Determining some physical properties of Azivash (Corchorus Olitorious L.) seed

Mohsen Azadbakht*, Roghayeh Pourbagher

(Department of Bio-system Mechanical Engineering; Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran)

Abstract: Used Azivash (Corchorus Olitorious L.) seed in the research has been provided in summer 2013. The samples were cleaned and separated manually. Residuals and broken seeds were taken apart from them and healthy seeds were provided for testing. Then diameter, area of image and round coefficient were calculated using image processing application. Mass of 1000 seeds, mass density, real density, porosity percentage, static friction coefficient, repose angle in two modes of fullness and emptiness were measured. Liquid replacement method has been used to calculate density and volume of the seeds. The results showed that a positive relationship between physical properties of Azivash seed including geometric properties (diameter, volume), gravity properties (weight of 1000 seeds, real density and porosity)and frictional properties (stability angle of evacuation) with increased moisture, while a negative relationship between specific mass and increased moisture. Average amounts of diameter, area, volume, round coefficient, weight of sample unit, particle density, and mass density at 7% moisture (w.b.) consist of 2.147 mm, 1.961 mm^2, 1.483 cm^3, 0.74, 0.0014 g, 0.961 and 0.794 g/cm^3.

Keywords: Azivash seed, physical properties, geometric properties, gravity properties, frictional properties, moisture content

Citation: Azadbakht, M., and R. Pourbagher. 2015. Determining some physical properties of Azivash (Corchorus Olitorious L.) seed. AgricEngInt: CIGR Journal, 17(3): 384-391.

1 Introduction

Agricultural products are usually affected by different processes and factors from harvest to consumption. These processes can be simple processes such as cleaning, separating, washing, transport and weighting or complementary process in such a way that product properties are influenced. Then identifying their different biological, chemical, mechanical and physical properties, their maintenance and or changing them in the direction of desirable process can have significant effects in storage quantitatively and qualitatively of products (Masoudi, 2004). Determining physical features of agricultural products had been received more attention as an index for designing and constructing machineries and transmission equipment and also processing agricultural products. Regardless of the parameters, designing agricultural machines will be incomplete and weak.

With the scientific name of *Corchorus Olitorious L.*, Azivash belongs to *Tiliaceae* family with 25 chromosomes and it has been planted with different names in various countries. This plant belongs to the areas with the weather conditions of higher 25 ˚C to 35 ˚C. Although this plant is found in parts of Asia, there is with much more genetic diversity in Africa. Its life has been about 45 days or less and the height of its bushes reaches to 35 to 45 cm. Its leaves are oval in shape with a narrow tip and yellow flowers. Finally, after three years of research and the implementation of two research projects, adopted by research deputy of Gorgan Agricultural Sciences and Natural Resources University, the plant was cultivated for the first time in the farm belonging to the university. Some properties of the plant could be mentioned anti-tumor, smoothing toothache, appetizer, antipyretic, constipation.

Received date: 2015-05-24 **Accepted date:** 2015-07-13

***Corresponding author: Mohsen Azadbakht,** Department of Bio-system Mechanical Engineering; Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran. Email: azadbakht@gau.ac.ir.

According to the findings of Zakaria et al. (2006), this plant has been used in the traditional medicine for treating gonorrhea, dysuria, and chronic inflammation of the bladder, fever and tumors. Its leaves are also smoothing toothache (Hillocks, 1998). Azivash is used as an appetizer and ergogenic stuff (Duke, 1983). The seeds of the plant are cathartic the extract of the plant improves significantly heart failure (Chopra et al., 1986). Because this plant doesn't have cumulative effect, then it is used as strophanthin in treating heart failure. Azivash contains large amounts of iron and folic acid and is useful to prevent anemia (Innami et al., 2005; Oyedele et al. 2006). Its seeds have vast antibacterial properties (Pall et al., 2006). The goal of the research is to identify some geometric, gravity and fictional properties of Azivash seed.

