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Physical Properties of (Basmati CSR 30) variety Cultivated in Jammu Region of India

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ABSTRACT: Physical properties of paddy seeds plays a crucial role in designing and development of different parts of farm machinery. The understanding of these properties also proves useful in developing an ergonomically fit machine. In the present study, some of the engineering properties such as size, volume, surface area, angle of repose, porosity, etc. of raw paddy (variety Basmati CSR 30) are discussed briefly. At moisture content of 13-16 % (w.b.), the average grain length, width and thickness were 11.02 mm, 2.30 mm and 1.92 mm, respectively. The sphericity and aspect ratio were 31.34 and 0.22% respectively.

Keywords: Paddy, Basmati, Physical properties.

INTRODUCTION

Paddy is one of the stable and leading food crops in India. About 25 % of world's rice is grown in India, contributing to 21 % of global rice production (FAO, 2018). In order to meet the global rice demand, it is projected that an additional 96 million tons of milled rice will be needed by 2040 as compared to 2015 (Valera and Bali´e 2020).

The different varieties of paddy that are cultivated in Jammu province of Jammu and Kashmir Union territory are IET 1410, Ratna, Tawi (PC-19), SJR-5, Jaya, PR-113, RR-8585 KHR-2 (Hybrid), PHB-71 (Hybrid), China-1039, K-39 (SKAU-5) and Basmati varieties which are Basmati-370, Basmati-564, Ranbir Basmati, Saanwal Basmati, PRH-10 (Basmati hybrid), Basmati CSR 30 and Pusa 1121. Among these varieties, Basmati rice (*Oryza sativa*) has tremendous export potential and has been listed under ten agricultural commodities for sustainable export promotion and planning a consistent policy for the export of the same in a report given by the ministry of commerce.

Basmati variety of paddy cultivated in Jammu region of India are famous for aroma and quality. Physical properties of *CSR 30*varieties have not yet been reported. Hence, the objective of this study was to evaluate some of the physical properties of it as a function of moisture content.

MATERIAL AND METHODS

Paddy samples (Basmati CSR 30) were harvested directly from the farmer's field in R.S. Pura Jammu. *Basmati CSR 30* (aromatic, long grain and salt tolerant) was harvested during third week of October 2020. The samples were cleaned manually to remove all foreign matter, dust, dirt, broken and immature grains. Awns in *Basmati CSR 30* were removed manually by gentle beating. Properties of cleaned and graded grains of paddy were determined using set standards. Different properties of Basmati-CSR 30 variety of paddy crop that were studied are presented below.

The following methodology was adopted to determine various physical and engineering properties of the selected paddy seeds.

A. Dimensions

A sample of 100 kernels were randomly selected and the dimensions of paddy grain such as length (*L*), width (*W*) and thickness (*T*) were measured in mm with the help of a digital vernier caliper having a least count of 0.01 mm.

B. Equivalent diameter

The equivalent diameter (*D*) in mm was calculated through the following expression (Ravi and Venkatachalam 2014)

$$D = [4L\ (W + L/4)1/2] \quad \text{(i)}$$

Where, L = length of the grain, mm, W = width of the grain, mm, T = thickness of the grain, mm

C. Surface area and volume

The volume (*V*) and surface area (*S*) of paddy was calculated by using the following relationship given by Ravi and Venkatachalam (2014).

$$V = 0.25\left[\left(\frac{\pi}{6}\right)L(W+T)^2\right] \quad \text{(ii)}$$

$$S = \frac{\pi B_L^2}{2L - B} \quad \text{(iii)}$$

Where $B = \sqrt{WT}$ (iv)

D. Aspect Ratio

The paddy seed shape is classified by the aspect ratio (R_a) and it was calculated by relationship given below (Ravi and Venkatachalam 2014):

$$R_a = \frac{W}{L} \quad \text{(v)}$$

Where, Ra=Aspect Ratio, W = Width (mm), L=Length (mm)

E. Sphericity

Shape of paddy can be expressed in the terms of sphericity (Ø). It is defined as the ratio or the surface area of sphere having the same volume as that of the paddy to the surface area of the paddy Ravi and Venkatachalam (2014). Sphericity was calculated by the following formula given by Mohsenin (1986).

$$\theta = \left(\frac{LWT}{L}\right)^{1/3} \quad \text{(vi)}$$

Where, L = length of the grain, mm, W = width of the grain, mm, T = thickness of the grain, mm

F. Thousand seed mass

In order to determine mass of thousand seeds approximately 1 kg of paddy sample was roughly divided into 4 equal portions and then 1000 numbers of paddies were randomly picked from each portion and weighed on a digital electronic balance with an accuracy of 0.01 g. The measurement was repeated for 3 times and the mean value was taken as weight of 1000 seeds.

