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ENGINEERING PROPERTIES OF GREEN PEAS PODS

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ABSTRACT
The aim of this research study the effects of some engineering properties of green peas grown in Egypt at different moisture contents of 45and 57w.b.% (wb) . Knowledge of physical and mechanical properties of green peas seeds are essential for the design of equipment's to handle, transport, process and store the crop. The moisture content of green peas is different at the harvest than at storage; thus affecting different physical and mechanical properties of the green peas. It has been identified axial dimensions, mean diameters, length, width ,diameters, sphericity, surface area, and angle of repose of green peas were determined using standard methods. The physical properties of green peas seeds were dependent on the moisture . The average length, width, thickness, geometric mean diameter, thousand grain mass, angle of repose and surface area of peas seeds ranged from 8.19 to 8.50 mm, 7.6 to 7.8 mm, 7.1 to 7.4 mm, 7.62 to 7.89 mm,360 g to 422g,25° to 30° and 182.18 to 195.33 mm2, respectively. The influence of different moisture levels (45and 57 w.b.%), in two loading orientation (longitudinal and transverse) and tow loading speed (6 and 8 mm min-1) on the mechanical properties of peas such as maximum deformation, rupture force of peas was investigated. The rupture force increased from 39 to 45 N, as the moisture content decreased from 57 to 45 % (wb). It was observed in the mechanical properties that moisture changes were effective on maximum deformation, rupture force. Also loading speed was effective on maximum deformation, rupture force.

Keywords: deformation, rupture force, engineering properties, physical properties.

1. INTRODUCTION
Knowledge Access to scientific information on the physical characteristics of seed for the design of the equipment to handle storage, transportation, cleaning, processing and packaging peas necessary. Shape, size, volume, surface area and color physical appearance of the characteristic that in many issues related to machine designs .Seed shape and physical dimensions are important for measuring, sorting, screening and separation processes (Mohsenin.,1986) . In the study about the physical properties of hazelnut and its seed it was observed that with increasing moisture, dimensions, weight, volume and surface area increased and sphericity decreased (Aghkhani et al ,2012)In a study the physical properties of 3 varieties of chickpeas at 3 levels of moisture was investigated. It was observed that the effect of moisture on physical properties such as volume and geometric diameter were significant (Kermani 2008). Researchers investigated the effect of moisture on physical properties of wax bean. They observed that the effect of moisture on physical properties was Significant (Dizaji and Minai, 2007). Understanding the mechanical properties of agricultural products and food had always been interested in agriculture and food industry professionals. This is especially the case with agricultural machinery and it is important about impacts on different parts of machine during harvesting, transporting , storage and processing of the product [Sadeghi et al .2010].Mechanical damage in fruits and vegetables is an unwanted phenomenon which is associated with increased

product quality and reduced level of corruption [Azarang,2002]. Mechanical properties of agricultural products to design and improve harvesting equipment and then transmitting devices, separating, washing, processing, packaging and storage is necessary, which has been reported and researched by numerous scholars for products [Afkari,2007].The results of static and quasi-static tests can be a criterion for designing machines used in agriculture and food processing [Pravee and Irudayaraj 1995]. Energy required for knocking bean pods, with two of the pendulum and the force of friction and pressure were measured. Dried beans (15.3% to 13.3% moisture) are fully opened and then it was observed that the shells were broken. After the release of seed, pods with 17.3% moisture slowly open and never break[Simone,2000]. Researchers continue to investigate the mechanical properties of a bean named Christmas Lima bean observed that static and dynamic friction coefficient increased with increasing moisture. The average breaking force, deformation and rupture energy rupture pressure were checked and they found that the rate of deformation, rupture and rupture energy generally increases with the increase of moisture ratio (Aghkhani et al ,2012) Researchers investigated two loading orientation and three chickpeas varieties under the influence of quasi-static forces and found that power and energy required breaking the seed, in three levels of moisture (7%, 12%, and16%), the moisture, and the loading orientation on the power and energy leading to seed breakage was significant [Kermani,2008]. Given that one of the major problems in the peas harvest, is mechanical damage to it [Haciseferogullari,2007].

