J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (5): 495 - 507, 2011

AERODYNAMIC PROPERTIES OF SOME OILSEEDS CROPS UNDER DIFFERENT MOISTURE CONDITIONS

El-Gamal, R. A.; S. M. A. Radwan; M. S. ElAmir and G. M.A. El-Masry
Agric. Eng. Dept., Fac. Agric., Suez Canal Univ., Ismailia, Egypt

ABSTRACT

This study was carried out to evaluate some aerodynamic properties of some oilseeds (peanut kernels, soybean and cotton seeds) under different moisture conditions. Peanut kernels were conditioned to moisture contents of 6.1, 9.3, 16.0, 28.4 and 34.9% (w.b.), soybean seeds to 7.8, 14.4, 21.0, 26.0 and 31.8% (w.b.) and cotton seeds to 6.4, 8.6, 10.8 and 12.5% (w.b.). Aerodynamic properties such as terminal velocity, Reynold's number and drag coefficient were determined for all tested seeds as a function of moisture content. The results revealed that the measured aerodynamic properties are significantly affected by moisture contents for the three tested oil crops. When the moisture content increased the terminal velocity and Reynold's number increased for all investigated seeds. However, the drag coefficient did not show a consistent trend with moisture content increment for peanut kernels and soybean seeds. While, it decreased for cotton seeds with moisture content increment.

Keywords: Aerodynamic properties; Oilseeds; Moisture content, Peanut, Soybean, Cotton seeds.

INTRODUCTION

Oil seed processing has become a major industry throughout the world economy as food producers continue to develop more uses for these edible oils. Oil can be derived from numerous seeds such as soybean, cotton, and peanut. In Egypt, the total productivity of oil represents 15-25% of the total oil requirement while 75-85% is exported from different countries. In the last few decades, many efforts have been exerted for attempting to constrict the nutrition gab by increasing the average consumption of oil foods per person every year (Owies, 2003). In order to design equipment for cleaning, handling, aeration, storing, and processing of oil seeds, it is necessary to study the pneumatic conveying characteristics of these seeds (Kılıçkan and Güner, 2006).

Generally, in handling and processing of agricultural products, air is normally used as a carrier for transport or for separating the desirable products from undesirable materials, therefore the aerodynamic properties such as terminal velocity and drag coefficient are needed for air conveying and pneumatic separation of materials (Sahay and Singh, 1994). For conveying agricultural material, the range of proper air streams should be used. With low air speed, there is stagnation in the system, or with high air speed, there is not only energy loss, but also grains may be broken. The proper air speed can be determined from aerodynamic properties of agricultural materials (Khoshtaghazan and Mehdizadeh, 2006). Moreover, seed separation can be accomplished using pneumatic separators, screen cleaners, or gravity tables. Many commercial cleaners incorporate more than one of these cleaning methods. For optimum utilization of these methods, it is helpful to know the aerodynamic characteristics not only for seeds but also for undesirable materials (Hauhouot-O'Hara *et al.*, 2000). The behavior of particles in an air stream is governed by their aerodynamic properties. The parameters which characterize the aerodynamic properties of particles are the terminal velocity, the resistance coefficient and drag coefficient (Klenin *et al.*, 1985). Terminal velocity means the air velocity required to suspend the particles in the vertical stream (Mohsenin, 1984). In addition, the terminal velocity of seeds can be investigated by two methods. The first method utilizes time estimate for free fall from various heights. In the second method a particle is placed in a vertical air stream and the air velocity is adjusted until the particles are suspended. Since the forces acting on the body are then in equilibrium, the air velocity is equal the terminal velocity for the particles (Shokr and Sadaka, 1999).

On the other hand, the aerodynamic properties of seeds are highly affected by moisture content where for most grains and seeds, as the moisture content increased, the terminal velocity also linearly increased. In case of cotton seeds, it has been revealed that the terminal velocity increased from 8.46 to 8.67 m/s as the moisture content increased from 8.33 to 13.78% d.b. (Özarslan, 2002). Similar increasing trend of terminal velocity with increase moisture content was observed for squash seeds (Paksoy and Aydin, 2004), gram seeds (Nimkar *et al.*, 2005), sweet corn seeds (Coşkun *et al.*, 2006), linseed (Selvi *et al.*, 2006), pistachio nuts and kernels (Kashaninejad *et al.*, 2006) barbarian bean (Cetin, 2007) and pea seeds (Yalçin *et al.*, 2007). This increase in terminal velocity with the increase in moisture content can be attributed to the increase in mass of an individual seed per unit frontal area presented to the air stream (Dursun and Dursun, 2005).

The specific objectives of this work were to determine some aerodynamic properties such as terminal velocity, drag coefficient and Reynold's number for three different oil seed crops (peanut kernels, soybean and cotton seeds) at different levels of moisture content. Also, to develop mathematical models relate the change in the studied aerodynamic properties of seeds with the change in their moisture content.

