

Drying of sliced tomato (*Lycopersicon esculentum* L.) by a novel halogen dryer: Effects of drying temperature on physical properties, drying kinetics, and energy consumption

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Abstract

This study aimed to explore the impact of halogen drying temperature (60, 70, and 80°C) on drying kinetics and some sensory and physical properties of tomato slices. Also, the suitability of previously proposed models for predicting the drying process of tomato slices was assessed and compared with that of a newly proposed model using root mean square error, reduced chi-square, and determination coefficient. According to the results, increasing the drying temperature from 60 to 80°C reduced the drying time from 150 to 106 min but increased energy consumption. Experimental drying curves indicated only one falling drying rate period for the drying temperatures of 60 and 70°C, while two consecutive falling rate periods were observed for

drying temperatures of 80°C due to the case-hardening phenomenon. The highest sensory score was obtained for samples dried at 60°C. Also, the effective moisture diffusion varied between 7.96×10^{-9} and 1.07×10^{-8} m²/s. The color parameters (L^* , a^* , b^* , a^*/b^* , and ΔE) of samples were significantly affected by drying temperature. The browning index and mass transfer coefficient increased significantly ($p < .05$) with the increase of the drying temperature. The results introduced halogen drying as a promising processing technology for drying tomato slices.

Practical applications

Drying, such as tomato slices drying, is one of the common process in the food industry. A novel drying technique, that is, halogen drying, was explored in the present study. This innovative process showed a good potential for upscaling, considering its ability in saving energy consumption, reducing drying time, and producing high-quality products. Also, the effects of important process parameters, such as drying temperature, on the quality of the product were explained which can help with future commercial applications. Furthermore, the new mathematical models proposed in this

Abbreviations: a^* , redness for dried tomato slices; ANOVA, analysis of variance; a_{eff} , redness for fresh tomato; A_w , water activity; b^* , yellowness for dried tomato slices; BI, Biot number; BI, browning index; b_{eff} , yellowness for fresh tomato; CRD, complete randomized design; D , moisture diffusivity (m²/s); d_b , dry basis; D_{eff} , effective moisture diffusion (m²/s); D_0 , constant of Arrhenius equation (m²/s); DR, drying rate (g water/min); E_a , activation energy (kJ/mol); HD60, samples dried by halogen dryer at 60°C; HD70, samples dried by halogen dryer at 70°C; HD80, samples dried by halogen dryer at 80°C; J , lag factor (dimensionless); k_m , mass transfer coefficient (m/s); L , slab half thickness of tomato slices (m); L^* , lightness for dried tomato slices; \bar{L} , length of tomato; L_0 , lightness for fresh tomato; $M_1 + M_{\text{eq}}$, moisture content (kg water/kg db); M , moisture content (kg water/kg db); M_c , moisture content; M_{eq} , equilibrium moisture content (kg water/kg db); M_0 , initial moisture content; MR, dimensionless moisture ratio; MR_{exp} , experimental moisture ratio; MR_{pred} , predicted moisture ratio; M_1 , moisture content (kg water/kg db); M_{eq} , mass of water evaporated from tomato (kg); n , number of constants; N , number of observations; P , consumed power (kW); R , gas constant (8.31451 kJ/mol K); R , regression coefficient; R^2 , determination coefficient; RMSE, root mean square error; S , drying coefficient (1/s); SEC, specific energy consumption (kJ/kg); t , drying time (min); T , temperature; T , thickness of tomato slices; W , width of tomato slices (mm); χ^2 , chi square; ϵ , drying efficiency (%).