2. DATA AND METHODOLOGY

2.1: physical properties:

The green peas investigation in this study were obtained from a local market in Giza city. The samples were shelling manually. In order to obtain different levels of the moisture content, the samples were drying by The oven 72°C for 24h according to ASAE Standard S 352.2.(1999).The physical properties of the seeds were investigated at tow moisture levels in the range of 45–57 % w.b. Ten replications of each test were made at each moisture level. For each moisture content, the length, width, thickness and weight of green seeds were measured in randomly selected 100 peas seeds were measured using a digital caliper with an accuracy of 0.01 mm. Thousand seed weight Thousand seed weight (TSW) was measured by counting 100 seeds and weighing them in an electronic balance to an accuracy of 0.001 g and then multiplied by 10 to give mass of 1000 seeds. The average diameter of the seeds was calculated by using the arithmetic mean and geometric mean of the three axial dimensions. The arithmetic mean diameter D_a and geometric mean diameter D_g of the seeds were calculated by using the following equation (Mohsenin, 1986).

$$D_a = \frac{L+W+T}{3} \quad (1)$$

$$D_g = (\mathrm{LWT})^{0.333} \quad (2)$$

The sphericityΦ, of green peas seeds was calculated by using the following relationship (Mohsenin, 1986):

$$\Phi = \left[\frac{(\mathrm{LWT})^{0.333}}{\mathrm{L}}\right] X100 \quad (3)$$

Where L is the length, W is the width and T is the thickness, all in mm.

The thousand seeds mass was determined using a digital electronic balance having an accuracy of 0.001 g. To evaluate the thousand seed mass, 100 seeds were randomly selected from the bulk sample and averaged. The surface area of green peas seed was found by analogy with a sphere of the same geometric mean diameter, using the following relationship (Sacilik et al., 2003; Tunde-Akintunde and Akintunde, 2004; Altuntaş et al., 2005).

Where: is the sphere city; L is the length in mm; W is the width in mm; and T is the thickness in mm.

$$S = \pi {D_g}^2 \quad (4)$$

Where S is the surface area in mm

The angle of repose was calculated from the measurement of the height of the cone and the diameter of cone (Kaleemullah&Gunasekar, 2002).

2.2: Determination of Mechanical Properties

To determine the mechanical properties of peas, a proprietary tension and compression testing machine (Nidec chipo-FGC-20) was used, equipped with a 20 kg compression load cell and integrator . The measurement accuracy was ±0.01 N in force . The individual seed was loaded between two parallel plates of the machine and compressed along with thickness until rupture occurred This point is detected by a continuous decrease of the load in the force-deformation. While the rupture point was detected, the loading was stopped. These tests were carried out at the loading rate of variable speed for all moisture levels (ASAE, 2006a).equipped with a50 kg load cell and stainless steel base plate . Compressive force was applied by a circular disc plate at a variable crosshead speed with an strain limit and a 0.2-N force. The force deformation data was acquired at points/test for the material properties. Compression in the longitudinal orientation was achieved by loosely holding the peas in the vertical position within a grove engraved in a metal support such that there was unrestrained deformation in all directions. At each loading, the force and deformation values at rupture point were directly recorded.

3. RESULTS AND DISCUSSION

3.1 Physical properties of green peas

3.1.1. Length, width and thickness

The data were collected and recorded in table (1) The mean axial dimensions, arithmetic and geometric mean diameters, sphericity, surface area, densities mean diameters, sphericity, surface area, different moisture content levels of 45and 57% (wb) are presented in Table I. Studying Table I shows that moisture effect on the length, width, thickness, geometric diameter and surface area and sphericity .Figs. (1-3) show that increasing moisture from 45% to 57% the length, width and thickness were increased This increase due to the High moisture can be related to cellular Inflation .

