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Determination of shape of different varieties of paddy of Mungeli district

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Abstract
Paddy (Orzya sativa L.) is the world's most important food crop and is primary food source for over one third of the world's population. The objectives were to analyze the shape of paddy and rice varieties in terms of roundness, roundness ratio and sphericity. Mahamaya, MTU1010, Bamleshwari, Sarna, Safri, HMT, Vishnu Bhog, and Sona Masuri which are very common varieties of rice found in Mungeli district were selected. The dimensions of paddy and rice were measured using vernier calliper and its shape was measured by projection method.1010 variety of paddy is longer in length but its kernel is smaller than kernel of Mahamaya, Bamleshwari and Sona masuri. This shows that it is not necessary that the paddy having longer size has longer kernels. The average length, width and thickness of paddy of these eight selected varieties is 8.425mm, 2.39 mm and 2.252 mm respectively and average length, width and thickness of rice kernel is 6.275 mm, 2.24 mm and 1.762 mm respectively Among selected varieties roundness values of paddy varies from 0.240- 0.360 and for rice it varies from 0.260-0.420. For paddy roundness is highest for Sona-masuri and lowest for HMT. For rice roundness is highest for Safri and lowest for Vishnu-Bhog. Results show that roundness of rice kernel is greater than paddy among all selected varieties except Vishnu Bhog and Sona Masuri. The value of roundness ratio of paddy varies from 0.080-0.150 and for rice it varies from 0.180-0.370. Roundness ratio of rice is higher than paddy among all selected varieties, which means paddy has the sharpest corner than rice. For paddy sphericity is highest for Sona-masuri and lowest for Bamleshwari. The value of Sphericity of paddy varies from 0.250-0.390 and for rice 0.250-0.774. For rice sphericity is highest for Safri and lowest for Sona masuri. Sphericity of rice kernel is greater than paddy among all selected varieties except Vishnu Bhog and Sona Masuri This study can be useful for designing of various types of processing and handling devices and equipment for paddy and its kernel.

Keywords: roundness; roundness ratio; sphericity; projection method

Introduction

Rice is a very important food crops of India in term of both area, production and consumer preference. India is the second largest producer and consumer of rice in the world followed by China. Rice production in India crossed the mark of 100 million MT in 2011-12 accounting for 22.81% of global production in that year. Milled rice is about 68% of paddy rice by weight. Agricultural production plays a vital role to feed the growing population of over 6 billion people, gradually increasing on a yearly basis (Traore, 2005).

The Chhattisgarh, 26th state of India, was carved out of Madhya Pradesh on November 2000. It covers one third of geographical area of undivided Madhya Pradesh. Chhattisgarh has a tremendous agricultural potential with a diversity of soil and climate, mountain, plateau, rivers, natural vegetation and forest.

The physical properties such as size and shape (roundness, roundness ratio and sphericity) are important in designing a particular equipment or determining the behaviour of the product for its handling. The shape and size of product is an important parameter which affects conveying characteristics of solid materials by air or water. The shape is also considered in calculation of various cooling and heating loads of foods materials.

Data on physical properties of grain are essential for the design of equipment for handling, aeration, and storage as well as processing cereals, grains and other agricultural materials. Basically physical properties of agricultural material are grain weight, roundness, roundness ratio, sphericity, size, volume, shape, surface area, bulk density, true density, porosity, static coefficient of friction and angle of repose. These properties vary widely, depending upon moisture content, temperature, bulk density, and density of cereals and grains. The experimental measurement of the physical properties of cereals and grains is the concern of postharvest technologist and researchers.

Various types of cleaning, grading and separation equipment are designed on the basis of physical properties of seeds such as size, shape, roundness, roundness ratio, and sphericity etc. For designing an air screen grain cleaner, the shape and size of the grain determine the shape and size of screens etc.

