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Evaluation the Some Physical Properties of Chickpea Seeds in Kurdistan Region of Iran

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Abstract Physical and mechanical properties of food crops gain importance during design, improvement and optimization of separation and cleaning. The objective of this work was comparing some physical properties between four varieties of chickpea seeds (Kaka, Pirooz, ILC and Jam). From each variety, 100 seeds were selected randomly and the length, width, thickness, geometric mean diameter, arithmetic mean diameter, surface area, sphericity, mass, true density, bulk density and porosity of them were measured. Analysis of the statistical parameters for each variety shows that the Jam and Kaka variety respectively presented high and low mean values for all of the geometric properties except sphericity, whose the high mean value belongs to ILC. The maximum values of bulk density and true density among the varieties were obtained for kaka, and jam had the highest porosity. The results of this research can be used for design and adjustment of agricultural machines of these varieties and recognition and classification of them.

Keywords Chickpea, Physical properties, Seed variety

1. Introduction

Pulses play an important role in supply the needs of food in human society, especially in the developing countries. Chickpea (*Cicer arientum* L.) is considered the 5th valuable legume in terms of worldwide economical standpoint. Chickpea is planted in Southern and Western areas of Asia and Mediterranean [10].

The chickpea is a good source of protein and carbohydrate and its protein quality is better than other legumes such as pigeon pea, black gram and green gram. It also supply some minerals (Ca, Mg, Zn, K, Fe, P) and vitamins like thiamine and niacin [25].

Information on physical and aerodynamic properties of agricultural products is needed in design and adjustment of agricultural machines [8]. The geometric properties such as size and shape are the most important physical properties considered during the separation and cleaning of agricultural grains [18].

In view of this, several studies have been conducted on the physical properties such as size, shape, bulk density, true density, porosity, angle of repose and coefficient of static and dynamic friction of different agricultural crops, such as; quinoa seeds [24], hemp seed [21], lentil seeds [3], safflower seeds [4], popcorn kernels [12], linseed [22], coriander seeds [5], faba bean [2], cucurbit seeds [16], wheat, barley, chickpea and lentil seeds [9], arigo seeds [6], rice seed [11], Parkia speciosa [1].

In a research, several physical properties of chickpea seeds including the average length, width, thickness, geometric mean diameter, unit mass, projected area, angle of repose, terminal velocity and static and dynamic coefficients as functions of moisture content were evaluated [13]. In another research, some moisture dependent physical properties of chickpea seeds of large kabuli, small kabuli and desi varieties were measured [15].

Because of varietal variability in chickpea seeds, knowing the physical properties of different varieties of them is necessary. The objective of this work was to study some physical properties of four varieties of chickpea seeds (Kaka, Pirooz, ILC, Jam) to develop appropriate technologies in design and adjustment of machines used during harvesting, separating, cleaning, handling and storing of them.

2. Materials and Methods

2.1. Sample Preparation

Four common chickpea varieties called Jam, ILC, Pirooz and Kaka, which are grown in Iran, were prepared from Kurdistan Center for Agricultural and Natural Resources Research. The samples were cleaned manually to remove stones, straw, and dirt and then sieved to remove broken and damaged seeds. Initial moisture content (MC) of samples

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was determined by using oven method at 105°C for 24 h [7]. Initial MC of Jam, ILC, Pirooz and Kaka were 7.45, 7.82, 6.95, 7.33% (w.b.), respectively.

2.2. Dimensions, Size, Surface Area and Sphericity

From each variety, 100 seeds were selected randomly. Length (L), width (W), and thickness (T) of seeds were the morphological features that were measured by micrometer with 0.02 mm accuracy. The geometric mean diameter, arithmetic mean diameter and surface area of seeds were respectively calculated by using the following equation [23]:

$$D_g = (LWT)^{1/3} \quad (1)$$

$$D_a = \left(\frac{L+W+T}{3}\right) \quad (2)$$

$$S = \pi (D_g)^2 \quad (3)$$

Where: D_g = geometric mean diameter of seed (mm).
D_a = arithmetic mean diameter of seed (mm).
S = surface area of seed (mm^2).

The used criteria to describe the shape of the seed are the sphericity. Thus, the sphericity (S_p) was computed as [8]:

$$\phi = \frac{(L+W+T)^{1/3}}{L} \quad (4)$$

2.3. Dimensions, Size, Surface Area and Sphericity

Mass (M) of individual seeds was measured by using a digital scale with 0.0001 gram accuracy. Seed volumes (cm^3) and true density ($g.cm^{-3}$) were measured by water displacement method. For each chickpea variety 100 seeds were weighed and replaced in water. Mass of water displaced by the seeds was recorded. Finally true densities ($g.cm^{-3}$) were calculated by using the following equation:

$$\rho_t = \frac{M}{M - M_w}\rho_w \quad (5)$$

where ρ_t is the true density ($g.cm^{-3}$), ρ_w is the water density (1.05 $g.cm^{-3}$ at laboratory temperature); M and M_w are mass of seeds and water, respectively [20].

Bulk density, ρ_b, is based on the volume occupied by the bulk sample as poured into a container of known volume. In order to measure the bulk density, the chickpea seeds without any compaction were poured into a calibrated container of known volume and weight. The ratio of the mass and volume was expressed as bulk density:

$$\rho_b = \frac{M}{V} \quad (6)$$

where: ρ_b is the bulk density ($g.cm^{-3}$), M and V are mass of seeds and box volume, respectively [14].

