International Journal of Agricultural Engineering, Vol. 2 No. 2 (October 2009 to March 2010) : 270-272

Research Paper :

Effect of moisture content on selected physical properties of pulses

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Accepted : *August, 2009*

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ABSTRACT

The physical properties *viz.*, true density, bulk density, porosity per cent and angle of repose were estimated at different moisture levels [10, 15, 20, 25 and 30 per cent (w.b.)] with an accuracy of ± 0.5 per cent in each level, with standard procedures. From the study it is concluded that the true density and bulk density decreases and the porosity per cent and angle of repose increases with increase in the moisture levels. The true density was observed highest in the Bengal gram (1415.09 kg/m^3) at 10 ± 0.5 per cent (w.b.) moisture level and lowest in Green gram (1229.52 kg/m^3) at 30 ± 0.5 moisture level. The bulk density was found highest in Pigeon pea (875.00 kg/m^3) at 10 ± 0.5 per cent (w.b.) and lowest in Black gram (669.00 kg/m^3) at 30 ± 0.5 per cent (w.b.) moisture content. The highest porosity per cent (47.59 per cent) was observed in Black gram at 30 ± 0.5 per cent (w.b.) and lowest in Pigeon pea (35.91 per cent) at 10 ± 0.5 per cent (w.b.) moisture levels. The angle of repose increased with increase in moisture levels. The highest angle of repose (41.98^0) was found in Bengal gram at 30 ± 0.5 per cent (w.b.) and lowest in Pigeon pea (30.11^0) at 10 ± 0.5 per cent (w.b.) moisture contents.

Key words : Pulses, Physical properties, Moisture content

Pulses are grown and used for food in nearly all the temperate and tropical areas of the world. Pulses are important crops both economically and nutritionally. Their importance is increasing day by day due to high nutritive value. Therefore, pluses and their products become important constituents in the human diet. Also they provide substantial quantities of minerals and vitamins to the diet. In addition pulses supply significant amount of energy through carbohydrates, fibers, lipids, minerals and vitamins including reasonable levels of thiamine, riboflavin and niacin.

Pulses such as chickpea, pigeonpea, black gram, green gram, etc. have been used as a source of protein in the diets of people in many regions of the world, especially where animal proteins are scare or expensive as food ingredient, it is desirable to improve their functional properties. Considering the importance of pluses in processing resources, efforts have been directed to improve grain yield, nutritional quality, digestibility, storage and processing technology of grains. Among the engineering properties, the physical properties of pluses are more important in the Agricultural Process Engineering for the post harvest operations. The angle of repose, porosity per cent, bulk density and true density are needed in the analysis of various operations in respect of separation, drying, handling and conveying of pulses (Oke *et. al.*, 1985). These properties are used in the design and construction of silos, storage bins, handling equipments and hoppers. These properties vary with moisture content of pulses and such information is highly useful for the designers as the grain undergoes various post harvest operations at different moisture contents (Dev *et al*., 1982).

The objectives of the present study was to study the effect of moisture content on angle of repose, porosity per cent, bulk density and true density for some selected pluses.

METHODOLOGY

The pulses and their variety used in the experiment were as follows:

1. Pigeonpea (*Caganus Cajan*) var. 'BDN-2'
2. Bengal gram (*Cicer arietnum*) var. 'Chaffa'
3. Green gram (*Phaseolus aureus*) var. 'S-8'
4. Black gram (*Phaseolus mungo*) var. I-9'

The physical properties *viz.*, true density, bulk density, porosity per cent and angle of repose were estimated at different moisture levels [10, 15, 20, 25 and 30 per cent (w.b.)] with an accuracy of 0 ± 0.5 per cent in each level (Adhoo *et al.*, 1976). The moisture contents of the samples were obtained by standard air oven method. The higher moisture contents of the samples were obtained by rewetting. (Brusewit, 1975).

The angle of repose was determined by using the experimental set-up. The grain filled in the grain holder was allowed to fall on a circular plate of known diameter and a natural heap was noted. (Verma and Prasad, 2000). From the known diameter and height of heap, the angle

of repose was calculated as:

$$\theta = \tan^{-1}\left(\frac{2h}{d}\right) \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Bulk density was determined by filling gently a container of known volume with the grain and taking the corresponding weight. From the volume and weight bulk density was calculated as (Mohsenin, 1970).

$$d = \frac{W_2 - W_1}{V} \times 1000 \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

True density was determined by adding a known weight of grain in a 100 ml fractionally graduated measuring cylinder containing a fixed volume of tolune and noting the increase in volume and calculated as:

$$D = \frac{\text{Weight of sample}}{\text{Volume (true)}} \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

Porosity per cent was calculated by the following relation:

$$\text{Porosity per cent} = \frac{D - d}{D} \times 100 \quad \ldots\ldots\ldots\ldots \quad (4)$$

RESULTS AND DISCUSSION

True density decreased with increase in moisture levels for all pulses (Table 1). The true density was observed highest in the Bengal gram (1415.09 kg/m^3) at 10 ± 0.5 per cent (w.b.) moisture level and lowest in Green gram (1229.52 kg/m^3) at 30 ± 0.5 per cent (w.b.) moisture level.

