Powder Technology 188 (2008) 1–8

Contents lists available at ScienceDirect

Powder Technology

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

Handling and frictional characteristics of soybean as a function of moisture content and variety

M. Kashaninejad *, M. Ahmadi, A. Daraei, D. Chabra

Department of Food Science & Technology, Gorgan University of Agricultural Sciences and Natural Resources, Beheshti Ave., Gorgan, 49138-15739, Iran

ARTICLE INFO

Article history:
Received 8 June 2007
Received in revised form 11 February 2008
Accepted 21 March 2008
Available online 1 April 2008

Keywords:
Angle of repose
Bulk density
Geometric mean diameter
Kernel density
Porosity
Soybean
Sphericity
Static coefficient of friction
Surface area

ABSTRACT

Handling and frictional properties of soybean are needed for the design of the storage, processing, drying, aeration and handling systems. In this research some handling properties (dimensions, volume, sphericity, surface area, bulk and kernel densities, porosity) and frictional properties (empyting angle of repose and friction coefficients against five different surfaces) were investigated for four varieties of soybean: Williams, BP, LWK and Sahar, as a function of moisture content in the range from 8 to 24 (w.b.%). All physical characteristics of soybean varieties were significantly affected by changing moisture content in the studied range. The results showed that the principal dimensions, unit mass, geometric mean diameter, surface area, volume, kernel density and porosity increased linearly with increasing moisture content for all varieties, while sphericity decreased linearly and bulk density showed a quadratic trend for all varieties when the moisture content increased from 8 to 24 (w.b%). The coefficient of static friction increased linearly against all the tested surfaces as the moisture content increased. As well as angle of repose for emptying increased linearly with increasing of moisture content for four varieties. The relationships between the measured properties and moisture content of soybean varieties were obtained and represented by regression equations.

1. Introduction

Soybean is a major member of the legume family and it plays an important role in healthy nutrition because of its valuable composition. Its protein content (38–44%) is higher than that of other legumes (20–30%) and much greater than that of cereals, (8–15%) [1]. This, coupled with its good amino acid profile, enhances its value as a foodstuff, and is one of the reasons for the economic importance of soybean.

The design of storage, handling and processing systems for bulk materials such as soybean requires data on bulk and handling properties namely, dimensions, sphericity, bulk and kernel densities, and friction coefficients of bulk materials on most commonly used structural materials. Theories used to predict the pressures and loads on storage structures require bulk density, angle of repose and friction coefficients against bin wall materials. Also the design of hoppers for processing machinery requires data on bulk density and angle of repose. Bulk density is also used in design of drying and aeration systems because it affects the resistance to airflow of a stored bulk. Bulk density, kernel density, and porosity can be useful in sizing grain hoppers and storage facilities; they can also affect the rate of heat and mass transfer of moisture during aeration and drying process. Principle axial dimensions of seeds are useful in selecting sieve separators and calculating grinding power during size reduction. They can also be used to calculate surface area and volume of kernels which are important during modeling of seed drying, aeration, heating, and cooling. Such information is useful in sizing motor requirements for seed transportation and handling. Therefore the determination and consideration of these properties has an important role in the soybean industry [2–4].

Bulk and handling properties have been studied for various crops such as pigeon pea, rapeseed, safflower seed, lentil seeds, cocoa beans, sunflower seed, chick pea seeds, cotton seed, caper seed, green soybean, pistachio nut and sorghum [5–16]. Although some physical properties of soybean and green soybean have been reported [14,17], but some important handling and frictional properties such as static coefficient of friction against various surfaces and angle of repose have not been reported.

The objective of this study was to determine some flow and handling properties of four varieties of soybean (Sahar, LWK, BP and Williams) as a function of moisture content in the range from 8 to 24% (w.b.). In this research three axial dimensions, geometric mean

* Corresponding author. Tel./fax: +98 171 4426432.
E-mail addresses: kashaninejad@yahoo.com, kashani@gau.ac.ir (M. Kashaninejad).

0032-5910/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.powtec.2008.03.004