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Computational studies of drying characteristics in thin-layer microwave-heated *Solanum tuberosum*

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Abstract

Solanum tuberosum is a starchy crop material, used significantly in food and beverages. It belongs to *Solanaceae* family and is globally known as potato. In this research article, the detailed computational and experimental analyses of the drying characteristics, such as rate of evaporated moisture, energy efficiency at various powers, and drying time have been carried out. Moisture removal is a function of preservation process from food spoilage, and it can be done by microwave heating. To study the behavior of spoilage due to various affecting parameters, a mathematical model for potato sample has been developed. Key parameters for the prediction are moisture distribution and drying efficiency at various microwave powers. For numerical solution of the developed mathematical model, MATLAB software has been used. The obtained results show the values of moisture content throughout the potato sample and drying efficiency of the microwave oven. Experiments have been performed in microwave oven for potato samples to obtain the required parameters. Computational results were found in good agreement with the experimental data.

Keywords Mass balance calculation · Moisture content · Energy efficiency · MATLAB software

List of symbols

D_{eff}	Effective diffusivity ($m^2\ s^{-1}$)
D_0	Pre-exponential factor ($m^2\ s^{-1}$)
M	Moisture content (g moisture g db^{-1})
E_a	Activation energy (W g^{-1})
m	Mass of the sample (g)
M_0	Initial moisture content (g moisture g db^{-1})
H	Sample thickness (m)
X_m	Moisture content at specified time (g moisture g db^{-1})
E_a	Activation energy (W g^{-1})
L	Length of the sample (m)
P	Incident power at the surface (W)
Δt	Drying time interval (min)
m_w	Mass of evaporated water (g)
λ_w	Latent heat of vaporization of water (J/g

Introduction

Crops and vegetables are the sources of proteins and useful nutrients. Recently, the demand and supply of fresh food have been increased by approximately 300 lb per capita (Zhou et al. 2018; Li et al. 2019; Aghbashlo et al. 2015). Grains are found as NRTE (Not ready to eat food), are in natural form, but we cannot intake or consume them directly. *Solanum tuberosum* is a vegetable and grown globally and also known as potato. There are more than 4000 varieties of the potato on our earth planet and 80 varieties are used for commercial purposes. Some important varieties of *S. tuberosum* are red potatoes, russet potatoes, white potatoes, purple potatoes, and yellow potatoes. The processed foods can be manufactured by removing the moisture content with drying operation. Dehydration is the oldest method for controlling the bacterial effect to prevent food spoilage (Barrett et al. 1998; Castro et al. 2018). All harmful microorganisms, such as *Bacillus cereus and Campylobacter jejuni*, etc., may grow in food material due to the presence of water (Huang et al. 2019). These microorganisms can cause some undesirable reactions. Due to this, the properties of food material, including flavor, odor, color, etc., may deteriorate and causes the food spoilage (Xu et al. 2019).

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