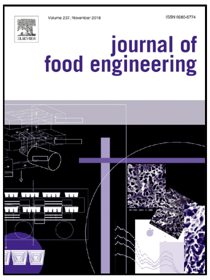

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Thermo-hydrous behavior of dried un-blanched potato samples

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Abstract

This study concerns a purely convective drying of parallelepiped un-blanched potato slices. A numerical model for heat and mass transfer has been developed in Lagrangian referential to overcome the structural changes. The thermo-physical properties of the slices vary with the temperature and moisture content. The finite volume method combined with a typically implicit time pattern was used to solve the model equations. The evaporated mass flux was calculated using the transfer surface area by which the water evaporates, and heat transfer coefficient was estimated using Nusselt number; The inverse method was used in this computation. The experiments were carried out under several thermo-aeraulics conditions in order to determine the most influent operating variable on the drying kinetic. A good agreement between experimental and simulated results was obtained with a moisture content determination coefficient (R^2) higher than 0.9980; Whereas, the surface and center temperatures are higher than 0.9328 and 0.9305 respectively. The results have shown that the air temperature is the most important parameter that controls the drying kinetic.

Keywords: Experiment; Convective drying; Mass and heat transfer; Numerical model; Drying rate, Potato.

Nomenclature

c_p	specific heat, J kg^{-1} K^{-1}
D	water diffusion coefficient, m s^{-2}
DR	draying rate, kg$_w$ kg$^{-1}_{ds}$ min^{-1}
e_p	thickness, m
F_m	evaporation rate, kg$_w$ m^{-2} s^{-1}
h_c	heat convective exchange coefficient, W m^{-2} K^{-1}
Hr	air relative humidity, %
l	width, m
L	length, m
L_v	latent heat of vaporization, J kg^{-1}
m	mass, kg
M_v	molecular weight, kg mol^{-1}
P_t	atmospheric pressure, Pa
P_v	water vapor pressure, Pa
R	universal gas constant, J mol^{-1} K^{-1}
S	surface, m^2
t	time, s
T	temperature, K,°C
V	velocity, m/s
v_s	solid displacement, m s^{-1}
X	moisture content, kg $_w$ kg$^{-1}_{ds}$

Dimensionless Numbers

Le: Lewis number
Nu: Nusselt number
Pr: Prandtl number
Re: Reynolds number

Greek letters

ρ: density, kg m^{-3}
ψ : linear shrinkage coefficient
ζ : Lagrangian coordinate
λ: thermal conductivity, W m^{-1} K^{-1}
σ: Stephan-Boltzmann constant, W m^{-2} K^{-4}
ε: Emissivity

Subscripts

$_0$: initial value
a: air
c: center, middle
cr: critical
ds: dry solid
eff: effectif
h: humid
l: liquid
moy: average
p: wall of dryer
s: solid
sat: saturated
$surf$: surface
v: vapor
w: water

Introduction

The moisture content of the most agro-foodstuffs is 70-95 % (wet basis) (Kiranoudis et al., 1993), this has imperatively an influence on microbiological activity (Nagwekar et al., 2017), volume and product stability (storage life). In 2016 total world production of potato was more 376 million tons (FAOSTAT, 2018), two thirds are consumed by people as food, the other third production is used in transformation industries (Friedman et al., 2017; Park & Yoon, 2018). However, Algeria is considered as the biggest producer of potato in Africa, more than 4.78 million tons in 2016. Unfortunately, some part of the harvest has to be left to the abundant because of a bad industrial or commercial orientation. The glucides are the principal constituent of potato dry matter (16-25 %), mainly starch (60–80 % of the total dry matter contents) (Youcef-ali et al., 2001; Levly & Rabinowitch, 2017); they are used in pharmaceuticals, cosmetics, textiles, woods and papers industries.

In recent years, drying consumes a lot of energy, up to 70 % for wood industry and 50% for the textile (Minea, 2013), whereas the food industry consumes about 15 % (Perussello et al., 2014), although an inappropriate drying can increase this consumption and decrease the final product quality. The quality concept can be characterized by microbiological activity, the shrinkage, nutritional control and the sensory characteristics (Tsami et al., 2000; Chua et al., 2000; Cui et al., 2008) which are directly related to product moisture content and temperature (Kalbasi et al., 2000). During drying, the product dehydrates on the surface faster unlike the heart (Wang & Brennan, 1993; Srikiatden et al., 2008; Mihoubi et al., 2009). Consequently, to