MATERIALS AND METHODS

Preparation of Samples

Samples of peanut (Giza-5 variety), soybean (Giza-22 variety) and fuzzy cotton (Giza-86 variety) seeds were provided by The Agricultural Research Center, Cairo, Egypt. The obtained samples were cleaned manually to remove foreign matters such as dirt, stones and chaff as well as damaged and immature seeds.

Moisture-Conditioning Apparatus

The tested seeds were conditioned to the desired levels of moisture content by using moisture-conditioning apparatus developed by Matouk *et al.*, 2005 shown in Figure (1). The apparatus consists of a plastic barrel rested horizontally over two iron bars enfolded with rubber layer and operated by 0.75 kW electric motor controlled by electric controller (Tosvert^{TM}, Toshiba

Co., Japan). The calculated amount of water required to reach a certain level of moisture content was added to the seed, inside the barrel and the mixing process is continued for 72 h to obtain the desired moisture level and to ensure uniform distribution of moisture inside the seeds. A timer was connected to the motor in order to control the mixing time.

The amount of water (kg) required to reach certain moisture level was calculated using the following formula described by Balasubramanian (2001):

$$Q = \frac{W_i \left(M_f - M_i\right)}{\left(100 - M_f\right)}, \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Where, Q is the mass of water to be added (kg), W_i the initial mass of the sample (kg), M_i the initial moisture content of the sample (%) and M_f is the final or the desired moisture content of the sample (%).

Based on this formula the tested samples of peanut kernels were conditioned to moisture contents of 6.1, 9.3, 16.0, 28.4 and 34.9% w.b., the soybean seeds to 7.8, 14.4, 21.0, 26.0 and 31.8% w.b., and the fuzzy cotton seeds to 6.4, 8.6, 10.8 and 12.5% w.b. The samples were then sealed in polyethylene bags and stored at -5 °C to prevent moisture loss and fungal growth. These levels of moisture contents were investigated because most of transportation, storage and handling operations of these crops are usually performed within these ranges. Before each experiment, the tested seeds were taken out from the freezer and kept in the room temperature and the actual value of moisture content of each sample was measured again before each test.

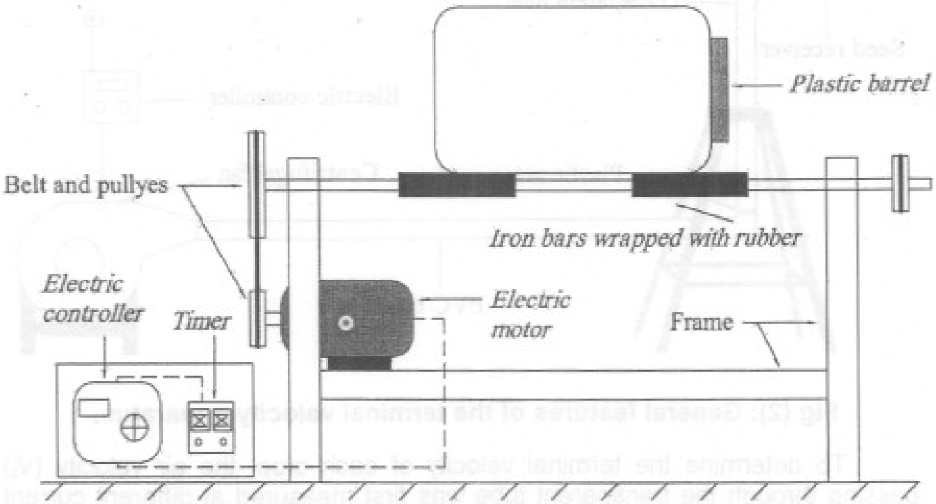


Fig. (1): Schematic diagram showing the components of the moisture-conditioning apparatus.

Moisture Content Measurement

The moisture content of tested samples before and after moisture conditioning was determined as wet-basis value by standard air oven method (ASAE Standard, 2003a and b) as shown in Table (1).

Table 1: Oven temperature and heating time for the seeds under studying.

Seed type	Oven temp., °C	Heating time, hour
Peanut	130	6
Soybean	103	72
Cotton	105	24

Determination of Terminal Velocity

An apparatus was designed according to (Matouk *et al.*, 2005) to determine the terminal velocity of seeds as shown in Figure (2). The apparatus consists of a 0.75 kW centrifugal fan controlled by an electric controller (Tosvert^{TM}, Toshiba Co., Japan). The fan was connected to 2 m PVC horizontal tube and 1 m vertical transparent glass tube. A PVC elbow was used for connecting the horizontal and vertical tubes. A seed receiver was fixed at the upper part of the transparent tube to receive the thrown-out seeds while a plastic net was fixed at the bottom part to prevent seeds from falling down inside the tube. The air velocity was measured by using an anemometer (Tri-Sense 37000-62, Col-Parmer, USA) with accuracy of 0.01 m/s, and a measuring sensor of 1 m long. A 20 mm round hole was opened at the center of the transparent tube to insert the anemometer measuring sensor inside the tube.