2 Material and method

Azivash seed used in the research has been provided in summer 2013. The samples were cleaned and separated manually and residuals and broken seeds were taken apart from them and healthy seeds were provided for testing. A certain amount of samples were placed into an oven for 24 hours at 105℃ to determine the initial moisture. The initial moisture of the seeds was measured using standard weight method of ASAE (Gupta and Das, 1997). Initial moisture of Azivash seed was estimated 7% (w.b.) To reach the samples to the desired moisture level (21%, 33% and 41%), at first mass of existing water, total mass and mass of water that must be added to each sample were calculated based on moisture content (w.b.%.). Then, the samples were sprayed slowly with distilled water and weighted by a digital scale with an accuracy of 0.01 g.

2.1 The measurement of geometric properties (diameter, area, volume and round coefficient)

Excel 2010 software was used to analyze the data. About 1750 seeds were scanned randomly to measure the average of dimensions. Then, diameter, di; area of image, p; and round coefficient, Ø; were calculated using image processing application. Liquid replacement method has been used to calculate the density and volume of the seeds.

2.2 The measurement of gravity properties (mass of 1000 seeds, mass density, real density and porosity percentage)

The mass of 1000 seeds was measured using a digital scale with an accuracy of 0.01 g. A certain amount of the sample was poured into a scaled dish with volume of 250 cm^2 (V_b). Seed mass (M) was estimated using weighing container in two modes (fill and empty). Seed density will be seed mass ratio to container volume (Mohsenin, 1986) (Equation 1).

$$\rho_{bulk} = {M_b}/{V_b} \quad (1)$$

For measuring real density, at first 1000 seeds were weighted (m_t) and then poured into a burette with volume of 250 ml, replaced water amount was red on scaled burette which equals with real volume of seeds (V_{true}). The volume of one seed was calculated dividing mass and volume of 1000 seeds by 1000. Equation 2 was used to estimate mass and volume (Mohsenin, 1986).

$$\rho_{true} = {m_t}/{V_t} \quad (2)$$

According to definition, porosity percent is empty space ratio to container volume and is calculated using mass density and real density (Mohsenin, 1986) (Equation 3).

$$\varepsilon = \left(1 - \frac{\rho_{bulk}}{\rho_{true}}\right) \times 100 \quad (3)$$

2.3 The measurement of frictional properties (static friction coefficient, repose angle in two modes of fullness and emptiness)

Five surfaces were used to measure static friction coefficient including galvanized iron, wood, glass, fire-proof fiber and rubber. An open-sided cylinder was used with the diameter of 32 mm and the height of 61.5 mm. Azivash sample was poured into the cylinder and then the cylinder was lifted up 2 and 3 mm, so that it has no contact with the frictional surface. Now the moveable surface is lifted up and when the cylinder along with the sample starts vibrating, the angle of gradient (α) will be red. Statics friction coefficient (μ_s) will be estimated using Equation 4.

$$\mu_s = \tan\alpha \qquad (4)$$

A cylinder-shaped pipe with the diameter of 42 mm and height of 61.5 mm and wooden stuff with diameter of 30 cm were used to measure the angle of stability in fullness mode. The cylindrical pipe was placed in the center of the screen and poured with the samples. Then the pipe was lifted slowly up. Mass height was measured and stability angle in fullness mode was calculated using Equation 5 (Kaleemullah and Gunasekar, 2002).

$$\theta_f = tan^{-1}\left(\frac{2h}{D}\right) \qquad (5)$$

Whereh is mass height in terms of centimeter; D is diameter of the cone.

Stability angle in emptiness mode was measured using a wooden box with 3 × 3 ×3 dimensions, equipped to sliding door. At first, the box was filled with the sample and then sliding door was lifted quickly up. After evacuating, the sample has been placed in the form of gradient surface. Stability angel of evacuation was calculated using Equation 6 (Fraser et al., 1978; Joshi et al., 1993; Pradhan et al., 2008).

$$\theta_e = tan^{-1}\left(\frac{h}{a}\right) \qquad (6)$$

Where, α is 3 cm and pile height (h) is in terms of centimeter.

