Powder Technology 203 (2010) 359–364

Contents lists available at ScienceDirect

Powder Technology

journal homepage: www.elsevier.com/locate/powtec

Resistance to airflow through bulk pistachio nuts (Kalleghochi variety) as affected by moisture content, airflow rate, bed depth and fill method

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ARTICLE INFO

Article history:
Received 26 September 2008
Received in revised form 22 March 2010
Accepted 27 May 2010
Available online 12 June 2010

Keywords:
Pistachio nuts
Drying
Aeration
Ventilation
Storage
Pressure drop

ABSTRACT

The prediction of airflow resistance is fundamental to the design of efficient drying and aeration systems for pistachio nuts. Using a laboratory unit, the pressure drop across a column of pistachio nuts (Kalleghochi variety) was investigated to determine the effect of moisture content, airflow rate, bed depth and fill method. Five levels of moisture contents (4.80, 14.50, 23.70, 37.60 and 45.60 w.b.%), four bed depths (25, 50, 75 and 100 cm) and two fill methods (loose and dense) were studied with airflow rates ranging from 0.08–1.00 m^3/S m^2. Results indicated that resistance to airflow through a column of pistachio nuts increased with increasing bed depth, moisture content and airflow rate for both dense and loose fill method. Airflow rate was the most significant factor affecting the pressure drop of pistachio nuts followed by fill method and moisture content. The dense fill of pistachio nuts produced higher resistance to airflow compared with the loose fill. Among the three models (Shedd, Hukill and Ives, and Ergun equation) investigated to describe pressure drop data of pistachio nuts, Ergun equation was found to be the most suitable for describing the pressure drop data of pistachio nuts.

1. Introduction

The pistachio is a nut with a high lipid content and very rich in unsaturated fatty acids and this makes a pistachio nut a very sensitive product to rancidity and mold contamination. Proper harvesting and postharvest handling are key operations in achieving maximum yield of good quality of pistachio nuts and determine marketability and profit. Processing right after harvesting is very important on pistachio quality. The quality of dried nuts and their cost are greatly influenced by the drying and storage operation. Drying, aeration and storage are key stages in pistachio nut production. During the inappropriate handling and processing, nuts can undergo undesirable reactions (particularly rancidity and oxidative reactions) which cause degradation of quality and mold growth. For long-term safe storage of nuts, they must be kept cool and dry. Common problems encountered during unsuitable storage of pistachio nuts are the growth of molds and the infestation of nuts by pests. In this case, control of moisture content and temperature are necessary to prevent quality and quantity deterioration during storage. Therefore, in order to remove moisture and temperature within bulk, aeration systems must be employed during storage.

Drying or aeration is done by forcing air through the bulk nuts to remove high moisture and temperature gradients within the bulk. An important step in designing drying and aeration systems is sizing the fans. Fans that are misplaced or sized incorrectly lead to failure of the entire system. For an energy-efficient design of drying and ventilation systems, as well as choosing correct fan size or assessment of filling depths in storage bins, information on the airflow resistance of grains or nuts is essential [1–3]. The airflow–pressure drop relationships are useful in the mathematical modelling of airflow pressure patterns and airflow distribution in stored grain masses [4–9]. Drying and aeration systems designed for cereal grains such as wheat or maize may not be suitable for oilseeds or nuts since they offer higher resistance to airflow [10]. Hence, the data on airflow resistance of pistachio nuts are required for engineering design of drying and aeration systems. The resistance to airflow of cereal grains and oilseeds has been studied for 70 years [11]. The pressure drop through a bed of grains depends on the airflow rate, bed depth, filling method, moisture content, presence of foreign matter and surface and shape characteristics of the grain [12]. The effect of these parameters on the airflow resistance of grains or oilseeds has been reported by Akritidis (1979) for pumpkin seed, Jayas (1987) for canola, Siebenmorgen (1987) for rough rice, Gunasekaran (1988) for sorghum, Patil (1988) for oilseed rape, Sokhansanj (1990) for lentil, Dairo (1994) for sesame, Giner (1996) for wheat, Pagano (2000) for oat seeds, Chung (2001) for sorghum and rough rice, Nalladurai (2002) for paddy, Nimkar (2002) for green gram, Tabil (1999) for sugar beets and Maw (2002) for sweet onion [13–24]. Kashaninejad and Tabil (2009) studied the airflow resistance of Ohadi variety of pistachio nuts but there is no data on the resistance to airflow through bulk pistachio nuts of Kalleghochi variety, although

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doi:10.1016/j.powtec.2010.05.030