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Research Article

STUDY OF BIOPHYSICAL PROPERTIES OF 3 VARIETIES OF PISTACHIOS (AKBARI, KHANGARI, FANDOGHI) CITY OF DAMGHAN

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ABSTRACT
To reduce the damages and keep the quality of agricultural products (crops) safe in harvesting time and also in operating after harvesting, and in order to designs the machines needed for processing, it seems to be necessary to have enough information about physical and mechanical properties. In this research some of the physical and gravitational characteristics as volume, mass density , true density, porosity, the angle of slip and repose, the rate of moisture, the average of geometrical dimensions, the mathematical average of diameter, sphere city and the slenderness ratio with 5% possibility level on three types of pistachio (Akbari, Khankary, fandogi) were studied in Damghan. In most cases a significant difference between Akbari and the other types was seen. There is a significant difference between three types of pistachio in the geometrical average, sphere city, shape factor, which Khanjary and Fandogi type are very different in the average of geometrical dimension and also a significant difference wasn't seen in Khanjary and Fandoghi types in studying dimensions- length, width, and height.

***Keywords*:** *Pistachio, Biophysical Properties, Density, Moisture*

INTRODUCTION
As one of the agricultural crop, pistachio is very important for Iran's economy and export. According to the National Agricultural Statistics Service (NASS), the statistical branch of the U.S. Department of Agriculture, having produced around 210,000 tons pistachios in crop year 2010, Iran is the world's No. 2 producer of pistachios after the United States. This report introduced Iran as the largest exporter of pistachio and ranked it number one with the export of 160,000 tons of its production. Iran pistachio export increased in that year by 31,000 tons as compared to the previous year (Gholami *et al.*, 2012).
In recent years, there has been much debate on the issue of mechanized production, because exporting corps lacking of the required standards and quality would not be much profitable. Designing transportation and processing machines and equipment is one of the requirements of a mechanized production industry. The first step in developing such machine is to know physical and mechanical features of pistachio kernels (Heydari *et al.*, 2003).
This would have a significant impact on the function and output of processing machine and equipment. Pistachio shapes and sizes are those parameters having effect on cooling curve and separating the crops out of unrequired materials and rating them (Mohsenin, 1980). This is a contributing factor in keeping and in the stage of removing junk materials and empty shells by equipment and machines (Gholami *et al.*, 2012). Gravitation properties are of physical properties which should be considered in designing equipment and machine. Mass density and porosity should also be taken into account in designing dryers and aeration systems.
These properties, at the same time, affect the resistance of the stored mass against air. They are used to predict the load structure for storages. The apparent and true densities are considered as a factor to specify the quality of crops and grading systems. Regarding this matter significantly helps to correctly design grading systems (Gholami *et al.*, 2012; Levin, 1970).

This is to study properties such as density, porosity, and mass, slip angle, angle of repose, slenderness ratio, sphericity, arithmetic mean, and arithmetic mean diameter, and shapes such as Fandoghi, Akbari, and Khanjari all produced in Damghan.

MATERIALS AND METHODS

Preparing Sample

Among different types of pistachio available in Damghan, we bought Akbari, Khanjari and Fandoghi types, placed them in special paper packets and transferred them into laboratory. All nuts were then cleaned by hand, broken ones were separated and good and healthy ones were kept to be tested. In the next step, the primary humid was measured by putting samples at oven at 105°C. The humid was iterated three times at the temperature of 75°. The measurement continued for 60 minutes and the time and humid diagram was studied based on dryness and the speed of drying and the following diagrams were achieved (Kashaninejad *et al.,* 2008; Amin *et al.,* 2004).

Volume

Liquid handling was used to measure the volume. A number of nuts were poured in a graduated burette containing toluene. Liquid handling into burette was read and measured by equation 1. Instead of water, toluene was used, because its surface tension is low and a very little is absorbed by nuts (Razavi *et al.,* 2008; Kashaninejad *et al.,* 2008).

Vs=(Wpt-Wp)-(Wpts-Wps) (1)

Mass Density

A dish with certain volume and mass was selected to measure mass density (pb). It was filled with nuts more than its capacity. Nuts should be poured in a fixed speed from a height of 150 mm by tapping the dish at the time of filling it.