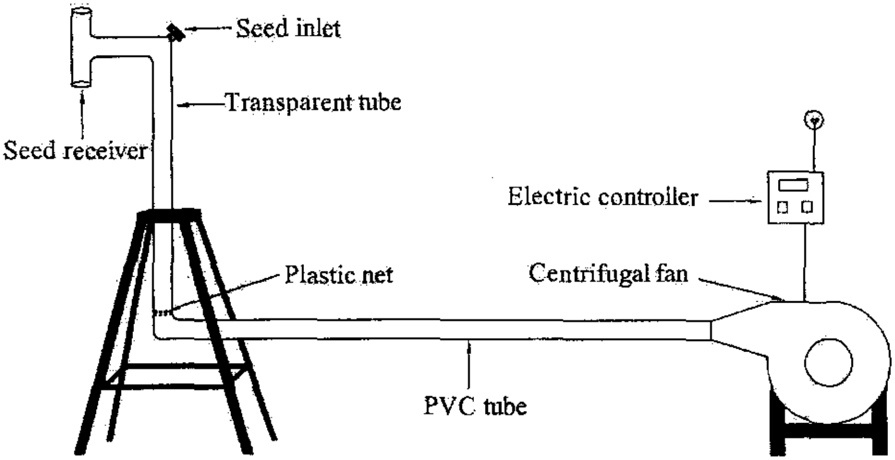


Fig (2): General features of the terminal velocity apparatus.

To determine the terminal velocity of each crop, the air velocity (V_t) passing through the transparent tube was first measured at different current frequencies of the inverter (F) and then a linear relationship was obtained as shown in Figure (3). A sample of 100 seeds in three replicates were randomly selected from each moisture group for each tested crop and placed over the plastic net of the transparent tube. The centrifugal fan was operated and the inverter frequency was gradually increased until the floating air suspends the seeds in the vertical central part of the transparent tube. When approaching a relatively steady suspension condition, the suspended seeds were counted and the frequency of the electric current was recorded. Then, the frequency of the electric current was gradually increased and the number of suspended seeds was recorded each time. The test was repeated until all seeds flow out from the transparent tube. The average terminal velocity of the 100 seeds was calculated using the weighted mean method as follow:

$$\overline{V_t} = \frac{N_1V_{t1} + N_2V_{t2} + ... + N_kV_{tk}}{N_1 + N_2 + ... + N_k} \quad ....(2)$$

Where, N_1, N_2, ..., and N_k are the numbers of seeds which were suspended at the terminal velocities V_{t1}, V_{t2},..., and V_{tk}.

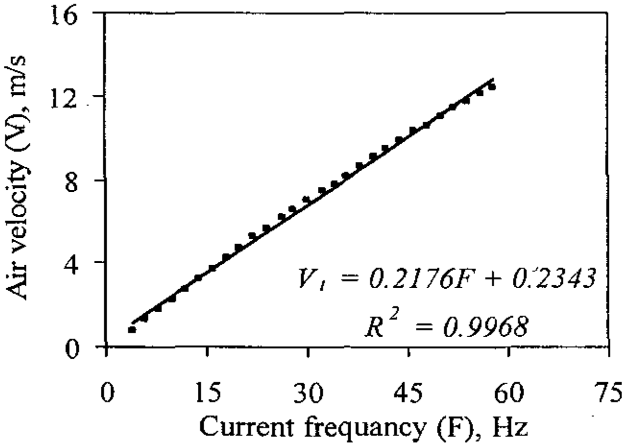


Fig (3): Relationship between electric current frequency and air velocity for calibrating anemometer.

Calculation of Drag coefficient and Reynold's number

In free fall, the seed will attain a constant terminal velocity (V_t) at which the net gravitational accelerating force (F_g) equals the resisting upward drag force (F_r). According to Mohsenin (1984) the terminal velocity could be calculated using the following formula:

$$V_t = \sqrt{\frac{2mg(\rho_p - \rho_f)}{\rho_p \rho_f A_p C}}, \text{ m/sec} ....(3)$$

And the drag coefficient (C_d) could be derived as follows:

$$C_d = \frac{2mg(\rho_p - \rho_f)}{\rho_p \rho_f A_p V_t^2}, \quad ....(4)$$

Where *m* is the mass of the seed (kg), *g* is the gravitational acceleration (m/s^2), ρ_f is the mass density of the air (1.191 kg/m^3), ρ_p is th mass density of the seeds, (kg/m^3), A_p is the seed projected area (m^2), and V_t is the terminal velocity (m/s).