3 Results and discussion

3.1 The based analysis of the properties of Azivash seed

Table 1 provides variance analysis of geometric and gravity properties of Azivash seed. The results indicate that there is no significant relationship between moisture with diameter, area and round coefficient, but the moisture has significant effect on the volume and weight of 1000 seeds, real density, apparent density and also porosity ($p < 0.01$). Tables 2 and 3 indicate the result of average amounts of geometric and gravity properties. The results indicate that with the increasing moisture content from 7% to 41% (w.b.), the average amounts of diameter, volume, weight, density and porosity will increase from 2.147 to 2.293 mm, 0.00148 to 0.00199 cm^3, 0.00142 to 0.00198 g and 17.37% to 24.61%, respectively, while specific mass will reduce linearly from 0.795 g/cm^3 in 7% moisture to 0.751 g/cm^3 in 41% moisture. Tabatabaeefar (2003) studied the physical properties of five figures of wheat in moisture range of zero to 22%. He found that the real and apparent densities and porosity depend on the moisture of wheat. In another research, physical and mechanical properties of millet (geometric dimensions, sphericity coefficient, apparent density, real density, porosity and repose angel was studied in moisture range of 5% to 22.5% (Baryeh, 2002).

Table 1 Variance analysis of geometric and gravity properties

Source of variation	Diameter ,mm	Area ,mm^2	Volume ,cm^3	Sphericity coefficient	Mass of one seed, g	Mass of 1000 seeds, g	Real density, g/cm^3	Apparent density, g/cm^3	Porosity
Moisture content	0.0182^{ns}	0.264^{ns}	0.137^{**}	0.0019^{ns}	$1.66E^{**}$	0.166^{**}	0.00066^{**}	0.0011^{**}	29.68^{**}
C.V.	10.65	12.41	0.4	10.69	0.41	0.41	0.24	0.24	1.25

**Significance at 1% level, * significance at 5% possibility level, ^{ns} non – significance

Table 2 Average and standard deviation of geometric properties of Azivash seed

Moisture content, w.b.%	Geometric properties			
Based on wet weight	Diameter, mm	Aria, mm^2	Volume, cm^3	Sphericity coefficient
7	2.147±0.276	1.961±0.367	1.483±0.005	0.740±0.080
21	2.159±0.219	2.641±0.0972	1.67±0.00015	0.786±0.916
33	2.284±0.282	2.519±0.356	1.791±0.011	0.791±0.109
41	2.293±0.142	2.426±0.282	1.993±0.005	0.749±0.011

Table 3 Average and standard deviation of gravity properties of Azivash seed

Moisture content, w.b.%	Gravity properties				
Based on wet weight	Mass of 1000 seeds, g	Real density, g/cm^3	Apparent density, g/cm^3	Porosity	Mass of one seed, g
7	1.426±0.005	0.961±0.003	0.794±0.002	17.37±0.44	0.0014±5.77E
21	1.63±0	0.975±0.0001	0.782±0.002	19.78±0.2	0.0016±0
33	1.766±0.01	0.986±0.0001	0.765±0.001	22.41±0.096	0.0017±0.00001
41	1.986±0.005	0.996±0.003	0.751±0.002	24.61±0.166	0.0019±5.77E

Table 4 indicates the results of variance analysis of frictional properties. The table shows there is a significant relationship between moisture content and stability angle of evacuation at 1% possibility level, while the moisture content doesn't have significant effect on static friction and stability angle in fullness mode. Table 5 indicates the average and standard deviation of frictional coefficient of Azivash seed. Also Table 6 indicates the comparative results of stability angles at four moisture levels. In all moistures contents, stability angle of evacuation is bigger than stability angle in fullness mode. Maximum and minimum stability angles are related to 41% and 7% moisture levels, while the maximum stability amount is in fullness mode is at 41% moisture and the minimum stability amount is at 33% moisture level.