This makes some materials deposited at the bottom of the dish when storing. After filling the dish, the apparent density was calculated by mass (m) to total volume (the same dish) ratio or v according to equation 2 (Razavi *et al.,* 2008; Kashaninejad *et al.,* 2008).

$\rho_b = m/V\rho$ (2)

True Density

To measure the true density (pk), a number of nuts were weighted (using a digital weight with precision of 0.001) and poured into a graduated burette containing toluene. The amount of toluene read from the graduated burette column was equal to the true volume of nuts (tv). The true density was calculated by equation 3 (Mohsenin, 1980; Razavi *et al.,* 2005).

$\rho k=m/vt$ (3)

Prosity

In some references, porosity is called as packing factor. Packing factor or porosity is calculated by measuring true and mass density and putting them in equation 4 (Mohsenin, 1980; Razavi *et al.,* 2005).

$\varepsilon=1-\rho b/\rho p$ (4)

Slip Angle and Repose of Angle

Slip angle and angle of repose were measured separately using equation 5 and 6 respectively (Mohsenin, 1980).

$\text{Tan } R = \frac{L}{H}$ (5)

$\text{Tan } R = \frac{\frac{L}{2}}{H}$ (6)

Geometric Properties

Geometric properties such as length (L), width (W), height (T), geometric means diameter (Dg), arithmetic mean diameter (De), sphereiety (Φ), slenderness ratio (R), and shape factor (Z) were studied as follows.

Dimension Measurment

Length, width and height were measured by a digital caliper with precision of 0.001. In this measurement, 120 were selected and studied (Mohsenin, 1980; Razavi *et al.*, 2005).

Geometeric Mean Diameter (DG)

Geometric Mean Diameter was measured by equation 7 for all types of pistachio (Mohsenin, 1980; Razavi *et al.*, 2005).

$dg=(lwt)^{1/3}$ (7)

Arithmetic Mean Diameter (Da)

Arithmetic mean diameter was measured by equation8 for all types of pistachio (Mohsenin, 1980; Razavi *et al.*, 2005).

$da = \frac{l+w+t}{3}$ (8)

Sphericity (ϕ)

Sphericity (Φ) was measured by equation 9 for all types of pistachio (Mohsenin, 1980; Razavi *et al.*, 2005).

$\phi = \frac{(lwt)^{1/3}}{l} \times 100$ (9)

Slenderness Ratio (s)

slenderness ratio (R) was measured by equation 10 for all types of pistachio (Mohsenin, 1980; Razavi *et al.*, 2005).

$S=\frac{w}{l}$ (10)

Shape Factor (z)

Shape factor (Z) was measured by equation 11 for all types of pistachio (Mohsenin, 1980; Razavi *et al.*, 2005).

$\mathbf{z=(\frac{\pi}{6})(\frac{de}{dg})^{3}\times(\Phi)}$ (11)

Statiscal Analysis

Data were obtained by standard deviation as mean. Result variance was assessed by ANOVA in SPSS21. Means were randomly compared and grouped by any series of data by means of Duncan mean.

RESULTS AND DISCUSSION

Some physical properties (for Khanjari, Fandoghi, and Akbari) were measured and table 1 present data mean ± standard deviation.

Table 1: Biophysical properties pistachio

Sample		**Akbari**	**Fandoghi**	**Khangari**
mean±std	l	21.64	17.79	20.72
dimension	w	11.96	10.69	10.69
	t	13.08	13.01	10.90
Shape Factor		40.52	571.28	605.24
Arithmetic Mean Diameter		15.56	32.82	35.04
Geometric Mean Diameter		15	13.50	13.41
Sphericity **%**		69.40	76.05	64.84
slenderness ratio		0.55	0.60	0.52
Repose Angle		0.041	0.051	0.049
Slip Angle		4.77	5.87	4.88
Volume		3	2	1.5
Porosity		15.92	32.41	30.67
Density	Mass Density	0.56	0.56	0.56
	True Density	0.0276	0.0188	0.0143

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To study temperature at 105 and 75° C, humid ratio had a linear relation based on dryness and time. It was measured all three types and an optimal gradient was obtained between 0.94 and 0.99 (see figure 1). To study the speed of drying to humidity content based on dryness, no linear relation was observed and the line gradient was obtained at 0.55 to 0.66 (see figure 2).