Usually, a horizontal wind tunnel is used to measure drag coefficient of large objects. In this method, external parameters such as size and velocity are varied and values of drag coefficient are obtained over a wide range of Reynold's number. But for small particles (like seeds), the drag force cannot be measured directly by this method. So, drag coefficient of agricultural materials can be calculated from their terminal velocity which is experimentally measured (Khoshtaghazan and Mehdizadeh, 2006).

On the other hand, Reynold's number (Re) of the seed can be calculated from its terminal velocity using the following relationship:

$$\mathrm{Re} = \frac{\rho_a V_t D_g}{\mu_a}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where μ_a is the air viscosity at room temperature (1.85×10^{-5} N.s/m^2), D_g is the geometric mean diameter of seeds (m) $D_g = (L \times W \times T)^{1/3}$ and L, W and T are the seed length, width and thickness (m).

Determination of Seed Physical Properties

In order to calculate the drag coefficient and Reynold's number of seeds using the above mentioned relationships, some physical properties of tested seeds were determined as follows:

After preparing the samples, 100 seeds were selected from each moisture class, their principal dimensions (length, width and thickness) were determined manually by digital caliper (Mitutoyo DAG-500, Japan). The length (L) is the distance from the tip cap to the seed crown. Width (W) is the widest point to point measurement taken parallel to the face of the seed. Thickness (T) is the measured distance between the two seeds faces (Karababa, 2006). And then the geometric mean diameter of seeds was calculated using the following equation (Mohsenin, 1984):

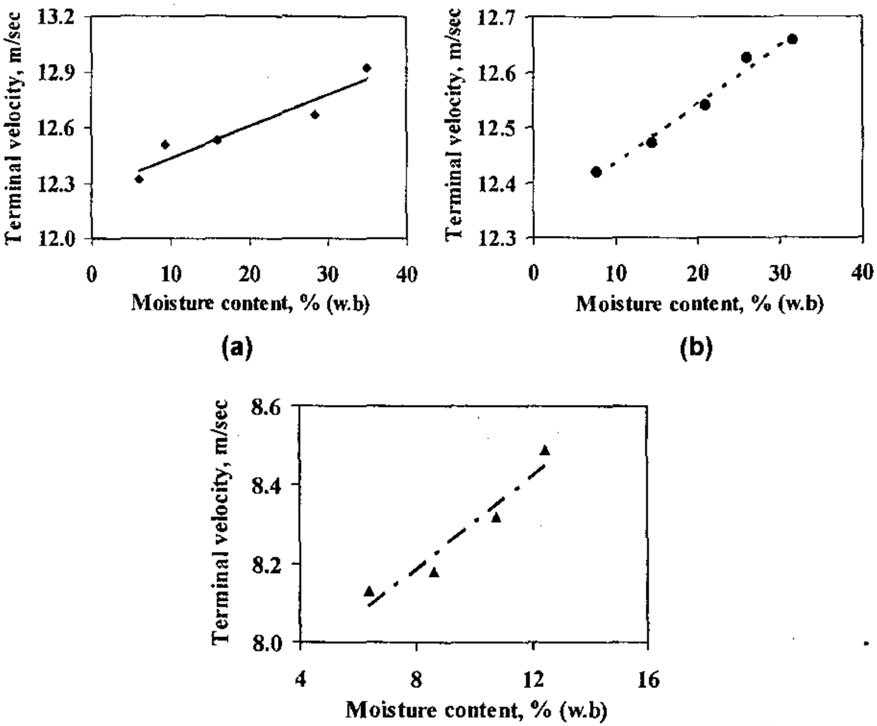
$$D_g = (L \times W \times T)^{1/3}, \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The projected area (A_p) of the seed was measured by image analysis method (ElMasry *et al.*, 2009) by which a digital image was acquired for the seeds of each condition and the essential geometrical features were then extracted from the images using a program written in Matlab (The Mathworks Inc., Natick, MA, USA). The thousand seed mass was determined by means of a digital electronic balance reading to 0.001 g and the true density of the seeds of each crop was determined using a toluene displacement method.

RESULTS AND DISCUSSION

Effect of Moisture Content on Seeds Terminal Velocity

The effect of moisture content on terminal velocity is shown in Figuer (4). It is obvious that, the terminal velocity of seeds increased linearly with the increasing of moisture content for all tested crops. For instance, the terminal velocity of peanut kernels increased from 12.32 to 12.92 m/s when seeds moisture content increased from 6.1 to 34.9 %, w.b.



(a) (b)

(c)

Fig. (4): Effect of moisture content (w.b) on terminal velocity of (a) peanut kernels, (b) soybean seeds and (c) cotton seeds.

Similarly, the terminal velocity of soybean seeds increased from 12.42 to 12.65 m/s with the increasing of seeds moisture content from 7.8 to 31.8%, w.b. These values are higher than that obtained by Mohamed (2007) for soybean seeds (Giza-111). This showed that the physical properties are not only affected by moisture content but also by crop variety.