Material and methods

Shape and size are important parameters to describe any physical property of food grains. Size is the measurement of dimensions while shape is the rigid form of the body. The dimensional characteristics of the material are called size. This may be measured in terms of length, breadth, thickness, height or diameter of the product whichever may

be most significant. Some of the most common methods used for this purpose are follows

1. Micrometer gauge method
2. Travelling microscope method
3. Sieve analysis method
4. Charted standard method
5. Projection method

Selection of sample

The common varieties of paddy and rice were selected which are found in Mungeli. The varieties Mahamaya, MTU1010, Sarna, Bamleshwari, Sonmasuri, HMT, Safri, and Vishnubhog were obtained from local market of Mungeli district. After the selection of different varieties of paddy and its rice, its measurement of length, width, and thickness is done by Vanier callipers.

Projection method

It is used for irregular shaped agricultural products. This method is suitable for size determination of vegetable and fruits like tomato, carrot, apples etc. It may also be successfully used for small grains like sorghum and millet seed. In this method, the object is placed in natural rest position and its projection is used for determination of shape of object. Scanned file of paddy or rice sample (avg. Sample) is projected on chart paper with the help of projector.

Then roundness, roundness ratio and sphericity is calculated by using following formulae.

A. Roundness

Roundness is a measure of the sharpness of the corners of the solid. Several methods have been proposed for estimating roundness. Those least objectionable are given below (curry, 1951)

$$\text{Roundness} = \frac{Ap}{Ac}$$

Where

Ap = largest projected area of object in natural rest position

Ac = area of smallest circumscribing circle

B. Roundness ratio

It is the ratio of radius of curvature, (r), of the sharpest corner and mean radius of the particles, (R) and is given by

$$\text{Roundness ratio} = \frac{\text{Radius of curvature,(r),of the sharpest corner}}{\text{Mean radius of the particle,(R)}} = \frac{r}{R}$$

C. Sphericity

Sphericity may be defined as the ratio of the diameter of a sphere of the same volume as that of the particle and the diameter of the smallest circumscribing sphere or generally the largest diameter of the particle. This parameter shows the shape character of the particle relative to the sphere having same volume.

$$\text{Sphericity} = \frac{Di}{Dc}$$

Where

Di = diameter of largest inscribed circle and

Dc = diameter of smallest circumscribed circle

Considering the volume of the particle is equal to the volume of a ellipsoid having three axes with intercepts l, b, and t and diameter of the circumscribed sphere is the largest intercepts, l, of the ellipsoid, the degree of sphericity can be expressed as given below

$$\text{Sphericity} = \sqrt[3]{\frac{\text{volume of the particle}}{\text{volume of circumscribed sphere}}}$$

$$= \sqrt[3]{\frac{\frac{\pi}{6}lbt}{\frac{\pi}{6}l^3}}$$

$$= \frac{(lbt)^{1/3}}{l}$$

$$= \frac{\text{geometric mean diameter}}{\text{major intercept}}$$

Where

l= largest intercept

b= largest intercept perpendicular to l

t = largest intercept perpendicular to l and b

It is not necessary that the three intercepts of the particle intersect each other at a common point. The geometric mean diameter of the particle is also called as the "equivalent diameter".

Result and discussion

The dimensions (length, width and thickness) of paddy and its kernel were measured and presented in the Fig. 1 & 2. The shape of paddy and its kernel such as Roundness, Roundness Ratio and Sphericity of paddy and rice were evaluated and presented by Fig. 3, 4 and 5.