Table 1 Physical properties of green peas at different moisture content level .

M.C	Axial dimension (mm)			d_a	g_d	Sphericity %	Surface area mm^2	Repose angle(°)	1000 seed Mass (g)
45	8.19	7.60	7.10	7.63	7.62	93%	182.18	25	360
57	8.50	7.80	7.40	7.90	7.89	93%	195.33	28	422

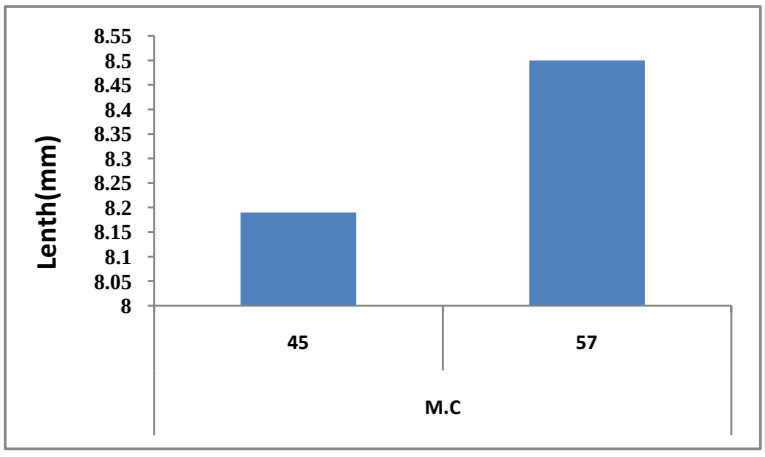

Fig. 1 .The effect of moisture contents on peas length

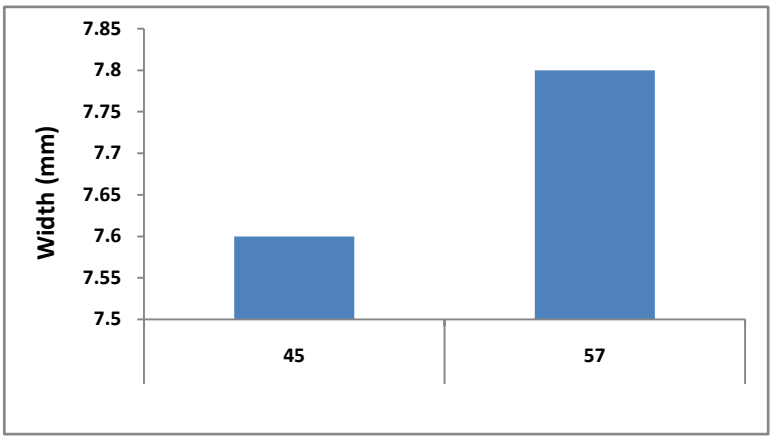

Fig. 2 .The effect of moisture contents on peas width

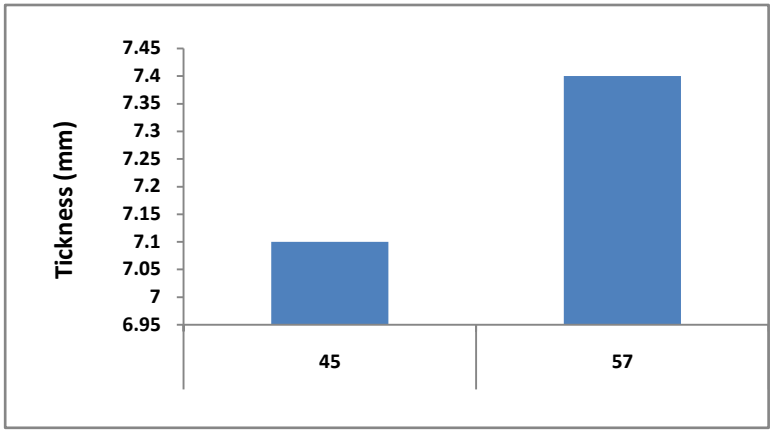

Fig. 3 .The effect of moisture contents on peas thickness.