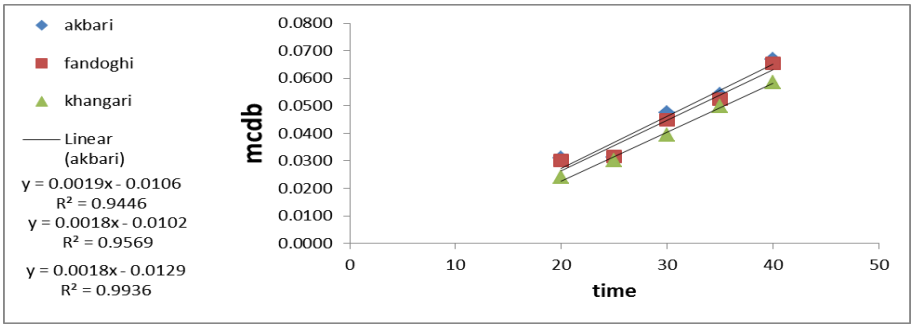

Figure 1: Shows the effect of time on moisture content (dry basis)

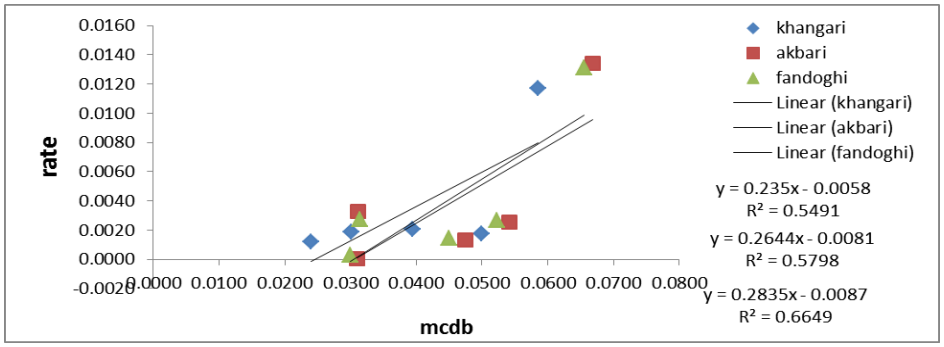

Figure 2: Effect of fast -drying the moisture content (dry basis)

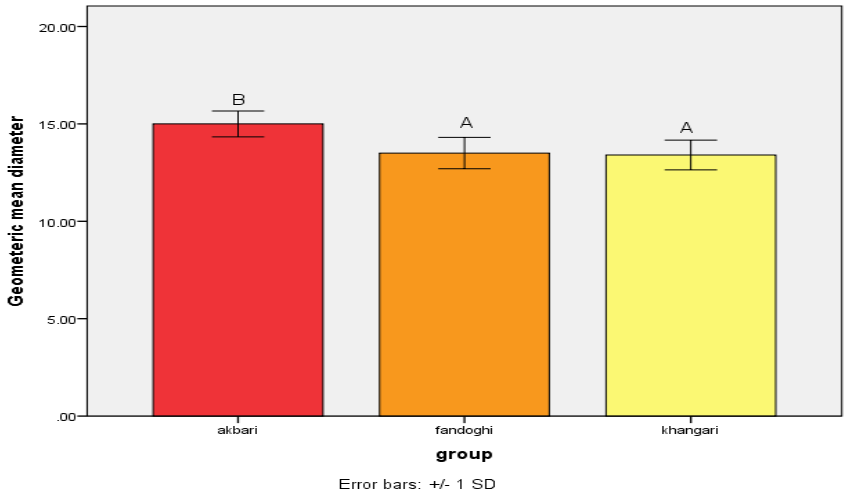

Figure 3: Dimension Geometric Mean (Dg)

Geometric mean diameter (Dg) was considered for these three types and no significant difference was observed between Fandoghi and Khanjari ($p>0.05$). However, Akbari was significant different from two other types ($p<0.05$). And the dimension geometric mean range for all above types was between 13.40 and 15 (see figure 3). The difference between Latin letters over column shows the difference of pistachios.