The porosity (ϵ) was calculated from the measured values of bulk density and true density using the following relationship [17]:

$$\varepsilon = \left(\frac{\rho_t - \rho_b}{\rho_t}\right) \times 100 \quad (7)$$

3. Results and Discussion

3.1. Dimensions, Size, Surface Area and Sphericity

The average, minimum, maximum, standard deviation and coefficient of variation values for the length, width, thickness, geometric mean diameter, arithmetic mean diameter, surface area and sphericity of four chickpea varieties are shown in Tables 1 to 7.

Analysis of the statistical parameters for each variety shows that the Jam and Kaka variety respectively presented high and low mean values for all of mentioned physical properties in table 1 to 7 except sphericity, whose the high mean value belongs to ILC. The mean sphericity of kaka and jam, and mean sphericty of ILC and Jam varieties were in the same range, respectively.

The importance of dimensions is in determining the aperture size of machines, particularly in separation of materials [19]. These dimensions may be useful in estimating the size of machine components. The major axis has been found to be useful by indicating the natural rest position of the material and hence in the application of compressive forces to induce mechanical rupture. The values sphericity indicate strong tendency of seed shape towards a sphere.

3.2. Mass, True Density, Bulk Density and Porosity

The average, minimum, maximum, standard deviation and coefficient of variation values of Mass are shown in table 8. As this table shows the Jam and Kaka variety respectively presented high and low mean values of seeds mass.

Table 9 shows the average values of true density, bulk density and porosity for chickpea seeds. It appears that true and bulk density decrease, and porosity increases with regard to increasing size.

The seed mass, bulk density and true density are very important in separating and grading of grains according to density and aerodynamic properties.

Table 1. The statistical parameters for length (mm) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	7.5	6.52	9.06	0.453259	6.043456
pirooz	8.45	7.2	9.54	0.49639	5.874438
ILC	9.02	7.76	10.36	0.467218	5.179797
jam	9.69	8.56	10.88	0.512182	5.285679

Table 2. The statistical parameters for width (mm) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	5.06	3.56	6.74	0.429583	8.48979
pirooz	5.7	4.62	6.38	0.364721	6.398609
ILC	7.1	5.86	8.82	0.448843	6.321734
jam	7.56	6.14	9.48	0.480685	6.358261

Table 3. The statistical parameters for thickness (mm) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	5.16	4.1	5.84	0.334463	6.481847
pirooz	5.85	4.6	6.54	0.323377	5.527809
ILC	7.3	6.48	8.62	0.363139	4.974503
jam	7.74	4.72	10.08	0.548466	7.086125

Table 4. The statistical parameters for geometric mean diameter (mm^3) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	5.8	5.06	6.61	0.312252	5.383647
pirooz	6.55	5.6	7.33	0.322421	4.922462
ILC	7.76	6.7	8.57	0.34761	4.479515
jam	8.27	7.04	9.86	0.396802	4.798084

Table 5. The statistical parameters for arithmetic mean diameter (mm^3) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	5.91	5.2	6.73	0.313371	5.302387
pirooz	6.67	5.76	7.45	0.325617	4.881812
ILC	7.81	6.74	8.62	0.348967	4.468209
jam	8.33	7.34	9.86	0.388713	4.666421

Table 6. The statistical parameters for surface area (mm^2) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	105.93	80.32	137.17	11.4222	10.78278
pirooz	136.1	98.65	219.64	13.09677	9.6229
ILC	189.7	140.86	230.54	16.82481	8.869169
jam	215.49	155.85	305.59	20.8167	9.66017

Table 7. The statistical parameters for sphericity (%) of chickpea varieties

variety	mean	min	max	STD	CV
kaka	77.37	69.3	85.07	2.669184	3.449896
pirooz	77.62	67.68	83.5	2.752797	3.546505
ILC	86.15	80.61	93.81	2.6545	3.081254
jam	85.46	73.83	98.23	3.537803	4.139718

Table 8. The statistical parameters for mass (g) of chickpea varieties

Variety	mean	min	max	STD	CV
kaka	0.129	0.088	0.194	20.91658	16214.41
pirooz	0.202	0.133	0.31	31.03208	15362.42
ILC	0.324	0.215	0.454	45.08071	13913.8
jam	0.391	0.292	0.49	46.35728	11856.08

Table 9. The average values of true density, bulk density and porosity for chickpea seeds

variety	True density ($g.cm^{-3}$)	Bulk density ($g.cm^{-3}$)	Porosity (%)
kaka	1.408	0.825	41.4
pirooz	1.402	0.809	42.3
ILC	1.386	0.772	44.3
jam	1.379	0.759	45

4. Conclusions

The present study provides information on some physical properties of four Iranian varieties of chickpea. The results showed that these properties vary from variety to variety. Among the varieties, jam had the highest and kaka had the lowest values of geometric properties. The maximum values of bulk density and true density among the varieties were obtained for kaka, and jam had the highest porosity.

This data can be used for design and adjustment of agricultural machines in agricultural process of these varieties of chickpea. Another application of this data can be recognition and classification of them.

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