The variation of bulk density of pluses with moisture levels is shown in Table 2. The rate of decrease in bulk density with respect to moisture content was rapid in case of pigeonpea and slow in green gram. The bulk density was found highest in pigeonpea (875.00 kg/m^3) at 10 ± 0.5 per cent (w.b.) and lowest in Black gram (669.00 kg/m^3) at 30 ± 0.5 per cent (w.b.) moisture content.

Highest porosity per cent (47.59 per cent) was observed in Black gram at 30 ± 0.5 per cent (w.b.) and lowest in pigeonpea (35.91 per cent) at 10 ± 0.5 per cent (w.b.) moisture levels (Table 3).

The effect of moisture content on angle of repose is shown in Table 4. The angle of repose increased 1.4 - 1.8 degrees for every 5 per cent increase in moisture content. The highest angle of repose (41.98^O) was found in bengal gram at 30 ± 0.5 per cent (w.b.) and lowest in pigeonpea (30.11^O) at 10 ± 0.5 per cent (w.b.) moisture contents.

Table 1 : Effect of moisture content on true density of pulses

Sr. No.	Pulses	Variety	True density (kg/m^3) at moisture level, per cent (w.b.)				
			10	15	20	25	30
1.	Pigeonpea	BDN-2	1324.40	1313.52	1300.00	1289.82	1277.37
2.	Bengal gram	Chaff	1415.09	1395.34	1376.14	1357.46	1339.28
3.	Green gram	S-8	1304.39	1287.55	1265.82	1250.00	1229.52
4.	Black gram	I-9	1333.33	1321.58	1304.39	1293.10	1276.59

Table 2 : Effect of moisture content on bulk density of pulses

Sr. No.	Pulses	Variety	Bulk density (kg/m^3) at moisture level, per cent (w.b.)				
			10	15	20	25	30
1.	Pigeonpea	BDN-2	875.00	841.00	812.50	785.50	758.00
2.	Bengal gram	Chaff	848.21	834.82	816.96	803.57	782.32
3.	Green gram	S-8	736.60	723.21	714.28	700.89	691.93
4.	Black gram	I-9	736.60	718.75	705.35	687.50	669.00

Table 3 : Effect of moisture content on porosity per cent of pulses

Sr. No.	Pulses	Variety	Porosity (per cent) at moisture level, per cent (w.b.)				
			10	15	20	25	30
1.	Pigeonpea	BDN-2	33.91	35.97	37.50	39.10	40.65
2.	Bengal gram	Chaff	40.05	40.17	40.63	40.80	41.35
3.	Green gram	S-8	43.52	43.82	43.98	44.02	41.10
4	Black gram	I-9	44.75	45.47	45.92	46.83	47.59

Table 4 : Effect of moisture content on angle of repose of pulses

Sr. No.	Pulses	Variety	Angle of repose (degrees) at moisture level, per cent (w.b.)				
			10	15	20	25	30
1.	Pigeonpea	BDN-2	30.11	31.38	32.61	34.01	35.37
2.	Bengal gram	Chaff	35.56	37.23	39.03	40.69	41.98
3.	Green gram	S-8	34.61	34.21	35.75	37.49	38.65
4.	Black gram	I-9	33.22	34.99	36.88	38.65	40.36

Conclusion:

True density and bulk density decreases with increase in the moisture contents for all the pulses. The porosity per cent and angle of repose increases with increase in the moisture contents for all the pulses. The highest true density was observed in bengal gram at 10 ± 0.5 per cent moisture content (w.b.) and lowest in Green gram at 30 ± 0.5 per cent moisture content (w.b.). The highest bulk density was found in pigeonpea at 10 ± 0.5 per cent moisture content (w.b.) and lowest in Black gram at 30 ± 0.5 per cent moisture content (w.b.). The highest porosity per cent was observed in Black gram at 30 ± 0.5 per cent moisture content (w.b.) and lowest in pigeonpea at 10 ± 0.5 per cent moisture content (w.b.). Angle of repose was found highest in bengal gram at 30 ± 0.5 per cent moisture content (w.b.) and lowest in pigeonpea at 10 ± 0.5 per cent moisture content (w.b.)

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