1. Graphical representation of different varieties of paddy

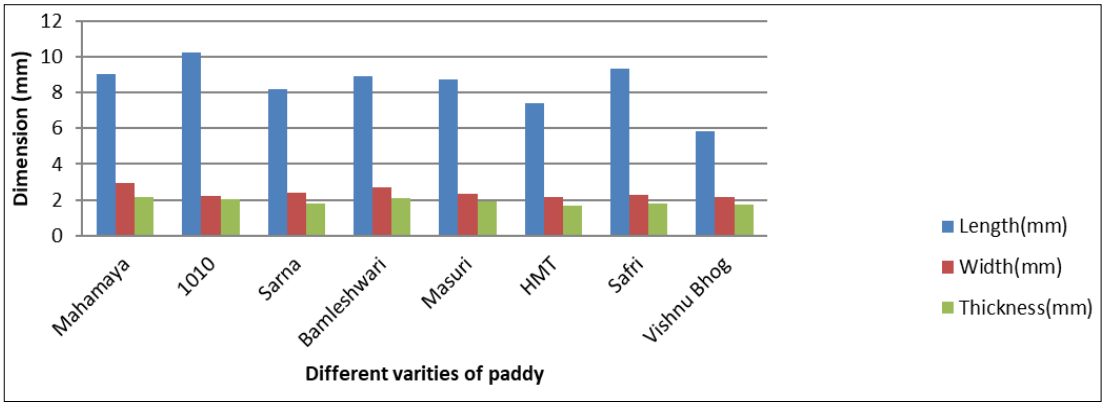

Fig 1: Graphical representation of different varieties of paddy

All varieties of paddy have different dimensions. Among the selected varieties of paddy, MTU1010 is the longest but Mahamaya is widest and thickest. Vishnu-bog is the shortest in length and width but HMT is the shortest in thickness. Length of paddy in descending order is MTU1010, Safri, Mahamaya, Bamleshwari, Sona-Measure, Saran, HMT, and Vishnu-bog. Width of paddy in descending order is Mahamaya, Bamleshwari, MTU1010, Saran, Sona-masuri, Safri, HMT, and Vishnu-bog. Thickness of paddy in descending order is Bamleshwari, Mahatma, MTU1010, Saran, Sona-masuri, Safri, HMT, and Vishnu-bog.