Arithmetic mean diameter (Da) was studied for these pistachio. Accordingly, there was a significant difference between them ($p<0.05$) with arithmetic mean diameter range between 15 and 35 (see figure 4). The difference between Latin letters over column shows the difference of pistachios.

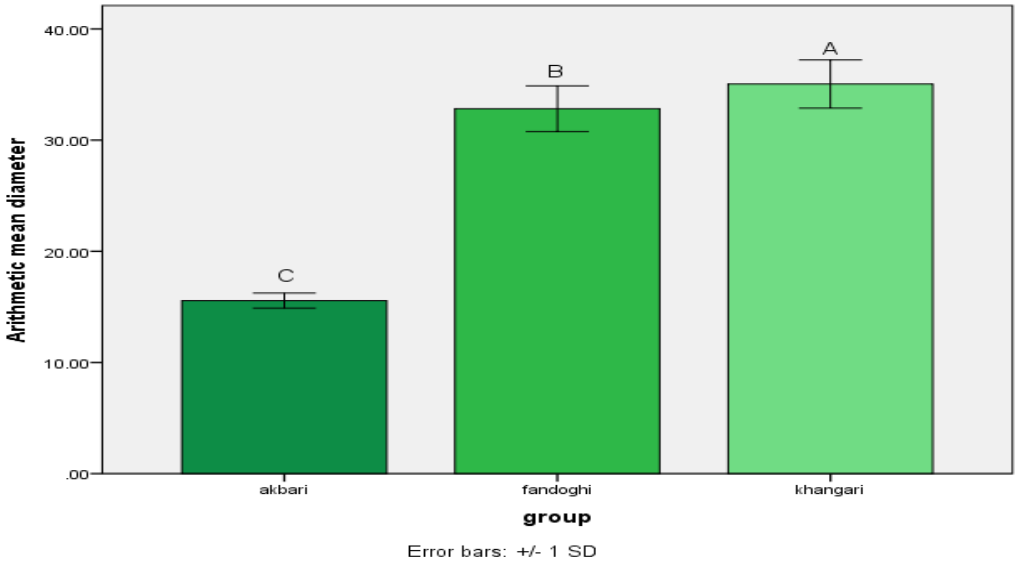

Figure 4: Arithmetic Mean Diameter (De)

Dimensions (length, width and height) were measured for all three types. Dimension ratio is one of the most important features in terms of packaging. No significant difference was observed between Fandoghi and Khanjari on this ground ($p>0.05$). However, Akbari was significantly different from the other types ($p<0.05$) with mean range 6 for three types and the length standard deviation between 20 and 22 mm. And with the mean range of 6, the width standard deviation of length for all pistachio was between 20 and 22 mm, and the height standard deviation was between 10 and 13.5 mm (see figure 5). The difference of Latin letters indicates the difference of pistachios.