G. Bulk density

The bulk density is the ratio of mass of the paddy to its total (bulk) volume. The bulk density was determined by filling an empty 100 ml graduated cylinder with the seed and weighed (Mohsenin, 1986). The weight of the seeds was obtained by subtracting the weight of the cylinder from the weight of the cylinder and seed. To achieve uniformity in bulk density, the graduated cylinder was tapped 10 times for the seeds to consolidate. The volume occupied was then noted. The process was replicated four times and the bulk density for each replication was calculated from the following relation:

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

Where, ρ_b - bulk density, kg·m^{-3}, *M* - mass of the paddy sample, kg, *V* - volume of container, m^3

H. True density

The true density (ρ_t) is the ratio of mass of the paddy to its true volume. It was determined using Toluene displacement method. Toluene (C_7H_8) was used in place of water because paddy absorbed toluene to a lesser extent Garnayak *et al*. (2008)

$$T_D = (W/V) \quad \text{(viii)}$$

Where,

T_D = true density (g/cm^3), W = Weight of sample (g), V = Displaced volume (cm^3)

I. Porosity

The porosity (ε) of the paddy is the ratio of the volume of internal pores in between the paddy to its bulk volume Ravi and Venkatachalam (2014). Porosity was calculated using the formula given by Mohsenin (1986):

$$\rho_b = \frac{M}{V} = \frac{\rho_t - \rho_b}{\rho_t} \times 100 \quad \text{(ix)}$$

Where,

ε - porosity, %, ρ_b - bulk density, kg·m^{-3}, ρ_t - true density, kg·m^{-3}

J. Angle of repose

The angle of repose for grain was calculated by the method suggested by Waziri and Mittal (1983). The angle of repose was determined by keeping vertically a plastic cylinder (inner diameter 70 mm and height 270 mm) on horizontal ply wood sheet and filled with sample. The cylinder was tapped during filling to obtain uniform packing and to minimize the wall effect, if any. The cylinder was then slowly raised above so that whole material could slide and form a heap. The height (H) and the diameter (D) of the heap were measured with the help of measuring scale, and the angle of repose (Φ) of paddy seed was computed using the following expression:

$$\theta = \tan^{-1} \quad \text{(x)}$$

Where,

θ = angle of repose, degree h= height of the cone, mm r= radius of the disc, mm.

RESULTS AND DISCUSSION

The various engineering properties of paddy like length, width, thickness, equivalent diameter, surface area, volume, aspect ratio, sphericity, thousand grain weight, true density, bulk density, porosity and angle of repose were calculated at the moisture content of 13-16 % (w.b.) and are presented in Table 1.

Table 1: Physical Properties of Paddy Basmati CSR 30.

Sr. No.	Physical Properties	Maximum	Minimum	Mean
1.	Length (mm)	11.25	10.35	11.02
2.	Width (mm)	2.60	2.01	2.30
3.	Thickness (mm)	2.00	1.61	1.92
4.	Equivalent Diameter (mm)	3.62	3.15	3.32
5.	Surface area	54.00	44.00	47.00
6.	Volume (mm^3)	19.50	16.72	17.31
7.	Aspect Ratio (%)	0.25	0.21	0.22
8.	Sphericity (%)	32.80	30.00	31.34
9.	Thousand Grain Weight (g)	26.50	22.30	23.00
10.	Angle of repose (Degree)	35.00	31.50	32.30
11.	Bulk density (g/cc)	0.77		
12.	True density (g/cc)	1.41		
13.	Porosity (%)	59		

CONCLUSIONS

Basmati CSR 30 is one of the most popular varieties grown in the Jammu division of Jammu and Kashmir and is known for its cooking quality and scented nature. The physical properties such as length, width, thickness, equivalent diameter, volume surface area, aspect ratio, sphericity, thousand grain weight, angle of repose, true density, bulk density and porosity of Basmati CSR 30 were calculated in the study. The study concluded that at moisture content of 13-16% (w.b.), the average grain length, width, thickness, sphericity and aspect ratio were 11.02 mm, 2.30 mm, 1.92 mm, 31.34 and 0.22% respectively.

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