3.1.2. Geometric diameter and the surface area:

Figs. 4-5 indicated that the geometric diameter and the surface area increased with increasing moisture content . Geometric and Arithmetic Mean Diameters: The mean geometric and arithmetic mean diameters are presented in fig (4) The mean values increased from 7.62mm to 7.9mm and 7.63 to 0.63mm for the geometric and arithmetic mean diameters respectively as the moisture content increased from 45 – 57 % (wb). The surface area of green peas seeds increased from 182 to 195 cm2with increase in moisture content from 45% to 57% w.b. Filling Angle of Repose: The filling angle of repose increased with increase in moisture content of green peas. The mean values of the filling angle of repose was increase from 25° to 30° as the moisture content increased from 45% to 57% w.b (Table 1).

3.2. Mechanical Properties:

The effect of different levels of moisture, loading orientation and maximum loading speed on deformation, rupture force, to defeat(deformation and rupture) the peas seeds were investigated. Effects of moisture content , loading orientation and loading rate on maximum deformation of green peas are shown in Fig 6-10.Fig (6) showed that decreasing moisture the deformation decreases.

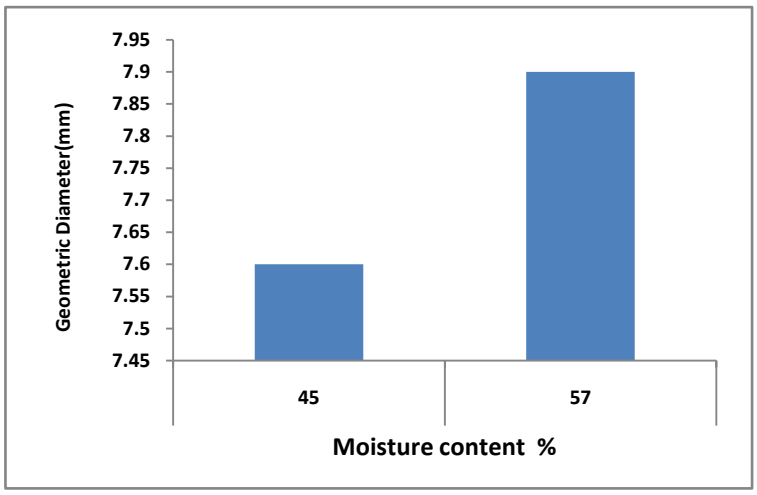

Fig. 4 .The effect of moisture contents on geometric dia.

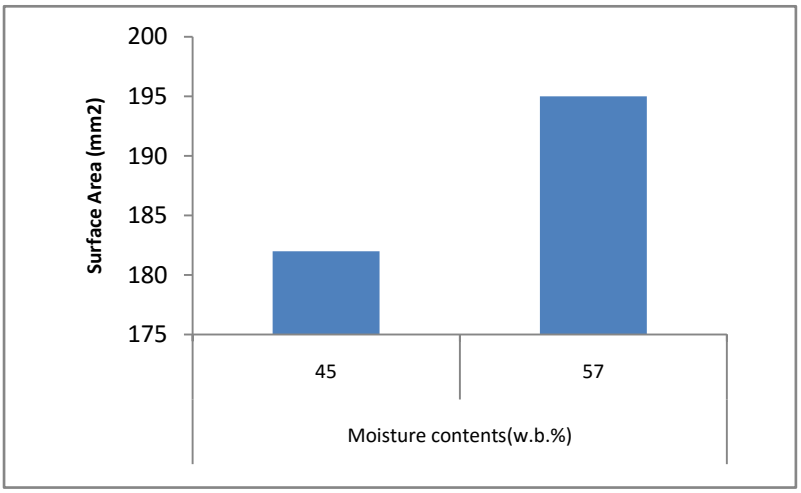

Fig. 5The effect of moisture contents on surface area.