For cotton seeds, the terminal velocity increased from 8.13 to 8.49 m/s with the increasing of seeds moisture content from 6.4 to 12.5%, w.b. Terminal velocity of cotton seeds is very important to design any pneumatic planter. In the dynamic case, the air velocity must be equal to or higher than the terminal velocity of seed (Singh *et al.*, 2005). So, according to the results the cotton seeds need to be at the lowest moisture content to minimize the required air velocity and the required power in pneumatic planter.

A simple linear regression analysis was applied to relate the change in terminal velocity of seeds (V_t) with the change in moisture content (MC) for all tested crops. The obtained linear relationships were:

$Vt = 12.263 + 0.0172MC, (R^2 = 0.91)$ .... (7) *"for peanut kernels "*
$Vt = 12.330 + 0.0105MC, (R^2 = 0.98)$ .... (8) *"for soybean seeds"*
$Vt = 7.7183 + 0.0587MC, (R^2 = 0.93)$ .... (9) *"for cotton seeds"*

The results also showed that there is a similarity between these results and the findings of quinoa seeds (Vilche *et al.*, 2003), peanut kernels (Aydin 2007), sunflower, soybean and canola seeds (Mohamed, 2007), barbarian bean (Cetin, 2007), cowpea seeds (Yalçin, 2007), and sunflower seeds (Gupta *et al.*, 2007). In their results, the terminal velocity of seeds increased linearly with the increase of moisture content.

In brief, the terminal velocity of peanut kernels and soybean seeds was in the same range but the terminal velocity of cotton seeds was smaller than that of peanut kernels or soybean seeds. Based on these results, the pneumatic separators could be used to separate the cotton seeds from peanut kernels or soybean seeds. Thus, undesirable materials can be removed with air flow from a product if it has a different terminal velocity. Also, terminal velocity of oil seeds is very important to remove undesirable materials using air flow when crops are mechanically harvested. Agricultural materials are routinely conveyed using air stream in pneumatic conveyers. If these systems are not used properly, they could cause problems (Sahay and Singh, 1994). For example, in a soybean combine harvester, fan speed is the key adjustment for cleaning. If the air speed is lower than the terminal velocity of soybean seeds (12.42 m/s) at harvesting moisture content (31.8%), the materials would not be separated from each other and there will be extra foreign material within the soybean seeds. If air speed is high, the soybean seeds will be exhausted along with extra materials and product loss will be increased.

Effect of Moisture Content on Reynold's number (Re)

The effect of moisture content on Reynold's number for peanut kernels, soybean seeds and cotton seeds are shown in Figuer (5).

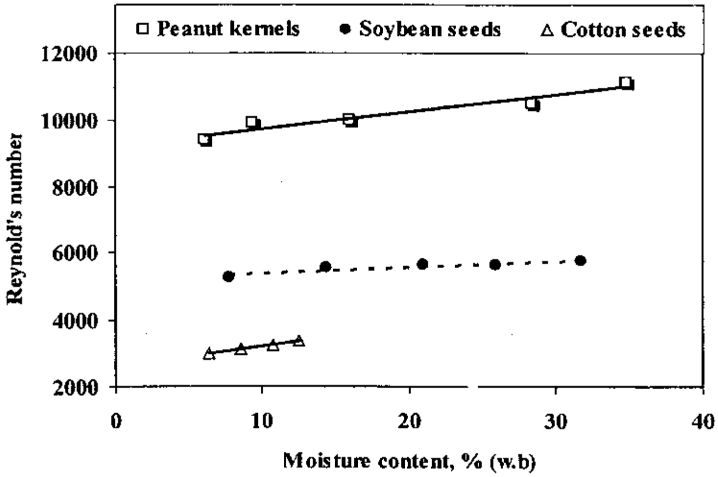


Fig. (5): Effect of seeds moisture content on Reynold's number of peanut kernels, soybean seeds and cotton seeds.

It is evident that, Reynold's number generally increased with the increase of seeds moisture content. This observed increase of Reynold's number with moisture content may be owing to the increase in terminal velocity and geometric mean diameter of seeds when seeds moisture content increased.

For peanut kernels, the Reynold's number increased from 9403 to 11140 as the moisture content increased from 6.1 to 34.9%, w.b. Also, for soybean seeds, the Reynold's number increased from 5260 to 5760 when seeds moisture content increased from 7.8 to 31.8%, w.b. Similarly, the Reynold's number for cotton seeds increased from 2985 to 3386 with the increasing of seeds moisture content from 6.4 to 12.5%, w.b. respectively.

Linear relationships between Reynold's number (Re) and seeds moisture content (MC) was emphasized in the tested range and expressed as:

$Re = 51.75\ MC + 9210.6 \quad (R^2 = 0.94)$ .... *(10)* *"For peanut kernels"*

$Re = 18.564\ MC + 5187.4 \quad (R^2 = 0.88)$ .... *(11)* *"For soybean seeds"*

$Re = 64.509\ MC + 2577.6 \quad (R^2 = 0.99)$ .... *(12)* *"For cotton seeds"*

Similar increasing trend of Reynold's number with the increasing in moisture content has been reported for rice, corn, wheat and barely grain (Matouk *et al.*, 2005), and for sunflower, soybean and canola seeds (Mohamed, 2007).