Table 4 Variance analysis of frictional properties

Source of variation	Stability angles		Frictional properties				
	Fullness	Evacuation	Iron	Wood	Incombustible fiber	Glass	Rubber
Moisture content	0.7^{ns}	39.79**	0.00095^{ns}	0.00041^{ns}	0.00060^{ns}	0.0011^{ns}	0.00037^{ns}
C.V.	3.31	3.1	11.91	11.91	17.27	10.47	5.48

**Significance at 1% level, * significance at 5% possibility level, ^{ns} non – significance

Table 5 Average and standard deviation of frictional coefficient of Azivash seed

Moisture content, w.b.%	Frictional properties				
Based on wet weight	Glass	Iron	Incombustible fiber	Wood	Rubber
7	0.265±0.0173	0.250±0.0387	0.265±0.0634	0.224±0.0233	0.229±0.0155
21	0.247±0.0098	0.247±0.0098	0.237±0.0292	0.243±0.213	0.233±0.0106
33	0.244±0.0408	0.208±0.0317	0.239±0.0229	0.252±0.0354	0.226±0.0158
41	0.218±0.0233	0.226±0.010	0.259±0.0455	0.239±0.0317	0.251±0.0075

Table 6 Average and standard deviation of stability angle in two modes of emptiness and fullness

Moisture content, w.b.%	Frictional properties	
Based on wet weight	Stability angle of fullness	Stability angle of emptiness
7	21.336±0.510	38.32±0.71
21	20.90±0.798	40.08±1.119
33	20.462±0.972	43.50±1.98
41	21.532±0.32	46.52±1.13

3.2 Weight of 1000 seeds

According to the figure, weight of 1000 Azivash seeds increased linearly from 1.42 to 1.98 g in certain moisture range (P<0.01). This could be attributed to moisture absorption by the seed via increasing moisture content. Weight of 1000 seeds is a useful and effective indicator to determine the equivalent diameter and it can be used to estimate theoretical volume and cleaning the seeds by aerodynamic force.

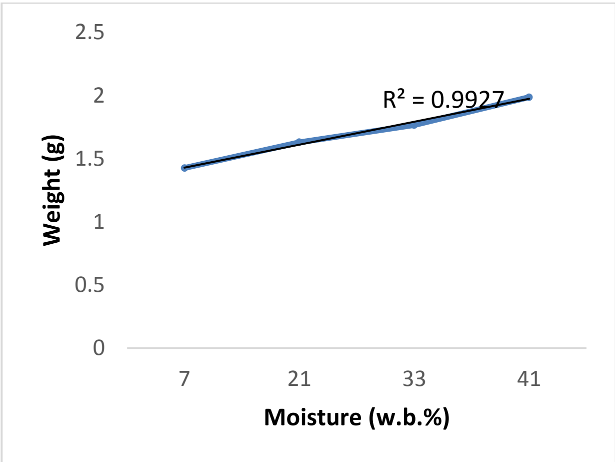

Figure 1 Effect of moisture content on weight of 1000 seeds

Similar results were obtained in other research by Sasilic et al., (2003) for cannabis, Yalsin and Ozarslan (2004) for vetch, Cagatay Selvi et al., (2006) for cotton and Coskuner and Karababa (2007) for linseed. It was approved that there is an increasingly linear relationship between moisture content and the weight of 1000 seeds.

3.3 Volume

According to the figure, sample volume increased linearly from 0.000148 cm^3 in 7% moisture to 0.00199 cm^3 in 41% moisture (Figure 2) (P<0.01). Also, Kermani (2012) found similar results on hazelnut.

