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Original Research Article

Physical Properties of Green Gram Split

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ABSTRACT

Green gram Split *(Mung dal)* is being used for the preparation of *mungwadi*. *Mungwadi* is the traditional value added product of Maharashtra (India). Physical properties are important for design of *mungwadi* and other processing equipment. Therefore, physical properties of green gram split were studied at moisture content 9.89 % w.b. and 64.04 % (w.b.). All the properties of splitted green gram increased with increase in moisture content except bulk density, true density and sphericity. As the moisture content increased from 9.89% (wb) to 64.04% (wb), length increased from 4.84mm to 6.90mm, width increased from 3.49mm to 4.33mm, thickness increased from 1.88mm to2.67mm, thousand seed mass increased from 23 g to 44.51 g, porosity increased from 43.84% to 45.19%.and angle of repose increased from 22.88°to 48.84° whereas bulk density, true density and sphericity decreased from 831.95 to 568.3 kg m^{-3}, from 1481.45 to 1037 kg m^{-3}, and from 65% to 63%, respectively.

Keywords

Green gram split, Moisture content, Physical properties

Introduction

India is world's largest producer of pulses with its total pulse production contributing a quarter of world's total production. While one-third of world's total acreage under pulses is in India, Indian population consumes 30% of world's total pulses. Pulses are very important in the diets of human being throughout the world particularly to the vegetarian eaters supplementing their daily requirements of protein, carbohydrate and minerals and are the sources of bioactive compounds.

Green gram (*Vigna radiate*) belongs to the family Leguminoseae commonly called as a mung bean. Green gram is one of the important pulse crops in India. It is believed that green gram is a native of India and Central Asia and grown in these regions since prehistoric times. It contains about 25 percent protein, which is almost three times that of cereals. It is consumed in the form of split pulse (dal) as well as whole pulse, which is an essential supplement of cereal based diet.

One of the important legumes like green gram which is short season summer growing crop grows widely throughout tropics and subtropics of the world.

It is widely grown in Asia particularly in Thailand, India and Pakistan. Major states growing green gram in India are Rajasthan, Maharashtra, Karnataka, Andra Pradesh, Orissa, Bihar and Tamil Nadu.

Knowledge of various physical properties of agricultural grains is an important which provides an essential engineering data in design of various processing machines, structures, processes and controls, in analysis and determining the efficiency of a machine or an operation, in developing a new consumer product and in evaluating and retaining the quality of final product. Number of researchers has studied the physical properties for various grains and seeds Nimkar and Chattopadhyay (2008), Sawant *et al.,* (2009), Davies and Zibokere (2011). All these researchers have studied physical properties of whole grain. No one conducted experiment on the properties of spilted (dal) pulses. There are number of processing operation like de-hulling of *dal*, preparation of value added products of dal, which has to be carried out after splitting of pulses. Therefore, the present study was undertaken to investigate physical properties of green gram split (dal).

Materials and Methods

Sample preparation

The green gram splits (dal) used in the study was obtained from a local market. The splits were cleaned manually to remove all foreign matter such as dust, stones and chaff as well as immature and broken seeds. The initial moisture content of the green gram splits was determined by hot air oven method at 103 ± 1° C for 72 h (ASAE). The physical properties of green gram splits were studied at moisture content 9.89% (w.b.) and 64.04% (w.b.). These two moisture contents were selected for the study of physical properties of green gram splits because the operation for preparation of *mungwadi* has to be carried out at this moisture content. The 64% w.b. moisture content was obtained by soaking the sample in distilled water for 4 h and 9.89% w.b. was obtained without soaking *i.e.* dried as received from market.

Determination of physical properties

Geometric properties

Size

To determine the average size of grain, 25 grains were randomly selected and their three axial dimensions namely, length L, width W and thickness T were measured using digital vernier caliper (Manufactured by Mutiutoyo least count 0.01 mm) The longest dimension in the longitudinal direction was considered as length while smallest dimension was measured as a thickness of splits. The size was calculated using the following equation (Mohsenin, 1970).

$$Size = (abc)^{1/3}$$

Sphericity

The sphericity is a measure of shape character compared to a sphere assuming that volume of solid is equal to the volume of tri-axial ellipsoid with intercepts a, b, c and that the diameter of circumscribed sphere is intercept of the ellipsoid. The degree of sphericity was calculated by using the equation.

$$\text{Sphericity} = \frac{\text{abc}^{1/3}}{\text{a}}$$

Gravimetric properties

Thousand grain mass

Thousand grain mass was determined by counting 1000 splits of green gram manually and weighing by digital electronic balance. Average of three replications were considered and reported as thousand mass (Mohsenin, 1970).

Bulk density

The bulk density of green gram splits was determined using the standard test weight procedure (Garnayak *et al.,* 2008) by filling a container of 500 ml with the splits from a height of 150 mm at a constant rate and then weighing the content. No separate manual compaction was done. The bulk density was calculated from the mass of green gram splits divided by the volume of the container. Average of three replications was reported as the bulk density value of green gram splits and was expressed in kgm^{-3}.

True density

The ratio of mass of sample to the true volume is termed as true density of the sample. It was determined by the liquid displacement method using toluene (Mohsenin, 1970), and it has little tendency to penetrate into the grains. Green gram splits will not absorb toluene within the short time. Green gram splits (about 10 g) were submerged in toluene in measuring cylinder having an accuracy of 0.1 ml. The increase in liquid volume due to sample was noted as true volume of sample. True density was then calculated using the following equation. The measurement of true density was replicated three times and average was expressed in kgm^{-3}.