Effect of Moisture Content on Drag Coefficient:

The effect of moisture content on drag coefficient for tested oilseeds is shown in Figuer (6). The drag coefficient values were inconsistent with moisture content increment. For example, the drag coefficient of peanut kernels decreased from 0.62 to 0.58 when moisture content increased from 6.1 to 16.0%, and then increased to 0.64 when the moisture content increased to 28.4% (w.b.) and then it was dropped again with further increase in seeds moisture content. Also, the same trend was found for soybean seeds, the drag coefficient decreased from 0.58 to 0.53 when seeds moisture content increased from 7.8 to 21.0%, and then it was increased to 0.57 at moisture content of 26% (w.b.) and then the value of drag coefficient dropped again with further increase in moisture content. While, for cotton seeds the drag coefficient decreased from 0.78 to 0.68 with the increasing of seeds moisture content from 6.4 to 12.5 % (w.b.).

Similar decreasing trend of drag coefficient with the increasing in seeds moisture content for cotton seeds has been reported also for sunflower seeds (Gupta *et al.*, 2007), rice, corn, wheat, barely seeds (Matouk *et al.*, 2005), soybean and canola seeds (Mohamed, 2007). The variation of drag coefficient of any particle depends on its density, suspension velocity and projected area. Since agricultural grains cover a wide range of sizes, suspension velocities, densities and shapes, an array of drag coefficient values in the range of spheres and cylinders (0.44-1.0) was expected (Gorial and O'callaghan, 1990). So, it is obvious to conclude that the decrease of drag coefficient with the increase of seeds moisture content means the seeds will be roll easily on transporting and conveying equipment. Therefore, information about drag coefficient and Reynold's number are highly important in the design of separation and conveying equipment.

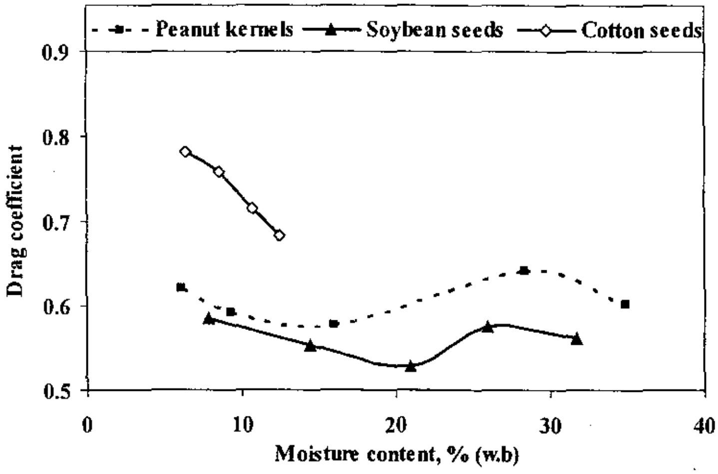


Fig. (6): **Effect of seeds moisture content on drag coefficient of peanut kernels, soybean seeds and cotton seeds.**

Physical Properties of Seeds

The average values of the determined physical properties of seeds at different levels of moisture content for all studied crops were tabulated in Table (2). These physical properties were used to calculate the aerodynamic properties of seeds.

Table 2: Some physical properties of the tested oilseeds (means ± standard deviation) at different levels of moisture content (MC).

Seeds type	MC, % (w.b)	Geometric mean diameter (D_g), mm	Projected area A_p, mm^2	Thousand seeds mass, (g)	True density, kg/m^3
Peanut	6.1	11.86±0.85	149.72±23.80	857.3±32.50	944±14.58
	9.3	12.32±0.50	162.39±20.64	912.7±23.29	955±25.52
	16.0	12.38±0.50	177.75±16.96	978.0±35.04	974±22.61
	28.4	12.89±0.68	186.92±20.25	1167.0±8.19	990±10.22
	34.9	13.39±0.65	215.38±26.61	1318.7±16.04	1013±12.82
Soybean	7.8	6.58±0.32	32.04±2.79	175.6±11.15	1216±15.40
	14.4	6.90±0.22	35.88±3.40	188.0±4.44	1198±14.95
	21.0	6.97±0.35	40.57±5.07	205.0±6.14	1184±9.62
	26.0	6.93±0.39	40.70±4.26	226.6±10.01	1166±9.34
	31.8	7.07±0.49	42.73±6.58	233.8±13.18	1143±11.55
Cotton	6.4	5.70±0.23	31.16±5.47	97.7±0.82	1053±11.69
	8.6	5.97±0.25	33.59±4.10	103.5±1.38	1020±13.02
	10.8	6.10±0.21	35.24±2.70	106.0±0.90	984±10.20
	12.5	6.19±0.26	36.27±4.22	108.5±1.05	965±11.72