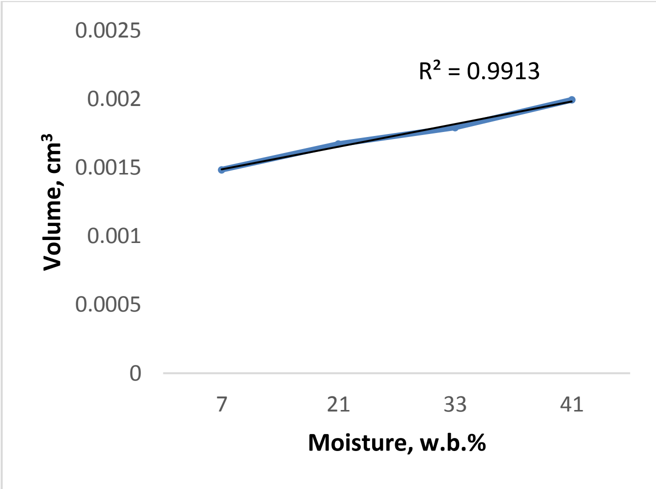

Figure 2 Effect of moisture content on volume

3.4 Specific and real mass

Specific mass reduced linearly from 0.795 g/cm^3 in 7% moisture to 0.751 g/cm3 in 41% moisture (P<0.01) (Figure 3). Negative relationship between specific mass and moisture content indicates that the increased mass of seed in result of moisture absorption is lesser than volume dilatation by increased moisture. Our reverse linear relationship between specific mass and moisture content has been reported by other researcher for other agricultural crops (Gupta and Das, 1997; Deshpande et al., 1993; Shepherd and Bhardwaj, 1986). While by increasing moisture content in certain range, real density increases from 0.961 to 0.996 g/cm^3 (Figure 4) (P<0.01). Increased real specific mass by increasing moisture to lesser real volume of seed in comparison with its corresponding mass could be attributed to water absorption. Similar results reported by Singh and Goswami (1996) for caraway and Ozarslan (2002) for linseed.

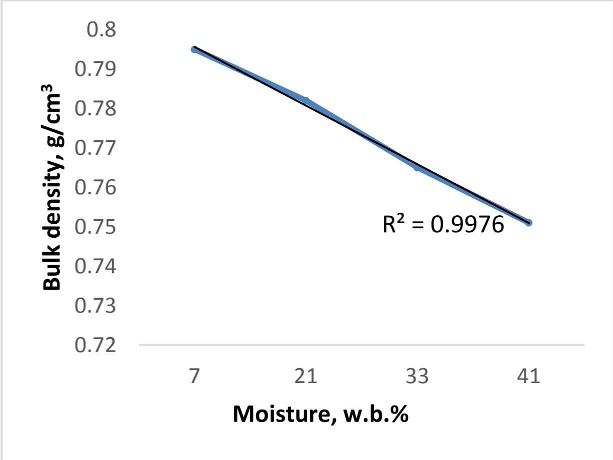

Figure 3 Effect of moisture content on specific mass

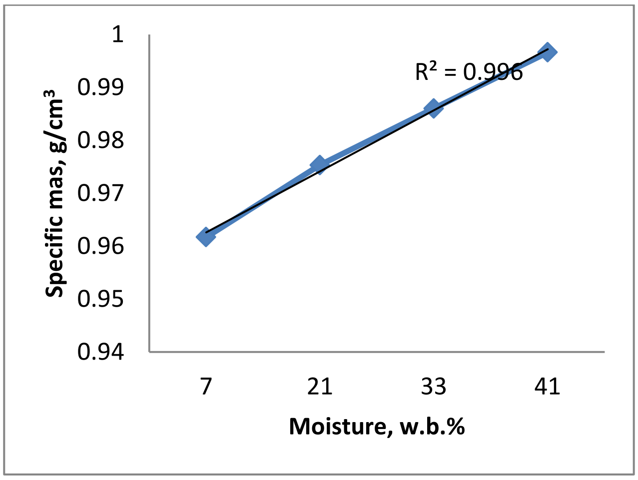

Figure 4 Effect of moisture content on real specific mass

3.5 Porosity

Porosity amount was increased with the increasing moisture content from 7% to 41% (w.b.) from 17.37 to 24.61% (P<0.01) (Figure 5). This indicates that there is a reverse relationship between specific mass and moisture content. Porous pile of cereal allows almost all seeds in contact with air during aeration. Porosity level is one of the factors affecting on needed power of fans (Navarro et al., 2002). Carman (1996), Sing and Goswami (1996) and Gupta and Das (1997) reported that there is a linear relationship between porosity and moisture content in lentil, caraway and sunflower, respectively.

