Studies on Manufacture of Micronutrient Fortified Rice Kernels Using Extrusion Technology

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(Roll No. 15AG92P05)

Abstract of the Thesis

Fortified rice kernels (FRK) were prepared using rice brokens and vitamin-mineral premix (VMP) using extrusion technology. The concentrations of iron, folic acid, and vitamin B_{12} in FRK were set as 280-425 mg, 750-1250 µg, and 7.5-12.5 µg per 100g, respectively as per FSSAI guideline (2018). The experimental plan included the study of mixing VMP in rice flour in the paddle blender with the rotational speed of the paddle, N_p (60-80 rpm) and mixing time, t_m (2-60 min) to evaluate the effect on homogenous distribution of iron and moisture content; optimization of extrusion process condition using die head temperature, T_{DHT} (70-110°C), extruder screw speed, S_{ES} (40-80 rpm) and feeder screw speed, S_{FS} (20-60 rpm) as machine parameters and feed moisture content, M_F (26-34 %wb) as a material parameter to find the impact on system parameters; physicochemical properties and cooking characteristics of FRK and the effect of drying conditions viz. drying temperature, T_{air} (40-70°C) and velocity, V_{air} (0.5 and 1.0 m/s) on quality of FRK. Further, the effect of the addition of hydrocolloids (HYC) viz. sodium alginate, guar, and xanthan gum (with 0.5-1.5% w/w concentration) on the cooking and textural properties of FRK and characterization of FRK and sensory evaluation of micronutrient fortified rice were studied. The results suggested the optimum mixing process parameters as 80 rpm N_s, 30 min t_m, and 40% filling level at which iron, folic acid, and vitamin B_{12} were found within the acceptable range. All the extrusion process parameters had significantly affected the properties of FRK. Based on numerical optimization to prepare FRK, the optimum extrusion condition was obtained as 29-31 %wb M_F, 90-92°C T_{DHT}, 58-60 rpm S_{ES}, and 38-40 rpm S_{FS}. The validation trial showed the variation between predicted and experimental values of responses less than 10%. The drying of FRK occurred in the falling rate region, T_{air}-t_d dependent while the effect of V_{air} was not significant. The Page, Diffusion, and Midlli-Kucuk models were found best for the drying of FRK. The drying of FRK at 40°C showed better cooking characteristics and no fissure formation in the kernels. The addition of HYC significantly reduced the solid losses during cooking and improved WAR and textural properties of HYC treated FRK as compared to control FRK. The sensory evaluation had shown no significant difference in quality attributes such as appearance, colour, aroma, texture, taste and overall acceptability of unfortified rice and micronutrient fortified rice (FRK + Natural rice: 1+99).

Keywords: Fortified rice kernel; Mixing; Extrusion, Drying; Hydrocolloids; Micronutrient fortified rice