Conclusions

The investigation of the aerodynamic properties of the tested crops as a function of moisture content revealed the following:

1-Terminal velocity of seeds increased linearly with the increasing of moisture content for all tested seeds. When moisture content increased from 6.1 to 34.9% (w.b.), terminal velocity of peanut kernels increased from 12.32 to 12.92 m/s. Similarly, terminal velocity of soybean seeds increased from 12.42 to 12.65 m/s as the moisture content increased from 7.8 to 31.8% (w.b.). While, the terminal velocity for cotton seeds was increased from 8.13 to 8.49 m/s with the increasing of seeds moisture content from 6.4 to 12.5% (w.b.).

2-Reynold's number increased in general with the increasing of seeds moisture content for all studied crops. The Reynold's numbers for peanut kernels, soybean and cotton seeds ranged from 9403 to 11140, from 5260 to 5760 and from 2985 to 3386, respectively, in the investigated ranges of moisture content.

3-The drag coefficient values in general were inconsistent with moisture content increment for peanut kernels and soybean seeds. While, it was decreased for cotton seeds.

4-In this work, the aerodynamic properties of oil seeds are expressed in the form of regression equations as a function of moisture content. The obtained mathematical equations may be used in predicting the studied properties at different stages of oil extraction lines.

REFERENCES

ASAE (2003a). ASAE Standard 410.1. Moisture measurement-peanuts. St. Joseph, MI, USA.

ASAE (2003b). ASAE Standard 352.2. Moisture measurement-unground grains and seeds. St. Joseph, MI, USA.

Aydin, C. (2007). Some engineering properties of peanut and kernel. Journal of Food Engineering 79 (3): 810-816.

Balasubramanian, D. (2001). Physical properties of raw cashew nut. Journal of Agricultural Engineering Research 78 (3): 291-297.

Cetin, M. (2007). Physical properties of barbunia bean (*Phaseolus vulgaris* L. cv. 'Barbunia') seed. Journal of Food Engineering 80 (1): 353-358.

Coşkun, M.B.; I. Yalçın and C. Özarslan (2006). Physical properties of sweet corn seed (*Zea mays saccharata* Sturt.). Journal of Food Engineering 74 (4): 523-528.

Dursun, E. and I. Dursun (2005). Some physical properties of caper seed. Biosystems Engineering 92 (2): 237-245.

ElMasry, G.M.; S. Radwan; M. ElAmir, and R. ElGamal (2009). Investigating the effect of moisture content on some properties of peanut by aid of digital image analysis. Food and Bioproducts Processing 87(4): 273-281.

Gorial B Y, O'callaghan J R. (1990). Aerodynamic Properties of Grain/Straw Materials. Journal of Agricultural Engineering Research (46): 275-290.

Gupta, R.K.; G. Arora and R. Sharma (2007). Aerodynamic properties of sunflower seed (Helianthus annuus L.). Journal of Food Engineering 79 (3): 899-904.

Hauhouot-O'Hara, M.; B.R. Criner; G.H. Brusewitz and J.B. Solie (2000). Selected physical characteristics and aerodynamic properties of cheat seed for separation from wheat. Agricultural Engineering International. The CIGR Journal of Scientific Research and Development.Vol. II.

Karababa, E. (2006). Physical properties of popcorn kernels. Journal of Food Engineering 72 (1): 100-107.

Kashaninejad, M.; A. Mortazavi; A. Safekordi and L.G. Tabil (2006). Some physical properties of pistachio (*Pistacia vera L.*) nut and its kernel. Journal of Food Engineering 72 (1): 30-38.

Khoshtaghaza, M.H. and R. Mehdizadeh (2006). Aerodynamic properties of wheat kernel and straw materials. Agricultural Engineering International. the CIGR Ejournal. Manuscript FP 05007. Vol. VIII.

Kılıçkan, A. and M. Güner (2006). Pneumatic conveying characteristics of cotton seeds. Biosystems Engineering 95 (4): 537-546.

Klenin, N.I.; I.F. Popov and V.A. Sukun (1985). Agricultural machines. Theory of operation, computation of controlling parameters and the conditions of operation. Amerind publishing Co. PVT. Ltd., New Diem.

Matouk, A.M.; M.M. Elkholy; A.S. Hamam and T.R. Ewis (2005). Aerodynamic characteristics for different varieties of some cereal. Misr Journal of Agricultural Engineering 22 (3): 1086-1102.

Mohamed, A.T. (2007). Effect of some physical, mechanical and thermal properties on design parameters of handling and processing machinery of some oil seeds. Ph.D. Dissertation. Agricultural Engineering Department, Faculty of Agriculture, Mansoura University.

