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Research Paper :

Study on physical properties of finger millet *(Eleusine coracana)*

K.T. RAMAPPA, S.B. BATAGURKI, A.V. KAREGOUDAR AND H. SHRANAKUMAR

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See end of the article for authors' affiliations

Correspondence to:

K.T. RAMAPPA
Department of Agricultural Engineering, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA
Email: ramukt@yahoo.com

ABSTRACT

The present investigation was carried out to study the physical properties of two varieties of Ragi (GPU-28 and L-15). The average sizes of grain sample taken for the study were 1.7 and 1.63 mm for GPU-28 and L-15 ragi varieties, respectively. 1000 grains weight was 3.39 g for GPU-28 as compared to 3.27 g for L-15 ragi. There was not much difference in specific gravity between the two varieties. The bulk densities of 733.6 and 731.67 kg/m^3 were recorded for GPU-28 ragi L-15 varieties of ragi, respectively. Angle of repose and angle of friction for GPU-28 variety ragi were 17^0-58' and 30^0-58', respectively. For L-15 ragi, the angle of repose was 17^0-31' and the angle of friction 30^0-22'. The grain samples contained a moisture content of 9.61 and 9.58 per cent for the varieties GPU-28 and L-15 ragi, respectively. The colour of GPU-28 was very attractive with red brown, while that of L-15 was brown on dark brown. The colour also plays an important role as for as consumer's acceptance is concerned. It was noted that, the GPU-28 was bold in size (1.70 mm) while the L-15 was smaller (1.63 mm). Of the factors investigated, the seed size and bulk density showed linear relationship with milling yield.

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Key words : Bulk density, Specific gravity, Angle of repose, Angle of friction

Finger millet (*Eleusine coracana*) commonly known as ragi, is one of the important small millet crops grown in red soil areas of India. It is known for its hardy nature, drought tolerance and wonderful recovering ability on restoration of favorable conditions. It can adapt to conditions of stress like heat, alkalinity, salinity and acidity. The average yield of the crop under rain fed conditions is about 16 quintals per hectare and under irrigated conditions is about 25 quintals per hectare (Anonymous, 1999). Study of physical and engineering properties of ragi is very important to know the basic information about the geometry of ragi seeds which is required to design equipment and machinery Edward *et al.* (2001). Marshal *et al.* (1984) reported the relationship between grain size, shape and milling yield. For samples that had been segregated for test weight, there was a strong correlation between test weight and milling yield. The bulk wet processed to yield edible fractions containing 10.5 per cent protein. Paulsen and hill (1985) discussed about the physical quality factors of corn, which can be measured prior to accepting or rejecting incoming truck load of corn. Information about the effect of difference in the physical quality factors on the yield of large flaking grit can aid in the selection of corn best suited for dry milling. Yield of large flaking girt was significantly increased by selecting corn with low breakage susceptibility and high test weight. Saxena *et al.* (1981) studied and effect of grain texture on various milling and end use parameters of newly bred advanced triticle (wheat x Rye) lines. They found that increase in grain hardness, there was significant decrease in ash content of flour. Soft textured triticle contained significantly higher amount of protein in the flour. With increase in hardness, a significant decrease was observed in loaf as well as specific volume. The cookies prepared from soft and medium hard textured triticle recorded hard textured triticles. Wazari and Mittal (1983) studied the physical properties such as size, shape, weight, density, porosity, surface area, angle of repose and angle of internal friction of selected tropical agricultural products. They stated that the roundness and spherisity are important parameters that determine geometric shape of agricultural products.

METHODOLOGY

The Ragi crops of both varieties GPU-28 and L-15 were grown at the farm, Gandhi Krishi Vignana Kendra (GKVK). These were harvested at around 15-18 per cent moisture content (wet basis) and stacked. The stacks

were dried to around 8-12 per cent moisture content and threshed by tractor treading method. GPU-28 and L-15 ragi were procured from the millet scheme and ragi from Dry land Agriculture Project, GKVK.

The following physical properties of seeds were studied during the experiment.

- Shape and size (mm)
- 1000 grain weight (g)
- Specific gravity
- Moisture content on wet basis (%)
- Bulk density (kg/m^3)
- Angle of repose (^{0})

Shape and size:

The grain is spherical in shape. The size of the seed was measured by lining the seeds on a 10 cm marked line and total seeds were counted. Dividing 10 cm length by total number of seeds gave the average seed size.

1000 grain weight:

One thousand seeds were selected randomly from the seed sample and weighed using an electronic balance (capacity 2000 g, accuracy 0.1 g). Three samples of 1000 grains were weighed and the mean weight was calculated.

Specific gravity:

Specific gravity was determined by pycnometer (specific gravity bottle) method using a standard technique suggested by Mohsenin (1970) and Adhaco *et al.*(1976).