2. Graphical representation of different varieties of rice

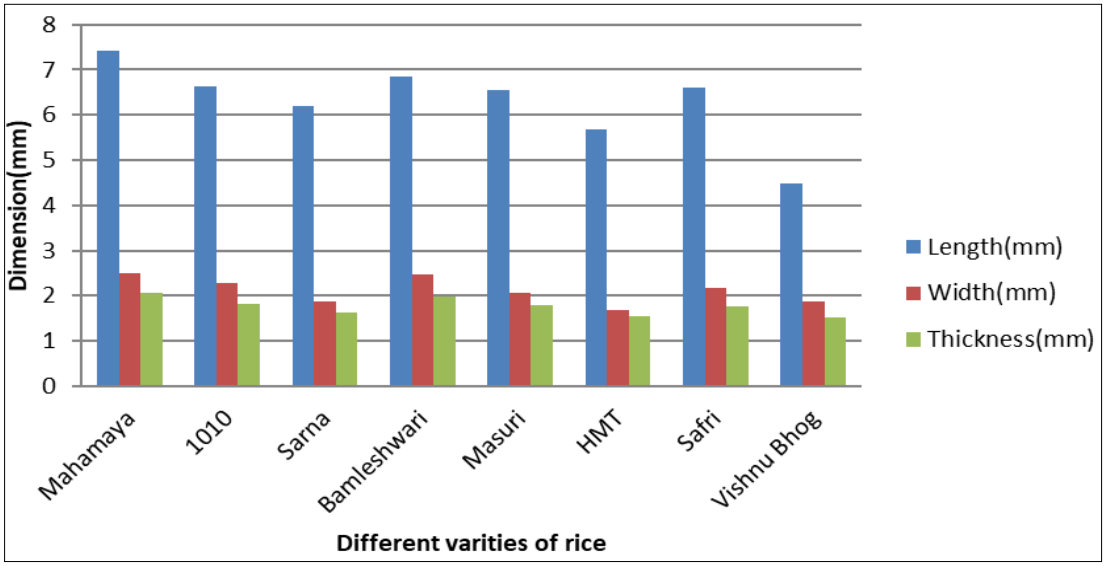

Fig 2: Graphical representation of different varieties of rice

All varieties of rice have different dimensions. Among the selected varieties of paddy, Mahamaya is the longest, widest and thickest. Vishnu-Bhog is the shortest in length and thickness but HMT is the shortest in width. Length of rice in descending order is Mahamaya, Bamleshwari, MTU1010, Safri, Sona-masuri, Sarna, HMT, Vishnu Bhog. Width of paddy in descending order is Mahamaya, Bamleshwari, MTU1010, Safri, Sona-masuri, Sarna, Vishnu Bhog, HMT. Thickness of paddy in descending order is Mahamaya, Bamleshwari, MTU1010, Sona-masuri, Safri, Sarna, HMT, Vishnu Bhog.

3. Graphical representation Roundness of paddy and rice

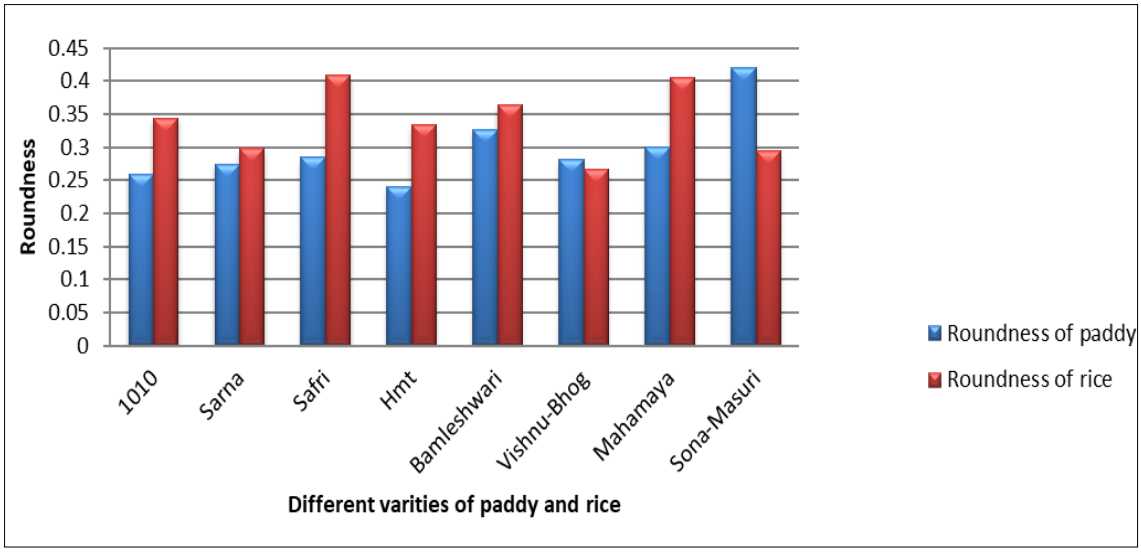

Fig 3: Graphical representation of Roundness of paddy and rice

Roundness indicated the circularity of the grain. Among the selected varieties of paddy, the roundness of paddy in descending order is Sona-masuri (0.421), Bamleshwari (0.327), Mahamaya (0.301), Safri (0.285), Vishnu-bhog (0.281), Sarna (0.274), 1010 (0.258), and HMT (0.24). Among the selected varieties of rice, the roundness of rice in descending order is Safri (0.408), Mahamaya (0.406), Bamleshwari (0.363), MTU1010 (0.344), HMT (0.333), Sarna (0.298), Sona-masuri (0.294), and Vishnu-bhog (0.267). For paddy roundness is highest for Sona-masuri and lowest for HMT. For rice roundness is highest for Safri and lowest for Vishbu-bhog. Results shows that roundness of rice kernel is greater than paddy among all selected varieties except Vishnu-bhog and Sona-masuri