Mohsenin, N.N. (1984). Physical properties of plant and animal materials. Gordon and Breach Sc. Pub., N.Y.

Nimkar, P.M.; D.S. Mandwe and R.M. Dudhe (2005). Physical properties of moth gram. Biosystems Engineering 91 (2): 183-189.

Owies, T.R. (2003). Developing a machine for extracting olive oil. Ph.D. Dissertation. Agricultural Engineering Department, Faculty of Agriculture, Mansoura University.

Özarslan, C. (2002). Physical properties of cotton seed. Biosystems Engineering 83 (2): 169-174.

Paksoy, M. and C. Aydin (2004). Some physical properties of edible squash (*Cucurbita pepo L.*) seeds. Journal of Food Engineering 65 (2): 225-231.

Sahay, K.M. and K.K. Singh (1994). Unit operations in agricultural processing. New Delhi: Vikas.

Selvi, K.Ç.; Y. Pınar and E. Yeşiloğ lu (2006). Some physical properties of linseed. Biosystems Engineering 95 (4): 607-612.

Shokr, A.Z. and S.S. Sadaka (1999). Pneumatic conveying velocity for different agricultural products and residues. Misr Journal of Agricultural Engineering 16 (1): 51-66.

Singh, R.C.; G. Singh and D.C. Saraswat (2005). Optimization of design and operational parameters of a pneumatic seed metering device for planting cotton seeds. Biosystems Engineering 92 (4): 429-438.

Vilche, C.; M. Gely and E. Santalla (2003). Physical properties of quinoa seeds. Biosystems Engineering 86 (1): 59-65.

Yalçin, İ. (2007). Physical properties of cowpea (*Vigna sinensis L.*) seed. Journal of Food Engineering 79 (1): 57-62.

Yalçin, İ.; C. Özarslan and T. Akbaş (2007). Physical properties of pea (*Pisum sativum*) seed. Journal of Food Engineering 79 (2): 731-735.

دراسة الخواص الايروديناميكية لبعض المحاصيل الزيتية عند ظروف مختلفة للمحتوى الرطوبى

رمضان عبد الحميد الجمل، شريف محمد عبد الحق رضوان، محمد صلاح الدين الأمير و جمال محمد أحمد المصري

قسم الهندسة الزراعية – كلية الزراعة – جامعة قناة السويس

أجريت هذه الدراسة لتحديد تأثير المحتوى الرطوبى على الخواص الايروديناميكية لبذور بعض المحاصيل الزيتية (الفول السوداني – فول الصويا – بذرة القطن) حيث تم تعديل المحتوى الرطوبى لبذور الفول السوداني إلى محتويات (٦.١، ٩.٣، ١٦.٠، ٢٨.٤، ٣٤.٩ % على أساس رطب)، وبذور فول الصويا إلى (٧.٨، ١٤.٤، ٢١.٠، ٢٦.٠، ٣١.٨ % على أساس رطب)، وبذور القطن إلى (٦.٤، ٨.٦، ١٠.٨، ١٢.٥ % على أساس رطب) لتمثل هذه المحتويات حالة البذور خلال المراحل المختلفة لعمليات الحصاد والتداول والتصنيع. وقد اشتملت الخواص الايروديناميكية التي تم دراستها على السرعة الحرجة (V_t)، رقم رينولد (Re) ومعامل الجرف (C_d) كذلك تم تقدير بعض الخصائص الطبيعية المرتبطة بحساب بعض من هذه الخواص الايروديناميكية.

وقد أظهرت النتائج أن الخواص الايروديناميكية للبذور تأثرت تأثرا واضحا نتيجة لتغير محتواها الرطوبى حيث زادت قيم السرعة الحرجة و رقم رينولد زيادة خطية بزيادة المحتوى الرطوبى لجميع البذور تحت الدراسة. على الرغم من ذلك فان معامل الجرف لم يعطى علاقة واضحة مع المحتوى الرطوبى خاصة لبذور فول الصويا وحبوب الفول السوداني.

أخيرا يمكن القول أن الخصائص الايروديناميكية التي تم تقديرها لبذور المحاصيل الزيتية يمكن أن تساعد كأساس لتطوير نظم ومعدات الحصاد، التداول، التنظيف، الفصل، التعبئة، التخزين والتصنيع لهذه المحاصيل. أيضا في هذه الدراسة تم التعبير عن هذه الخصائص في شكل معادلات انحدار باعتبارها دالة في المحتوى الرطوبي وهذه المعادلات الرياضية المتحصل عليها يمكن استخدامها في التنبؤ بالخصائص الايروديناميكية للبذور خلال خطوط ومراحل استخراج الزيت المختلفة.

قام بتحكيم البحث

أ.د / أحمد محمود عبده معتوق	**كلية الزراعة – جامعة المنصورة**
أ.د / محمد مصطفي الخولي	**مركز البحوث الزراعية**