DETERMINATION OF QUALITY CHARACTERISTICS OF INDIGENOUS ORGANIC ASIAN INDIAN RICE VARIETY - NEELAM SAMBA

Usha Ravi*, Lakshmi Menon, Ranjani Madhavan, Sangeetha Priyadharshini and M. Dhivya E.

School of Food Science, M.O.P. Vaishnav College for Women, Chennai-600 034, India

Received: 26-02-2013    Accepted: 12-09-2013

ABSTRACT

Organic farming is a production system that avoids or largely excludes the use of synthetically produced agricultural inputs like fertilizers, pesticides, growth regulators, live stock feed additives etc. Besides, the economic value of rice is largely determined by the milling quality of the rice varieties. Increasingly, consumers are also interested to get rice which possesses good cooking and eating qualities. In view of the health benefits of organic crops and the quality demands of the consumers, the present study was under. The results of this study highlighted that Neelam samba had acceptable physical, nutritional, cooking, and milling qualities. It was also observed that parboiled milling procedure yields better quality rice than raw milled rice.

Key words: Cooking quality, Milling quality, Organic farming, Rice quality, Neelam samba.

INTRODUCTION

Rice (Oryza sativa) is the most important cereal crop in the developing world and is the staple food for over half the world’s population (FAO, 1993). Oryza sativa is of Asian origin. India is one of the world’s major rice producing countries which cultivates diverse indigenous varieties of rice. However, in recent years there has been a marked decline in variety and diversity resulting in narrowing of genetic base.

The major reason for the disappearance of thousands of local varieties is their steady replacement with High Yielding Varieties. Farmers being impressed by the initial high yield of these so-called “miracle” seeds ignored the costs of external outputs, subsequent loss of non-grain biomass, loss of desirable traits and extensive deterioration of the environment including soil and water. The solution to this problem is organic agriculture, which is a holistic production management system that avoids the use of synthetic fertilizers, minimum pollution of air, soil and water and optimizes the health, interdependent communities of plants, animals and people (Müller-Lindenlauf, 2009).

A study by Swaminathan et al. (1984) revealed that cultivation of traditional Indian varieties employing organic farming is high yielding. Thus it is very essential not only to employ organic agricultural practices but also to conserve traditional crop varieties to revive our rich crop diversity.

Neelam Samba is a traditional variety which is highly suitable for cultivation in areas which are prone to water logging. The plant is resistant to pests such as brown plant hopper and ear head bug. Altogether, the cost of cultivation is very low. These facts are favourable and profitable to the rural farming community. This rice variety is ideal for making traditional rice preparations (Vijayalakshmi et al., 2007).

The objective of this study was to analyse and evaluate the milling, physicochemical, cooking and nutritive quality of organic traditional rice variety Neelam samba. This will facilitate further understanding of its inherent properties that will help towards optimizing its usage and make it commercially viable.

MATERIALS AND METHODS

The organically grown traditional rice variety (Neelam Samba) was obtained from Centre for Indian Knowledge Systems, Chennai, India. The rice was grown during the Sambha Season (July to
January) with crop duration of 175-180 days. The sample of rice was stored at 12% moisture content of the sample. The sample for the study was selected by random sampling of rice obtained through single farming. The experiments were conducted at school of Food science, M.O.P. Vaishnav College for Women, Chennai.

**Physical characteristics**

**Paddy moisture content:** 100 g paddy was weighed and dried in a hot air oven at 130°C. The final weight of the sample after 16 hours was measured and moisture content wet basis was computed (IRRI, 2009).

**Head rice yield and brokens:** Milled rice out-turn was expressed as percentage of milled rice yield. A double tray sizing device was used to separate head rice from the broken kernels and the percentage of the head rice and brokens were estimated using the formula given below.

\[
\text{Head Rice\%} = \frac{\text{Weight of whole grains}}{\text{Weight of paddy sample}} \times 100
\]

\[
\% \text{Brokens} = \frac{\text{Weight of broken grains}}{\text{Weight of paddy samples}} \times 100
\]

**Length–breadth ratio (L/B):** Length and breadth-wise arrangement of milled rice was done and their cumulative measurements (mm) were taken. The value of L/B was determined by dividing length by breadth (Singh et al., 2005).