4. Graphical representation of Roundness ratio of paddy and rice

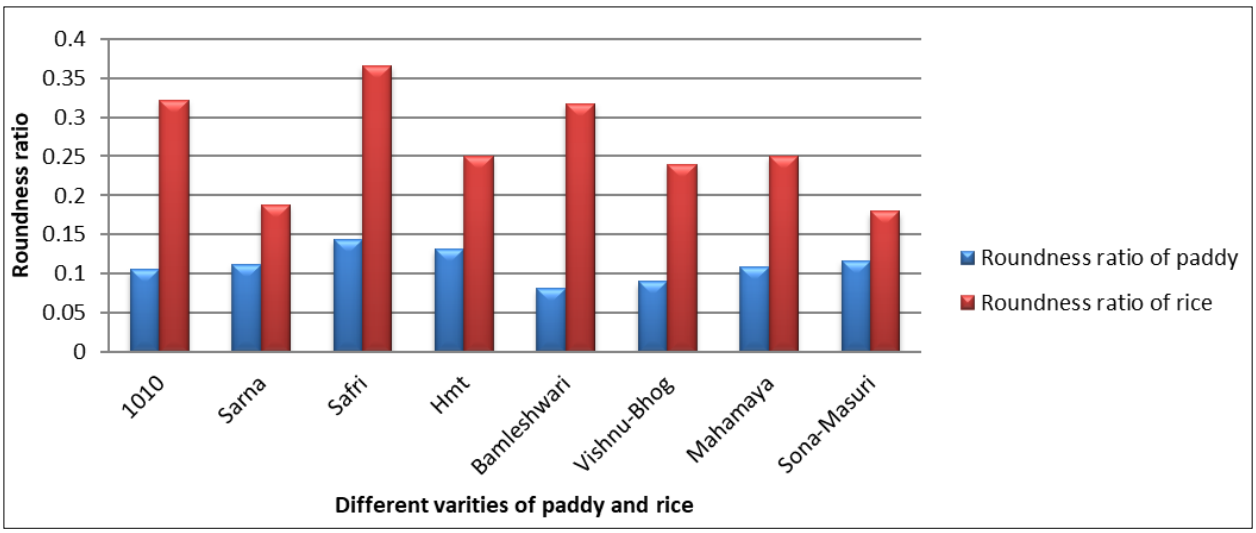

Fig 4: Graphical representation of Roundness ratio of paddy and rice

Among the selected varieties of paddy, the roundness ratio of paddy in descending order is Safri (0.144), HMT (0.132), Sona-masuri (0.117), Sarna (0.112), Mahamaya (0.108), 1010 (0.105), Vishnu-bhog (0.09), and Bamleshwari (0.081). Among the selected varieties of rice, the roundness ratio of rice in descending order is Safri (0.366), MTU1010 (0.322), Bamleshwari (0.317), HMT (0.25), Mahamaya (0.25), Vishnu-bhog (0.24), Sarna (0.188), and Sona-masuri (0.18). For paddy roundness ratio is highest for Safri and lowest for Bamleshwari. For rice roundness ratio is highest for Safri and lowest for Sona-masuri. Result shows that Roundness ratio of rice is higher than paddy among all selected varieties, which means paddy has the most-sharpest corner than rice.