Porosity

It is the percentage of volume of voids in the test sample at given moisture content. It was calculated as the ratio of the difference in the true and bulk density to the true density. Average of three replications was considered as a porosity of green gram splits.

$$\text{Porosity}, \varepsilon = \frac{\rho t - \rho b}{\rho t} \times 100$$

Where, ρb = bulk density, kgm^{-3}, ρt = True density, kgm^{-3}

Frictional properties

Angle of repose

The angle of repose of green gram splits was determined by standard circular platform method as given by Mohsenin (1970). A box having circular platform fitted inside was filled with green gram splits. The circular platform was surrounded by a metal funnel leading to a free discharge hole. The extra splits surrounding the circular platform were automatically discharged through the funnel leaving a free standing cone of green gram splits on the platform. Angle of repose was calculated by following equation. The experiment for angle of repose was conducted for three times and average of three replications taken as angle of repose.

$$\theta = tan^{-1}(2H|D)$$

Where, θ = Angle of repose, H = Height of cone, cm, D = Diameter of cone, cm

Coefficient of friction

Coefficient of friction is given by the tangent of the inclined surface and the components of the weight normal to the surface are acting. The static coefficient of friction of green gram splits was determined against galvanized iron surface. A topless and bottomless polyvinylchloride cylinder of 65 mm diameter and 40 mm height was filled with the sample and placed on the tilting surface at the top edge. The cylinder was raised slightly so as not to touch the surface. The inclined surface tilted until the cylinder began to move. The angle of inclination with the horizontal base was measured by a scale provided and taken as an angle of internal friction. The tangent of the angle was taken as co-efficient of friction between surface and sample (Theertha, 2014).

$\mu = \tan \theta$

Where, μ = Coefficient of friction, θ = Angle of tilt

Results and Discussion

Grain dimensions

Average values of the three principal dimensions of green gram splits namely, length, width and thickness determined in this study at moisture contents of 9.89 and 64.04% (w.b.) are presented in Table 1. The average length, width and thickness of the of the green gram split increased from 4.48 to 6.80 mm, 3.49 to 4.33 mm, 1.88 to 2.67, respectively as the moisture content increased from 9.89 to 64.04 % (w.b.). The geometric mean diameter was found to be increased with the increase in moisture content. The average geometric mean diameter ranged from 3.17 to 4.28 mm, as the moisture content increased from 9.89 to 64.04 % (wb). Similar results were also reported by Theertha *et al.,* (2014), and Bindu and Kasturiba (2017) for black gram and green gram, respectively.

Sphericity

The values of sphericity were calculated individually, and the results obtained are presented in Table 1. The sphericity of the green gram splitts decreased from 0.65 to 0.63 with the increase in moisture content from 9.89 to 64.04 % (w.b.). Unal *et al.,* (2008) reported the sphericity of whole green gram decreased from 0.795 to 0.789 with increased in moisture content from 6 to 18% (d.b.). This indicates that the sphericity of green gram splits was less that the whole grain.

Thousand grain mass

The thousand grain mass of green gram splits increased linearly from 23.02 to 44.51 g as the moisture content increased from 9.89 to 64.04 % (wb). Similar observations were reported by Theertha *et al.,* (2014) and Unal *et al.,* (2008) for whole black gram and green gram.

Bulk density

The bulk density of green gram split at specified moisture levels varied from 831.95 to 568.3 kg $m^{-3}$and indicated a decrease in bulk density with an increase in moisture content from 9.89 to 64.04 % w.b. This was due to the fact that an increase in mass owing to moisture gain in the sample was lower than accompanying volumetric expansion of the bulk.

True density

The true density of green gram splits at two different moisture contents decreased from 1481 to 1037.03 kg m^{-3}.This was due to the higher rate of increase in volume than weight. This results are agrees with results of Nimkar and Chattopadhyay (2001).

Porosity

As seen from the Table.1, the porosity of green gram splits increases from 43.84 to 45.19 % as the moisture content increased from 9.89 to 64.04 % w.b. The decrease in bulk and particle densities with increased moisture level producing higher values of porosity was also reported by Adegbulugbe and Olujimi (2008), for cowpea.

Table.1 Average physical properties of green gram splits (dal)

Particular	Moisture content, (w.b.)			
	9.89		64.04	
	Range	Average	Range	Average
Length, mm	4.02-5.24	4.84(±0.35)	4.59-8.72	6.80 (±0.70)
Width, mm	3.11-4.11	3.51(±0.26)	3.52-5.03	4.34 (±0.35)
Thickness, mm	1.60-2.15	1.88(±0.13)	2.29-3.40	2.68 (±0.28)
Geometric mean diameter, mm	2.73-3.54	3.17(±0.17)	3.76-5.09	4.28(±0.30)
Sphericity, %	58.54-72.75	65.63(±3.35)	57.69-66.80	63.32(±4.81)
Thousand grain weight, g	22.66-23.44	23.00(±0.40)	43.12-45.66	44.51(±1.29)
Bulk density, Kg/m^3	828.90-833.80	831.62(±2.49)	538.20-584.10	568.30(±26.08)
True density, Kg/m^3	1111.11-1666.66	1481.48(±320.75)	1000.00-1111.11	1037.04(±64.15)
Porosity, %	24.96-50.27	41.76(±14.56)	41.59-46.18	45.11(±3.13)
Angle of repose, degree	21.80-23.42	22.88(±0.93)	48.15-49.39	48.84(±0.63)
Coefficient of friction	0.31-.37	0.33(±0.029)	0.41-0.45	0.43(±0.021)

Angle of repose

The values of angle of repose were found to be increased from 22.88° to 48.84° with increase in the moisture from9.89 to 64.04 % (w.b.) This increasing trend in angle of repose with moisture content occurs because surface layer of moisture surrounding the particle hold the aggregate of grain together by the surface tension.

All the physical properties of green gram splits was found to be increased with increase in moisture content except true density, bulk density and sphericity.

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