPPH radical scavenging activity and higher amount of PUFA (20.2 %) than control ice cream sample (2.7 %).

Keywords: Vegetable oil blend, omega fats, rancimat, microencapsulation, thermo-oxidative stability, frozen dessert.