Specific gravity was calculated using the formula:

$$\text{Specific gravity} = \frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)} \times \frac{(W_4 - W_1)}{(W_5 - W_1)}$$

where

W_1 = Weight of empty specific gravity bottle

W_2 = Weight of specific gravity bottle + speed

W_3 = Weight of specific gravity bottle + speed + toluene

W_4 = Weight of specific gravity bottle + toluene

W_5 = Weight of specific gravity bottle + water

Moisture content:

Moisture content of seed sample was determined by using an electric hot air oven with thermostat control. The oven temperature was maintained at 105 ± 2^0 C. Three grain samples of each variety weighing 25 to 30g were taken in non-corrosive metal dishes and placed in hot air oven for 24 hours (Hall, 1957). After taking out from the oven, the samples were cooled in a desicator and weighed. The samples were again kept in the oven, heated for 2 hours and the weight was recorded. This procedure was repeated till the constant weight of the samples was attained. The average moisture content on wet basis of these seed samples was calculated using the following equation:

$$\text{M.C. (wb)} = \frac{W_1 - W_2}{W_1} \times 100$$

where

M.C = Moisture content on wet basis, %

W_1 = Initial weight of sample, g

W_2 = Final weight of sample, g

Bulk density:

The seed sample was filled in a box of standard size with internal dimensions of 10x10x10 cm. The top level of box was cut off and the sample was weighed (I.S. 4333 part IV, 1967).

$$\text{Bulk density} : \frac{\text{Weight of sample in the box (kg)}}{\text{Volume of the box (m}^3\text{)}}$$

The procedure was repeated three times and the mean bulk density was calculated.

Angle of repose:

The sample was placed in a hopper with a circular outlet at the bottom being closed. Then the grain was allowed to fall through the outlet on the flat surface. The height and diameter of the cone formed was noted down. The inclined angle between the horizontal and the inclined surface of the cone formed gave angle of repose.

$$\text{Angle of repose} = \tan^{-1}(2h/d),$$

where

h = height of cone formed, cm

d = diameter of cone, cm

The procedure was replicated three times and mean values of angle of repose was calculated.

Angle of friction between grain and hopper:

The inclined plane method was used to find the angle of friction. A single layer of the sample was placed on the galvanized plane. The surface was raised gradually with a screw device until the samples just started to slide down. The angle of inclination obtained from the graduated scale gave the angle of friction. The procedure was repeated three times.

Table 1 : Physical properties of cleaned ragi seeds (Variety GPU-28)

Sr. No.	Physical properties	R_1	R_2	R_3	Mean
1.	Seed diameter (mm)	1.71	1.67	1.67	1.70
2.	1000 seed weight (g)	3.28	3.30	3.39	3.39
3.	Specific gravity	1.4	1.48	1.37	1.42
4.	Bulk density (kg/m^3)	736.0	731.0	734.0	733.6
5.	Angle of repose (^{0})	17^0.58'	17^0.30'	18^0.60'	17^0.58'
6.	Moisture content, db (%)	9.61	9.59	9.63	9.61
7.	Angle of friction on metal sheet (^{0})	30^0-36'	30^0 -34'	30^0 -42'	30^0 -58'

Table 2 : Physical properties of cleaned ragi seeds (Variety L-15)

Sr. No.	Physical properties	R_1	R_2	R_3	Mean
1.	Seed diameter (mm)	1.63	1.65	1.62	1.63
2.	1000 seed weight (g)	3.23	3.28	3.29	3.27
3.	Specific gravity	1.38	1.41	1.43	1.40
4.	Bulk density (kg/m^3)	733.0	732.0	730.0	731.67
5.	Angle of repose (^{0})	17^0.26'	17^0.35'	17^0.33'	17^0.31'
6.	Moisture content, db (%)	9.62	9.54	9.59	9.58

Co-efficient of friction (u) = tan θ,
where θ = angle of friction

RESULTS AND DISCUSSION

The average sizes of grain sample taken for the study were 1.7 and 1.63 mm for GPU-28 and L-15 ragi varieties, respectively. 1000 grains weight was 3.39 g for GPU-28 as compared to 3.27 g for L-15 ragi. There was not much difference in specific gravity between the two varieties. The bulk densities of 733.6 and 731.67 kg/m^3 were recorded for GPU-28 ragi L-15 varieties of ragi, respectively. Angle of repose and angle of friction for GPU-28 variety ragi were 17^0-58' and 30^0-58', respectively. For L-15 ragi, the angle of repose was 17^0-31' and the angle of friction was 30^0-22'. The grain samples contained a moisture content of 9.62 and 9.58 per cent for the varieties GPU-28 and L-15 ragi, respectively (Table 1 and 2).

The colour of GPU-28 was very attractive with red brown, while that of L-15 was brown on dark brown. The colour also plays an important role as for as consumer's acceptance is concerned. It was noted that, the GPU-28 was bold in size (1.70 mm) while the L-15 was smaller (1.63 mm). Of the factors investigated the seed size and bulk density showed linear relationship with milling yield. The present study is, in agreement with the theoretical findings of Marshal *et al.* (1984) who reportdd that in samples of one wheat cultivar grown at one site there was a significant linear relationship among grain size, bulk density and milling yield.

Authors' affiliations:
S.B. BATAGURKI, A.V. KAREGOUDAR AND H. SHRANAKUMAR, Department of Agricultural Engineering, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

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