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Ultrasound in wet biological materials subjected to drying

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Abstract. The aim of this article is to present the effect of external action of air-borne ultrasound (US) upon biological wet materials subjected to drying. The study allows to determine the drying effectiveness of such products like fruits and vegetables by convective drying with ultrasound enhancement. The vibration and heating effects induced by power ultrasound are considered. The mathematical model of drying is developed and validated experimentally using the data obtained from the experimental tests carried out on the hybrid dryer equipped with ultrasonic generator. The obtained results prove that the vibration effect induced by ultrasound has a great impact on the acceleration of mass transfer without significant elevation of product temperature, and thus on the drying efficiency with respect to energy utilization and the quality of dried products like fruits and vegetables.

Key words: Drying; Ultrasound; Biological materials; Experimental; Mathematical modeling.

1. Introduction

Main aim of this article is a profound recognition of the interaction mechanism between ultrasonic wave and the saturated porous materials [Aksielrud & Altszuler, 1987; Scheidegger, 1974; Śliwiński, 2001; Povey, 1997; Galego-Juarez, et al. 1999], which entails the reason for intensification of moisture removal from dried products. Ultrasound represents a high-frequency waves passing through saturated medium in which the periodical high and low pressure is created [Kudra & Mujumdar, 2002; De la Fluente-Blanco, et al. 2006].

Lately more and more literature reported about very positive influence of ultrasound on drying efficiency of biological materials such as fruits and vegetables [Garcia-Perez, et al. 2007; Carcel et al. 2012; Musielak et al., 2016; Mulet et al. 2003; Patist & Darren, 2008]. However, these reports do not explain fully the US mechanism contributing to the process intensification and improvement of the product quality by drying with ultrasound enhancement [Ortuno et al., 2010; Zehn et al., 2011; Mujumdar & Jangam, 2012].