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Some studies on quality assessment of exotic promising rice cultivars on the basis of physical characteristics

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ABSTRACT

Physical properties play vital role in quality characterization, selection and process suitability of different raw materials for the design of different types of equipments. Promising exotic rice cultivars of Pusa Basmati-1, *Katarni, Tulsi Phul, Sarbati*, PR-106, OR-10-112 and Parmal were selected for the present study. These rice cultivars were having moisture content in the range of 9.67 to 13.15% on dry weight basis. While the dimensional comparison showed that OR-10-112 was the longest and *Tulsi Phul* was the shortest in length, the average transverse dimensions were highest for PR-106 smallest for *Katarni*. It was seen that among all the varieties *Katarni* was the thinnest. The other properties which include, sphericity, porosity, aspect ratio, angle of repose and coefficient of static friction differs significantly and cultivar dependent, which has paved the way for dimensional quality characterization through image analysis of selected rice cultivars.

KEYWORDS

Rice cultivar;
Variety;
Physical properties;
Image analysis.

INTRODUCTION

Rice is the member of the Gramineae (grass family) and is classified in the genus *Oryza*, which is having two common domesticated species of rice as *O.sativa* and *0.glaberrima*. *O.sativa* is the most common and often cultivated plant. The starchy kernel of this plant is used as a source of nourishment for over half of the world's population, thus, making it second most cereal grain. Rice is a rich source of carbohydrates, niacin, pantothenic acid and some of the minerals. Rice being staple food provides more than one-fifth of the calories consumed worldwide by humans. Studies have been done on the relationships between physical properties of brown rice and degree of milling[9]. Effect of soaking and phytase treatment on phytic acid, calcium, iron and zinc in rice fractions was investigated by[8]. Physical properties of cereal grains were studied[5]. Investigations were made on the effect of rice kernel microstructure on cooking behavior[13]. Studies have been done on effect of processing on hydration kinetics of three wheat products of the same variety[11]. Modeling changes in milled rice (*Oryza sativa* L.) kernel dimensions during soaking by image analysis were studied[19]. Under present study considerations were made to compare different rice varieties on the basis of physical characteristics so as to evaluate the suitability for image analysis.

MATERIALS AND METHODS

Pusa Basmati-1, Katarni, Tulsi Phul, Sarbati, PR-106, OR-10-112 and *Parmal* rice cultivar were procured from local market of Bhagalpur, Bihar and Sangrur, Punjab. They were cleaned in an air classifier to remove lighter foreign matter such as dust, dirt and broken small kernels. The initial moisture content of the rice varieties were determined using hot air oven method[6].

Physical Characteristics: The linear dimensions of the rice varieties were measured by using three major perpendicular dimensions, length (L), width (W) and thickness (T). The physical dimensions were determined randomly measuring the length, width and thickness of 100 rice kernels using dial type vernier caliper (Mitutoyo Corporation, Japan) having least count 0.02 mm. The geometric mean dimension (D_e) of rice kernel was found using the relationship given by[14] as:

$$\mathbf{D_e = \sqrt[3]{LWT}} \tag{1}$$

The criteria used to describe the shape of the seed are the sphericity and aspect ratio. Thus, the sphericity (S_p) was accordingly computed[14] as:

$$\mathbf{S_p = \frac{\sqrt[3]{LWT}}{L} \times 100} \tag{2}$$

The aspect ratio (R_α) was calculated (Maduako & Faborode, 1990) as:

$$\mathbf{R_\alpha = \frac{W}{L} \times 100} \tag{3}$$

The surface area ($S\alpha$) of kernels were calculated using the relationship (Eqn. 4) given by McCabe *et al.* (1986):

$$\mathbf{S_\alpha = \pi r^2 h} \tag{4}$$

The mass of the kernels were recorded using electronic balance (Ishida Co. Ltd., Japan) to an accuracy of 0.001 g. The true density is defined as the ratio of mass of seed to the solid volume occupied[1]. The kernel volume and its true density was determined using liquid displacement technique. Toluene was used in spite of water so as to prevent the absorption during measurement and also to get the benefit of low surface tension of selected solvent[15,17]. Kernel density was evaluated using the methods suggested by[18]. The bulk density is the ratio of mass of a sample of a kernel to its total volume. The porosity (ε) of bulk kernel was computed from the values of true density (ρ_t) and bulk density (ρ_b) using the relationship (Eqn. 6) given by[14] as:

$$\boldsymbol{\varepsilon = \frac{\rho_t - \rho_b}{\rho_t} \times 100} \tag{5}$$

To determine the angle of repose, a cylinder (50 mm diameter and 60 mm height) was kept vertically on a horizontal galvanized metal floor and filled with the sample. Tapping during filling was done to obtain uniform packing and to minimize the wall effect if any. The tube was slowly raised above the floor so that whole material could slide and form a heap[4]. The height of heap above the floor and the diameter of the heap at its base were measured and the angle of repose (ϕ) was determined using the relationship[7] as:

$$\varphi = \mathbf{\tan^{-1} \frac{2H}{D}} \tag{6}$$

Where, ϕ is the angle of repose in degree; H is the heap above the floor in mm and D is the diameter of the heap at its base in mm. The static coefficient of friction μ was determined for two structural materials namely glass and galvanized steel sheet. A plastic cylinder of 50 mm diameter and 60 mm height was placed on an adjustable tilting flat plate faced with the test surface and filled with the sample of about 100 g. The cylinder was raised slightly so as not to touch the surface. The structural surface with the cylinder resting on it was inclined gradually, until the cylinder just started to slide down. The angle of tilt was noted from a graduated scale[2,3,12].

All the above experiments were replicated and the average values were reported in TABLE 1.

RESULTS AND DISCUSSIONS

A summary of the results for all parameters are shown in TABLE 1. The graphical representations of the physical properties of the rice kernels are shown in Figure 1&2. The average value for moisture content (dry weight basis) was lowest for OR-10-112 with 9.67% and highest for *Sarbati* with 13.148%. The moisture content evaluated can help to suggest the sta-

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TABLE 1: Physical characteristics of exotic rice cultivar

Physical characteristics	Rice cultivars						
	Pusa Basmati-1	Katarni	Tulsi Phul	Sarbati	PR-106	OR-10-112	Parmal
Length, mm	7.17±0.39	5.33±0.33	4.22±0.17	7.02±0.45	6.39±0.29	8.29±0.61	7.08±0.37
Width, mm	1.74±0.11	1.71±0.15	1.79±0.08	1.73±0.12	2.12±0.05	1.86±0.13	1.92±0.12
Thickness, mm	1.52±0.08	1.46±0.09	1.47±0.04	1.49±0.11	1.69±0.04	1.54±0.13	1.62±0.06
Geometric mean dimension, mm	2.66±0.07	2.36±0.12	2.23±0.04	2.62±0.12	2.84±0.07	2.87±0.17	2.80±0.09
True density	1.27±0.03	1.14±0.003	1.32±0.03	1.39±0.04	1.27±0.011	1.2±0.003	1.07±0.03
Bulk density	0.82±0.01	0.83±0.006	0.86±0.01	0.83±0.04	0.83±0.004	0.82±0.32	0.82±0.005
Porosity, %	35.00±1.61	27.62±0.74	35.27±0.99	41.42±1.30	34.60±0.63	31.94±1.61	22.97±2.44
Sphericity, %	38.59±2.33	44.76±2.99	52.93±1.93	37.51±2.32	45.20±1.84	34.66±0.37	39.58±2.11
1000 kernel weight, gm	14.31±0.52	10.08±0.18	7.95±0.13	13.43±0.57	17.13±0.39	20.37±0.73	16.44±0.51
Aspect ratio	25.84±2.36	33.31±4.62	38.86±2.26	24.82±2.47	34.21±2.22	22.43±1.57	27.11±2.42
Angle of repose, ^{o}	36.52±0.95	43.53±0.49	43.52±0.49	21.43±0.32	21.16±0.42	20.14±0.56	25±1.57
Coefficient of friction							
Plywood	0.32±0.01	0.32±0.009	0.33±0.004	0.34±0.011	0.31±0.013	0.29±0.004	0.36±0.01
Glass	0.29±0.02	0.24±0.004	0.27±0.015	0.30±0.009	0.31±0.009	0.29±0.011	0.19±0.011
Steel	0.28±0.003	0.25±0.007	0.28±0.007	0.27±0.005	0.26±0.004	0.27±0.003	0.28±0.008