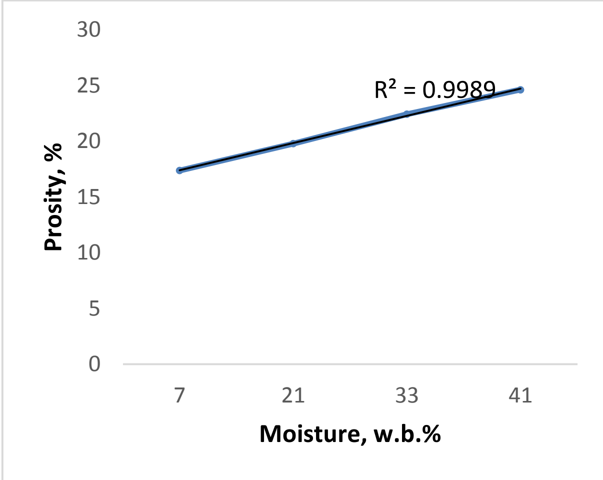

Figure 5 Effect of moisture content on porosity level

3.6 Stability angle of evacuation

Stability angel of evacuation was increased from 38.32 to 46.52 degree with increasing moisture from 7% to 41% (Figure 6) (P<0.01). It seems that in higher moisture, Azivash seed tends to stick more together and it leads to shape and stick them to the surface and consequently better stability and lesser fluidity. Stability angle is regarded as the best indicator for designing the opening of evacuating downpipe of material, determining slop of side walls of store pits and outlets of fruits and seeds.

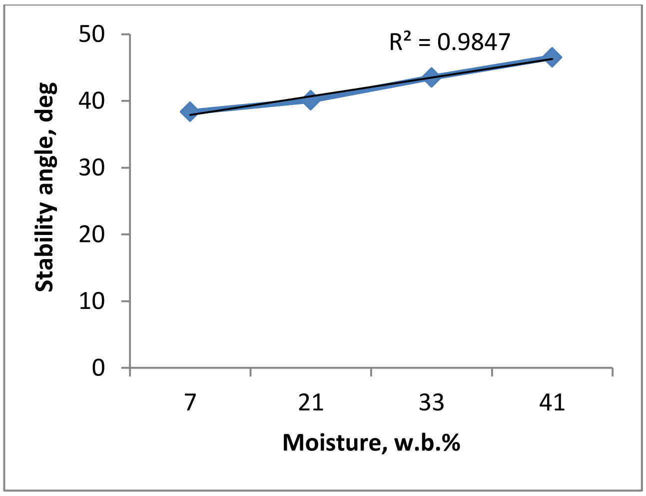

Figure 6 Effect of moisture content on stability angle of evacuation

Many researches have been conducted about the aerodynamic properties such as slip angle. In most of these studies, there was a positive relationship between slip angle and moisture content. Up to now, it has been reported increasing linear relationship between slip angle and moisture content about caraway, green pea, millet and lentil (Amin et al., 2004; Altuntas et al., 2005).

4 Conclusions

1). The results indicate that there was no significant relationship between moisture with diameter, area and round coefficient.

2). Moisture has significant effect on volume, weight of 1000 seeds, real density, apparent density and also porosity ($p < 0.01$).

3). Result of average amounts of geometric and gravity properties indicate that with the increasing moisture content average amounts of diameter, volume, weight, density and porosity will increase, while specific mass will reduce linearly.

4). There was a significant relationship between moisture content and stability angle of evacuation and stability angel of evacuation was increased with the increasing moisture content.

5). The moisture content doesn't have significant effect on static friction and stability angle in fullness mode. In all moistures contents, stability angle of evacuation is bigger than stability angle in fullness mode.

6). The weight of 1000 Azivash seeds increased linearly in certain moisture range ($P<0.01$).

7). Specific mass reduced linearly. While by increasing moisture content in certain range, real density increased.

References

Altuntas, E., E. Ozgoz, and O. Faruk Taser. 2005. Fenugreek seeds. *Journal of Food Engineering*, 71(12): 37-43.

Amin, M. N., M. A. Hossain, and K. C. Roy. 2004. Effect of moisture content on some physical properties of lentil seeds. *Journal of Food Engineering*, 65(1): 83-87.

Baryeh, E. A. 2002. Physical properties of millet. *Journal of Food Engineering*, 51(1): 39-46.

Carman, K. 1996. Some physical properties of lentil seeds. *Journal of Agriculture Engineering Research*, 63(2): 87-92.

Coskuner, Y., and E. Karababa. 2007. Some physical properties of flaxseed. *Journal of Food Engineering*, 78(3): 1067-1073.

Cagatay Selvi, K., T. Pinar, and E. Yesiloglu. 2006. Some physical properties of linseed. *Biosystems Engineering*, 95(4): 607-612.

