ABSTRACT

Ready-to-eat (RTE) foods are becoming increasingly popular in the present era due to their ease of preparation, consumption and storage. By the end of 2024, Indian snacks market will become more than ₹ 1 Billion. The study aimed to develop the process for a healthy snack rich in protein and fibre components with focus on utilization of apple industry waste by-product viz. apple pomace. Twin screw extrusion of pea flour (PF), corn flour (CF) and apple pomace (AP) composite flour at fixed extrusion process conditions was carried out to formulate the ingredients (D-Optimal mixture design) based on physical attributes viz. expansion ratio, bulk density and hardness. Optimum formulation was subjected to optimization of extrusion process parameter (central composite rotatable design) to arrive at optimum quality (physical) extrudates. Extrudate expansion ratio modeling was done using the extrusion process parameters. The optimized RTE snack was further investigated for nutritional, functional and sensory quality; thereafter storage studies and evaluation of shelf life of developed RTE snack was done.

PF (30-50 %), CF (50-70 %) and AP (0-15 %) at fixed moisture content (20 % wb) and process parameters yielded quality extrudates at optimum formulation ratio of 30:55:15 (PF: CF: AP). Optimized values of the physical attributes were ER 2.72, BD 505.29 kg/m^3, H 8.14 N with 0.704 desirability. Validation results showed that all the parameters resulted in values where the percentage error between the experimental and predicted values was less than 5 %. Extrusion process parameters *viz*., die head temperature (150-170 °C), screw speed (35-50 rpm) and feed moisture (15-25 % wb) yielded extrudates with ER 2.36, BD 435.95 kg/m^3, H 9.66 N, AOX (% RSA) 76.47, TPC 67.96 mg/100 g GAE and SME 12.09 W h/ kg with desirability 0.834. Validation results were compared by predicted values and the percentage error was within 10 % for all the parameters. Extrudate expansion modeling of the expansion ratio using extrusion process parameters was conducted by using Teaching-Learning-Based Optimization (TLBO) algorithm. Average absolute deviation (AAD %) and the relative deviation (RD %) was calculated based on 20 experimental runs. Relative deviation (RD %) values are less than 10 % in more than 15 experimental runs. The average absolute deviations (AAD %) of the model was 7.45 %, which was less than 10 % proving the model validated. Optimized protein-fibre rich RTE snack was low in fat and was categorized 'liked very much' through sensory acceptance. The developed RTE snack had 14.5 % protein and 3.5 % fiber quantity along with considerable amount of antioxidant and phenolics, which proved to be a healthy and nutritious snack made from low cost underutilized raw ingredient. BET model showed good fit which can describe the sorption behavior of RTE extruded snack. The critical water activity of the RTE extruded snack stored in metallic polyester (MP) pouch of 30 µ and 40 µ obtained was 0.472 and 0.467 respectively and the corresponding shelf life obtained was 37 days and 40 days in the accelerated storage conditions. The predicted shelf life of the RTE extruded snack stored in 30 µ and 40 µ pouch were 32 days and 36 days, respectively.

Keywords: Ready-to-eat snack, Pea flour, Corn flour, Apple pomace, Response surface methodology, Expansion ratio, Teaching-learning-based-optimization, Shelf life