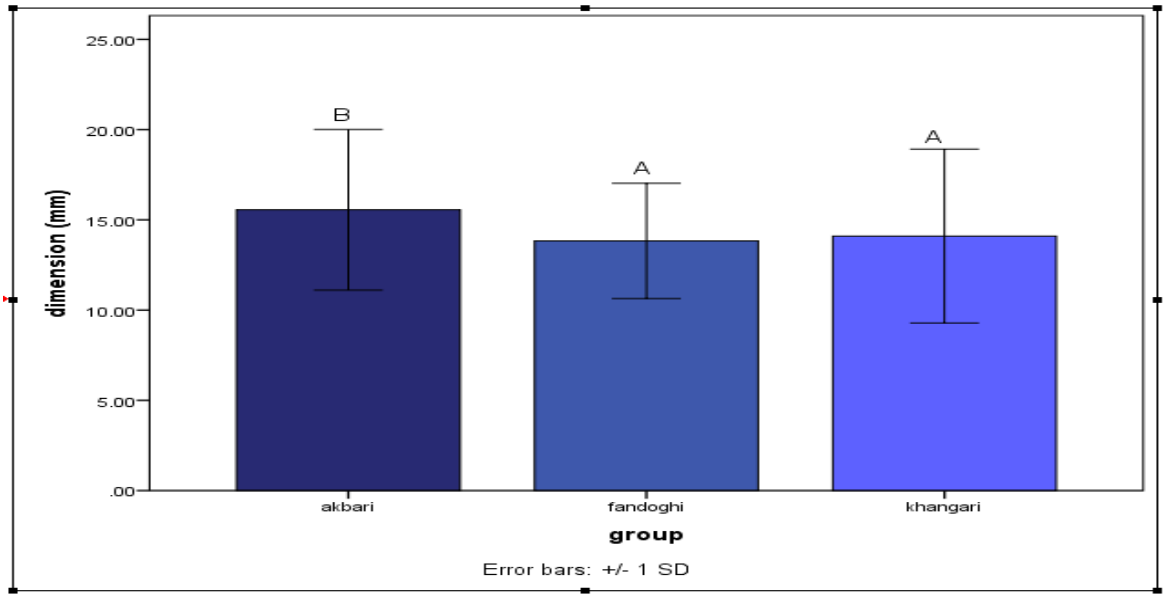

Figure 5: Dimension pistachio sample (L-W-T)

Sphereiety was studied for all three types of pistachios, and a significant difference was observed between them ($p<0.05$) with mean range ± standard deviation for all pistachios between 64 and 77% (see figure 6). The difference of Latin letters indicates the difference of pistachios.

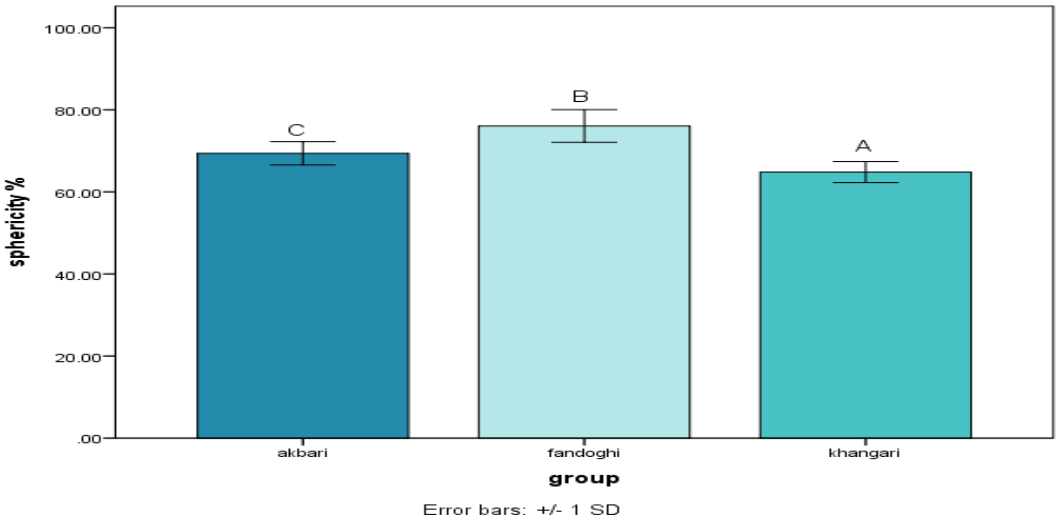

Figure 6: Sphericity

Shape factor (z) was also studied for all three types of pistachios, and a significant difference was observed between them ($p<0.05$) with mean range ± standard deviation for all pistachios between 40 and 605 (see figure 7). The difference of Latin letters indicates the difference of pistachios.

