Abstract

The aim of this study was to design and develop a hot air puffing machine and preparation of puffed ready-to-eat snack food from barnyard millet (BM) flour. For this purpose a lab scale hot air puffing machine run by 1 hp electric motor, suitable for puffing of pre-gelatinized cold extrudates (0.03 kg per lot) prepared from composite flour dough was designed. It was designed with a total height of 145 cm and to be operated by a single person. The operational temperature range of the machine can be adjusted from 80 to 270 °C and the air velocities from 0.4 to 10 m s⁻¹ can be obtained in puffing chamber.

The cold extrudates were prepared from BM flour, potato mash and tapioca powder in the proportion of 60:37:3 respectively, and were steam cooked. These cold extrudates with initial moisture of 0.60 kg kg⁻¹ dm could be optimally steamed at 0.85 kg cm⁻² steam pressure for 10 min and puffed at 234 °C temperature for 39 s followed by oven toasting at 116.3 °C for 20.3 min to prepare ready-to-eat barnyard millet snack food. The changes in chemical composition during all the stages of processing were nonsignificant except in fat content which reduced by 42.7 % during cold extrusion. The calorific value of the developed product was 380.74 kcal per 100 g. Thomson equation could be best fitted to the moisture removal behaviour with puffing time and the effective diffusivity increased from 2.62×10^{-9} to 4.97×10^{-9} m² s⁻¹ at air temperatures from 210 to 250 °C. The heating of the product during initial 8 to 15 s, resulted in case hardening followed by expansion of product and further heating up to 25 s, resulted in maximum expansion of the product. The rates of moisture removal were increased due to large pores and cracks which were evidenced in microstructural view of the product. The Colburn analogy was used to calculate the surface heat transfer coefficients, which decreased from 93.50 to 88.83 W m⁻¹ °C⁻¹ with increase in air temperatures. The sensory evaluation indicated that the puffed and toasted RTE BM snack food applied with spice was comparable with commercially available similar snack foods. At moderate relative humidity of 65 % and temperature of 32 °C, this product could be well stored in metallic polyester (60 micron) package for considerably long shelf life of 228 days, respectively.

Keywords: Hot air puffing, barnyard millet, snack food, cold extrudates, crispness, hardness, microstructure, effective diffusivity, CCRD, RSM.