It was observed that with increasing moisture, the deformation increases because of the increased moisture and softening of the skin. Fig. (7) Showed that the deformation in the longitudinal orientation is greater than the deformation in the orientation of the width.

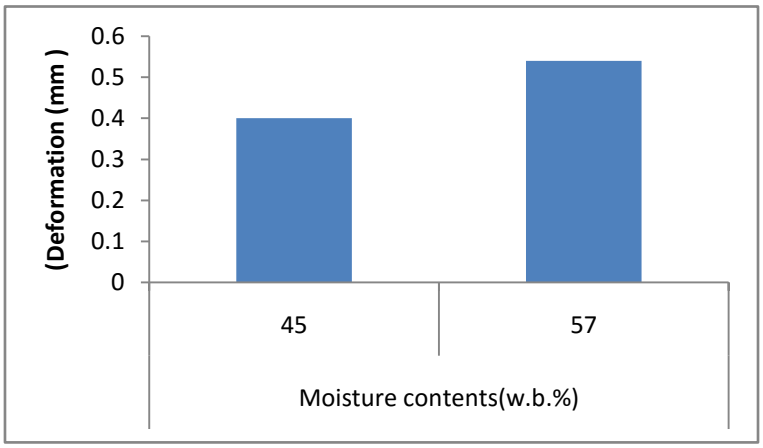

Fig. 6.The effect of moisture contents on deformation

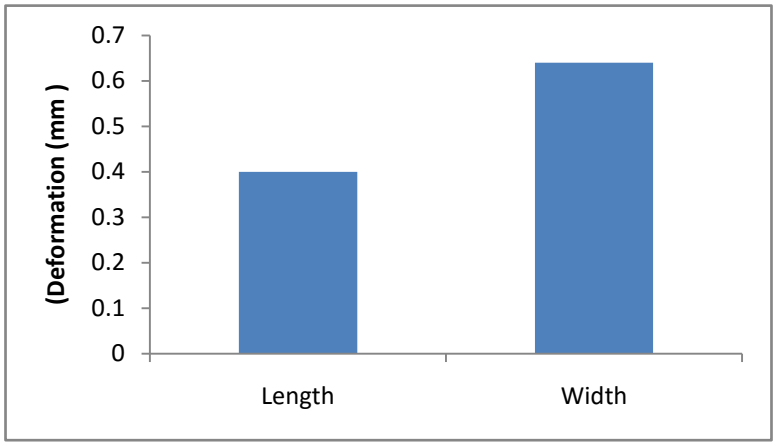

Fig. 7.The effect of orientation on deformation

Fig. (8) showed that with increasing loading speed the deformation decreases.

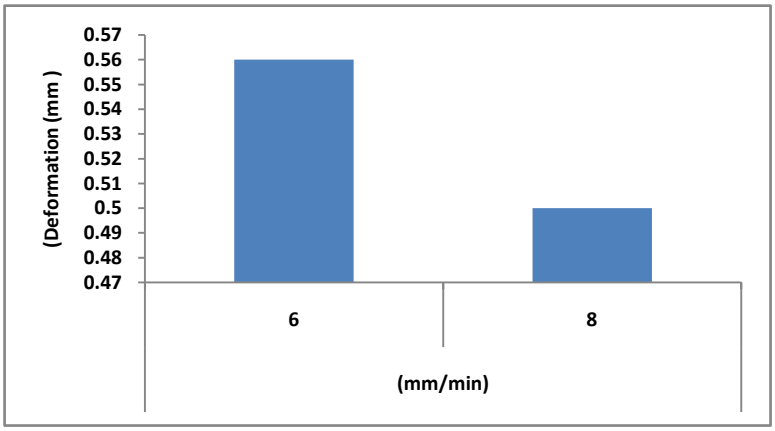

Fig. 8.The effect of loading speed on deformation

Figure (9) indicated that moisture content , and loading speed effect of on rupture force the results are shown in figure (9) shown the maximum and minimum rupture force equivalent to 39 N and 45 N, respectively at moisture level 45% and 57%, at a