Chopra, R. N. G., S. L. Nayor, and L.C. Chopra. 1986. Glossary of Indian medicinal plants (including the supplements) council of scientific and industrial research, New Delhi. 224p.

Deshpande S. D., S. Bal and T. P. Ojha. 1993. Physical properties of soybean. *Journal of Agricultural Engineering Research*, 56(2): 89-98.

Duke, J. Handbook of Energy Crops. 1983. Published only on the Internet, excellent information on a wide range of plants.

Fraser, B.M., S. S. Verma, and W. E. Muir. 1978. Some physical properties of fababean. *Journal of Agricultural Engineering Research*, 23(1): 53-57.

Gupta R. K. and S. K. Das. 1997. Physical properties of sunflower seeds. *Journal of Agricultural Engineering Research*, 66(1):1-8.

Hillocks, R. J. 1998. The potential benefits of weeds with reference to small holder agriculture in Africa. *Integrated pest management reviews*, 3(3): 155-167.

Innami, S., H. Ishida, K. Nakamura, M. Kondo, K. Tabata, T. Koguchi, J. Shimizu, and T. Furusho. 2005. Jew's mellow leaves (*Corchorus olitorius*) suppress elevation of postprandial blood glucose levels in rats and humans. *International Journal for Vitamin and Nutrition Research*, 75(1): 39-46.

Kaleemullah, S., and J. J. Gunasekar. 2002. Moisture-dependent physical properties of areca nut kernals. *Biosystem Engineering*, 82(3): 331-338.

Joshi, D. C., S. K. Das, and R. K. Mukherjee. 1993. Physical properties of pumpkin seeds. *Journal of Agricultural Engineering Research*, 54(3): 219-229.

Kermani, A. 2012. Evaluating some physical and mechanical properties of hazelnut and its core. *Journal of Food Technology and Sciences*, 4th year. No.2: 69-78 (In Farsi).

Masoudi, H. 2003. Studying change of mechanical properties of three cultivars of export apple during storage, Thesis of master degree, mechanic engineering group of agricultural machineries, agricultural college, Tehran University.

Mohsenin, N. N. 1986. Physical properties of plant and animal material, New York Gordon & Breach Science Publishers.

Navarro, S. and R. Noyes. 2002. The Mechanics & Physics of Modern Grain Aeration Management, CRC press.

Oyedele, D.J., C. Asonugho, and O.O. Awotoye. 2006. Heavy metals in soil and accumulation by edible vegetables after phosphate fertilizer application. *Journal of Agriculture and Food Chemistry*, 5(4): 1446-1453.

Ozarslan, C. 2002. PH-postharvest technology: Physical properties of cotton seed. *Biosystems Engineering*, 83(2): 169-174.

Pall, D. K, M. Mandal, G. P. Senthilkumar, and A. Padhiari. 2006. Antibacterial activity of cuscuta reflexa stem and Corchorus olitorius seed. *Fitoterapia*, 77(7-8): 589-591.

Pradhan, R. C., S. N. Naik, N. Bhatnager, and S. K. Swain. 2008. Moisture-dependent physical properties of Karanja (Ponjamia pinnata) kernel. *Industrial Crops and Products*, 28(2): 155-161.

Sasilik, K., R. Ozturk, and R. keskin. 2003. Some physical properties of hemp seed. *Biosystem Engineering*, 86(2): 191-198.

Singh, K. K., and T. K. Goswami. 1996. Physical properties of Gumin seed. *Journal of Agriculture Engineering Research*, 64(2): 93-98.

Shepherd, H., and R. K. Bhardwaj. 1986. Moisture-dependent physical properties of pigeon pea. *Journal of Agriculture Engineering Research*, 35(4): 227-234.

Tabatabaeefar, A. 2003. Moisture-dependent physical properties of wheat. *International Agrophysics*, 17(2): 207-211.

Yalcin, I., and C. Ozarslan. 2004. Physical properties of vetch seed. *Biosystems Engineering*, 88(4): 507-512.

Zakaria, Z. A., M. N. Somchith, A. M. Mat Jais, and M. R. Sulaiman. 2006. The in vitro antibacterial activity of Corchorus olitorius extracts. *International Journal of Pharmacology*. 2(2): 213-215.