ABSTRACT

Exploitation of natural preservatives in consumer goods has increased due to the rise of green consumerism. The oleoresin rosemary (*Rosmarinus officinalis*) can increase the oxidative stability of foods due to its antioxidant properties. The application of rosemary (ROS) as a natural preservative in sunflower oil (SO) can be exploited due to its antioxidant and nutraceutical property. The antioxidant activity of ROS was evaluated using photochemiluminiscent (PCL) assay, DPPH assay and Rancimat test. Using PCL assay, the antioxidant capacity of lipid (ACL) soluble compounds were quantified and compared with percentage radical scavenging activity (%RSA). The EC_{50} value of ROS obtained from PCL (22.7 mg/L) and DPPH assay (19.07 mg/L) were significantly correlated (r=0.997, p<0.01). High antioxidant activity of ROS (ACL, 82.28 µmol Trolox/g and RSA, 67.17%) was well supported by high phenolic (154.8 mg GAE/g) and flavonoid (32.1 mg QE/g) content. UPLC-MS/MS analysis revealed the presence of 23 different phenolic compounds categorized into phenolic acids, diterpenes and flavonoids. The oxidation kinetics of SO mixed with ROS (SORB) was tested at different concentrations (200-2000 mg/kg oil) using Rancimat test. The classification of samples was performed using principal component analysis (PCA) and hierarchical cluster analysis (HCA). The IP values and kinetic rate constant (k) of SORB samples were found to increase and decrease, respectively, with concentration from 200 to 1500 mg ROS/kg oil, respectively. PCA and HCA discriminated SORB from control SO ($SO_{control}$), and SO mixed with TBHQ (SO_{TBHQ}) at 200 mg/kg oil. SO containing 1500 mg ROS/kg oil possessed the highest oxidative stability and shelf life (SL) of 174 days. The synergistic blend of ROS (200–1500 mg/kg oil) and ascorbyl palmitate (AP) (100–300 mg/kg oil) was optimized using hybrid PCA–RSM approach to achieve maximal shelf life of SO. An optimal combination of 1309.62 mg ROS/kg oil and 129.29 mg AP/kg oil was optimized with predicted SL of 194 days at 25 °C. Three different empirical models *viz.*, partial least square, Rancimat and unified for SL prediction were developed for SO mixed with ROS and AP which estimated the SL with prediction error of ±2.99, ±11.22 and ±3.32%, respectively. The highest SL_{25} was estimated to be 337 days for SO containing 1309.62 mg ROS/kg oil and 129.29 mg AP/kg oil. The SO mixed with ROS and AP was tested for thermo-oxidative stability during frying process for 18 h at 180 °C. The formation of total polar compounds (TPC) and polymeric compounds *viz.*, trigyceride polymers (TGP) and dimers (TGD) were estimated during the frying. SO containing 1309.62 mg ROS/kg and 129.29 mg AP/kg reached the critical limit for TPC (25%) and TGDP (10%) after 15.9 and 15.2 h, respectively, which was higher than SO_{TBHQ} (14.7 h and 14.4 h, respectively). Using electronic nose, the frying disposal time based on critical limits of TPM and TGDP were estimated to be 14.34 and 13.7 h, respectively. The SORB sample containing 1309.62 mg ROS/kg and 129.29 mg AP/kg exhibited slightly better oxidative stability (PV 61.2 meq./kg, CDV 48.3 mmol/L, FFA 0.7 mg KOH/g, IP 0.4 h) during accelerated storage for 28 days at 60 °C, 75% RH, 600 lx (light) compared to SO_{TBHQ} at 200 mg/kg oil (PV 63.3 meq./kg, CDV 48.8 mmol/L, FFA 0.7 mg KOH/g, IP 0.1 h.

Keywords: Rosemary (*Rosmarinus officinalis*), sunflower oil, oxidative stability, shelf life, total polar compounds, frying.