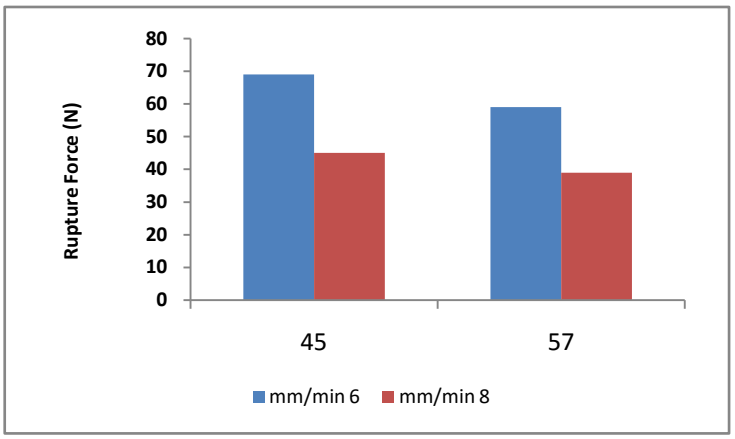

Fig. 9.The effect of moisture on rupture force

speed of 6 (min mm-1) and 8 (min mm-1).moisture reduction of 57% to 45% increases rupture force and with accelerating the loading speed rupture force decreased.

Fig. (10) showed that rupture force in the orientation of width is more than length. Fig (9 and 10) indicated that moisture content , loading orientation and loading speed effect on rupture force.

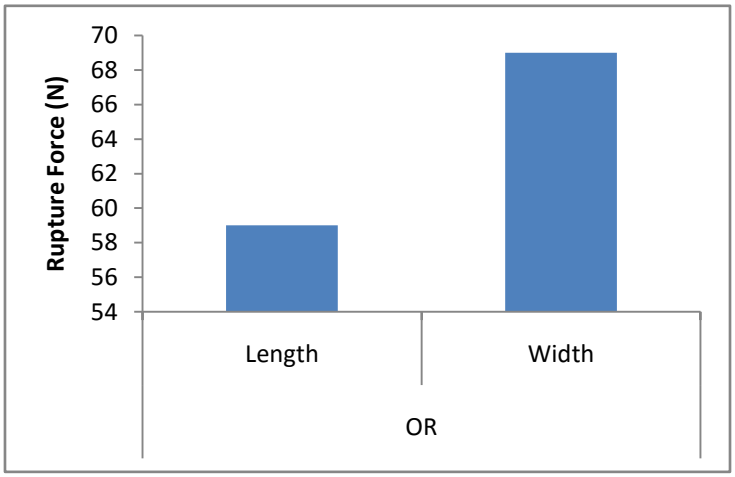

Fig. 10: The effect of loading orientation on rupture force.

4. CONCLUSION

The following conclusions were drawn from the investigation on the physical properties of green peas seeds within the moisture content range of 45 to 57% (wb). The mean dimensions, mean diameters, thousand seed mass and surface area of peas seed increased with increasing moisture level. The sphericity, decreased as the moisture content of the seeds increased. Physical and mechanical properties of green peas seeds for moisture content range of 45 to 57% (wb). The average length, width, thickness, geometric mean diameter, thousand grain mass, angle of repose and surface area of peas seeds ranged from 8.19 to 8.50 mm, 7.6 to 7.8 mm, 7.1 to 7.4 mm, 7.62 to 7.89 mm,360 g to 422g, 25° to 30° and 182.18 to 195.33 mm2, respectively. The rupture force decreased from 30 to 45 N, as the moisture content increased from 45 to 57 % (wb). With increasing moisture. Reducing the loading speed and loading deformation in the longitudinal orientation was at its highest value, So these conditions is suitable for shelling because deformation takes longer to break down.

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