3.5 Graphical representation of Sphericity of paddy and rice

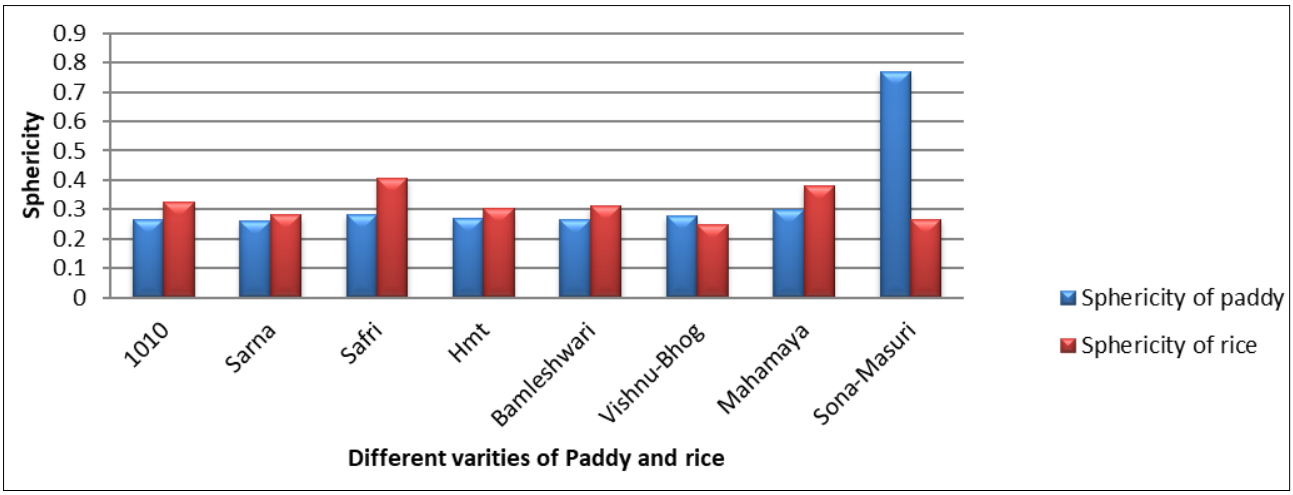

Fig 5: Graphical representation of Sphericity paddy and rice

Sphericity indicates the circularity of the grain. Among the selected varieties of paddy, the Sphericity of paddy in descending order is Sona-masuri (0.77), Mahamaya (0.3), Safri (0.283), Vishnu-bhog (0.279), HMT (0.271), MTU1010 (0.265), Bamleshwari (0.265), and Sarna (0.259). Among the selected varieties of rice, the Sphericity of rice in descending order is Safri (0.407), Mahamay (0.381), MTU1010 (0.326), Bamleshwari (0.311), HMT (0.302), Sarna (0.281), Sona-masuri (0.267), and Vishnu-bhog (0.25). For paddy Sphericity is highest for Sona-masuri and lowest for Bamleshwari. For rice Sphericity is highest for Safri and lowest for Sona-masuri. Results shows that Sphericity of rice kernel is greater than paddy among all selected varieties except Vishnu-bhog and Sona-masuri.

Summary and conclusion

Based on the results obtained from this study, selected varieties of paddy and rice was observed to have values of Roundness, Roundness Ratio and sphericity, thus the study of this literature it can be useful for designing of important equipment or determining the behaviour of the products for its handing

Various types of cleaning, grading and separation equipment are designed on the basis of physical properties of seeds such as size, shape, roundness, roundness ratio, and sphericity etc.

- Maximum length for paddy is MTU1010 (10.8mm) and minimum length is HMT (6.7mm) and maximum length for rice is Mahamaya (7.8mm) and minimum length is HMT (4.9mm).

- Maximum width for paddy is Bamleshwari (3.2mm) and minimum width is HMT (1.8mm). and maximum width for rice is 1010(2.7mm) and minimum width is HMT (1.5mm).
- Maximum thickness for paddy is Mahamaya (2.3mm) and minimum thickness is HMT (1.6) and maximum thickness for rice is Mahamaya (2.1mm) and minimum thickness is HMT (1.5).
- Maximum Sphericity for paddy is Mahamaya (0.770) and minimum Sphericity is sarna (0.259) and maximum Sphericity for rice is safri (0.407) and minimum Sphericity is Vishnu-Bhog (0.250).
- Maximum roundness for paddy is Sona Sona-masuri (0.421) and minimum roundness is HMT (0.240) and maximum roundness for rice is Safri (0.408) and minimum roundness is Vishnu-Bhog (0.267).
- Maximum roundness ratio for paddy is Safri (0.144) and minimum roundness ratio is Bamleshwari (0.081) and maximum roundness ratio for rice is Safri (0.366) and minimum roundness ratio is Sona Sona-masuri (0.180).

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