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

T.Bhatia¹, R.K.Sharma², Rajesh Kumar³, K.Prasad¹*

¹Department of Food Engineering and Technology, Sant Longowal Institute of Engineering and Technology, Longowal-148106, (INDIA)
²Agriculture Advisor, SCI India Pvt. Ltd., Bhagalpur-812002, (INDIA)
³Department of Mechanical Engineering, Sant Longowal Institute of Engineering and Technology, Longowal-148106, (INDIA)
E-mail : dr_k_prasad@rediffmail.com
Received: 27th July, 2009 ; Accepted: 7th August, 2009

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 O.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 milling⁹. Effect of soaking and phytase treatment on phytic acid, calcium, iron and zinc in rice fractions was investigated by⁸. Physical properties of cereal grains were studied⁵. Investigations were made on the effect of rice kernel microstructure on cooking behavior¹¹. Studies have been done on effect of processing on hydration kinetics of three wheat products of the same variety¹¹. Modeling changes in milled rice (Oryza sativa L.) kernel dimensions during soaking by image analysis were
Some studies on quality assessment of exotic promising rice

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:

$$D_e = \sqrt[3]{LWTD}$$

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:

$$S_p = \frac{\sqrt[3]{LWTD}}{L} \times 100$$

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

$$R_a = \frac{W}{L} \times 100$$

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

$$S_o = \pi r^2 h$$

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[11]. 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 ($e$) of bulk kernel was computed from the values of true density ($\rho_t$) and bulk density ($\rho_b$) using the relationship (Eqn. 6) given by[14] as:

$$e = \frac{\rho_b - \rho_t}{\rho_t} \times 100$$

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 ($\phi$) was determined using the relationship[7] as:

$$\phi = \tan^{-1} \left( \frac{2H}{D} \right)$$

Where, $\phi$ 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 $\mu$ 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-
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 importance of 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

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

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
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.

REFERENCES