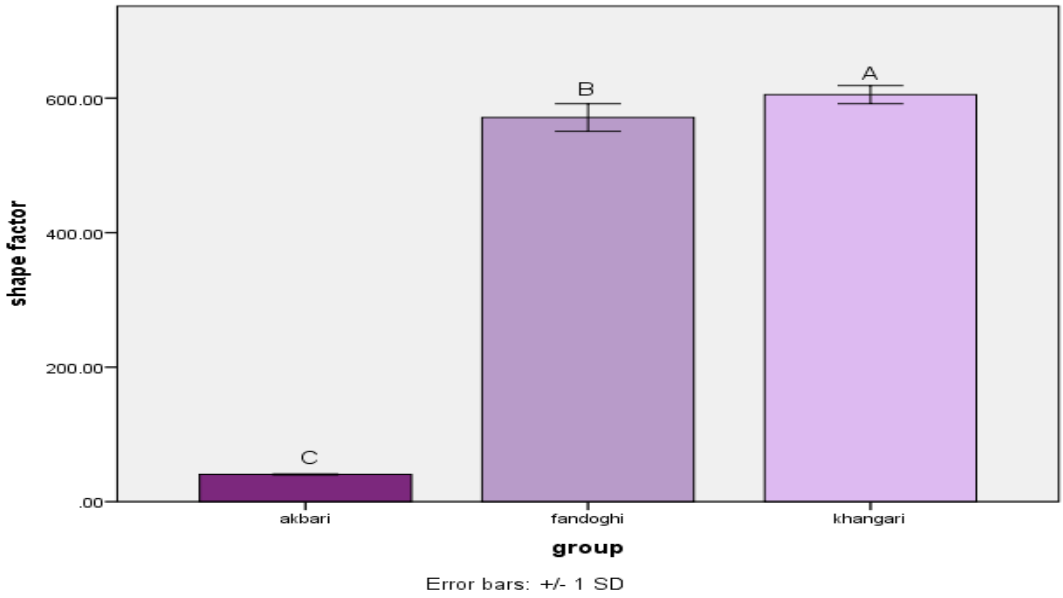

Figure 7: Shape factor

Slenderness ratio was studied for all three types of pistachios, and no significant difference was observed between them ($p>0.05$) with mean range ± standard deviation for all pistachios between 0.5 and 0.6 (see figure 8).

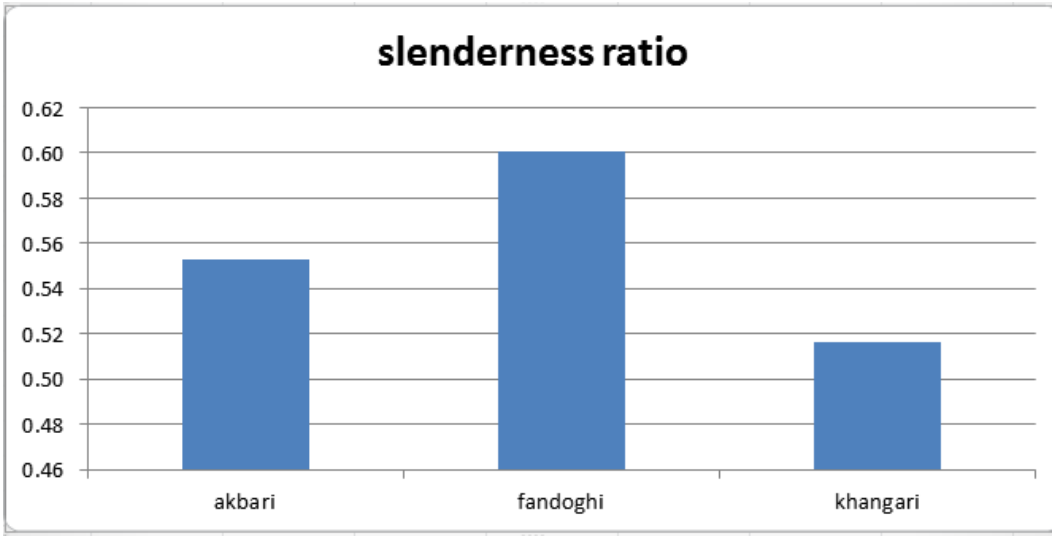

Figure 8: Slenderness Ratio

Conclusion

The physical and gravitation properties such as volume, mass density, true density, porosity, slip angle, angle of repose, and slenderness ratio were studied at 5% probability level for three types of pistachio (Fandoghi, Akbari, and Khanjari). In most cases, a significant difference was observed between Akbari and other types of pistachios and in terms of geometric dimensions, there was a significant difference on sphereiety and shape factor among all pistachios. No significant difference was observed between Khanjari and Fandoghi on geometric dimensions. There was also no significant difference on length, width and height between Khanjari and Fandoghi.

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