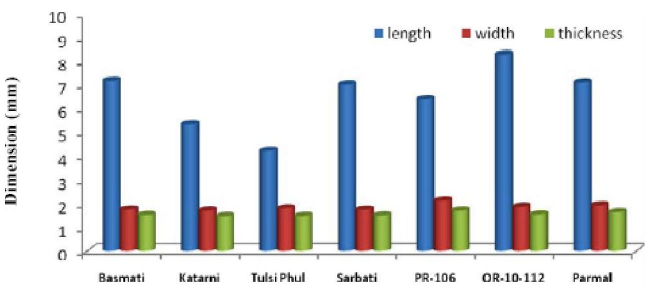

Figure 1 : Comparison of length (L), width (W) and thickness (T) of rice cultivar

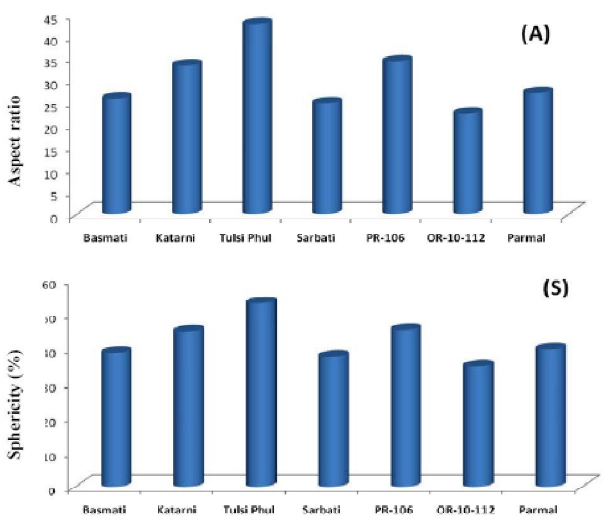

Figure 2 : Comparison of aspect ratio (A) and sphericity (S) of rice cultivar

bility during storage of kernels, as higher moisture elevate the risk of spoilage.

The longitudinal dimension (L) showed that OR-10-112 rice variety was longest with 8.29 mm and *Tulsi Phul* was shortest with 4.22 mm. Transverse dimension (W) of the kernels was highest for PR-106 with 2.12 mm and smallest for *Katarni* with 1.71 mm as clear in the graphical representation (Figure 1), whereas, PR-106 was found thickest and *Katarni* as thinnest with 1.69 mm and 1.46 mm, respectively. Although, Mohsenin (1970) had effectively highlighted the imperativeness of the axial dimensions in machine design, the comparison of the data with existing work on the other seeds can be sufficient in making symmetrical projections towards process equipment adaptation.

The sphericity of the different rice varieties are shown in TABLE 1 with the highest value for *Tulsi Phul* and lowest value for OR-10-112 with 52.93% and 34.66%, respectively. The aspect ratio is lowest for OR-10-112 with 22.43%. The lower sphericity value thus suggests that the kernels tend towards a non-spherical in shape being cylindrical in shape. Thus the values of the aspect ratio and sphericity generally indicate a likely difficulty in getting the kernels to roll. They can, however, slide on their flat surfaces. This tendency to either roll or slide should be necessary in the design of hoppers for milling process.

The true density of different rice cultivars revealed that *Sarbati* had the highest value with 1.39 g/ml. The porosity of the kernels was also highest for *Sarbati* with 41.42% and lowest for Parmal with 22.97%.

The frictional properties are the angle of repose and the coefficient of static friction. The angle of repose was the highest for *Katarni* with 43.53°and smallest for OR-10-112 with 20.14°. This phenomenon is imperative in the food grain processing, particularly in the designing of the hopper for milling equipment.

The coefficient of static friction for the kernels was determined with respect to plywood, glass and galvanized steel sheet. Their values have been clearly in the table.

CONCLUSION

The moisture content of promising rice cultivars range in 9.67 to 13.15% on dry weight basis. Existence of variability for different physical properties among the selected varieties of rice cultivars makes these varieties a suitable substrate for quality characterization through image analysis.

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