**Length, Breadth and Thickness:** To determine the average size of the grain, 100 grains were randomly picked and their three linear dimensions namely, length (L), width (W) and thickness (T) were measured using a micrometer (Miutoyo, Japan) reading to 0.01mm. (Alizadeh et al., 2006)

**1000 grain weight:** Thousand grain seed weight was determined by counting 100 kernels and weighing them in electronic weighing balance and then multiplied by 10 to give the mass of 1000 grains.

**Bulk Density:** Empty flask weight and grains filled flask weight was taken after which Bulk density was calculated using the formula

\[
\text{Bulk Density (g/ml)} = \frac{\text{Weight of the Grains}}{\text{Volume occupied by the Grains}}
\]

**Angle of repose:** The angle of repose was measured by means of an apparatus consisting of a plywood box of 0.3m by 0.3m by 0.3m, a circular platform of 120mm diameter fitted inside and the discharge gate at the bottom of the box. The box was filled with paddy or rice and the gate was quickly removed. The height of the grain piled retained on the circular platform was measured with the gauge reading to 0.01mm. The angle of repose was then calculated as (Reddy and Chakkavartly, 2004).

**Sun checks:** Using the paddy crack detector, count the number of cracked grains in a 100 grain sample, and then compute the % cracked grains using the equation (Srinivas and Desikachar, 1973).

**Color value:** Whiteness of the rice samples was measured using a Kett digital whiteness meter (Model C-300, Japan) and color was measured using color difference meter (Model JC 801, Japan) (Parnsakhorn and Noomhorm, 2008).

**Parboiled milled rice:** For the parboiling process, the paddy samples (500g) were soaked at 70°C for 2 hours. The brown rice was drained and tempered at ambient temperatures for 30 min. The brown rice was steamed for 20 min to moisture content of 30-35% using an autoclave. The steamed rice was dried to a moisture content of 13±1% in a mechanical tray drier at 30±1°C, Relative humidity (60±5%). The samples were then stored in airtight polythene bags.

**Nutrient analysis:** The protein, crude fiber, crude fat content of Neelam Samba was estimated by standard method (IRRI, 1993).

**Cooking quality**

**Optimal cooking time:** Head rice (2 g) samples were taken in a test tube from each variety and cooked in 20 ml distilled water in a boiling water bath. The cooking time was determined by removing a few kernels at different time intervals during cooking and pressing them between two glass plates until it was completely mashed. (Singh et al., 2005)

**Gruel solid loss:** Head rice samples (2 g) in 20 ml distilled water were cooked for minimum cooking time in a boiling water bath. The gruel were transferred to 50 ml beakers with several washings and made to volume with distilled water. The aliquot having leached solids was evaporated at 110 °C in an oven until completely dry. The solids were weighed and percent gruel solids were reported (Singh et al., 2005).
**Cooked rice volume:** Volume of 100 g of cooked grain was measured in a measuring cylinder and cooking quality graded as poor (350-375 ml), satisfactory (375-400 ml), good (400-425 ml) and very good (>425ml) (Sowbhagya et al, 1986).

**Elongation ratio and elongation index:** The procedure described by Juliano and Perez (1984) was used for measuring elongation ratio and elongation index. Length and width of milled grains were measured on 10 unbroken milled grains by slide calipers. Elongation ratio (ER) was defined and measured as the ratio of length of 10 sound cooked rice grains to the length of the uncooked sample while elongation index (EI) was calculated as the ratio of length/width ratio of cooked rice grains to that of the uncooked sample.

**Aroma:** To 50g of rice sample, 88.5 mg of collidine and 40.3 mg of 3-methylcyclohexanone were added as internal standards and was steam distilled with odor-free water for 1 hr. The distillate was treated with 1M NaOH to pH 9 and extracted with freshly distilled diethyl ether (3 × 100 mL). The combined ether solution was treated again with 1M NaOH (100 mL) to completely remove acids, washed with water, and dried over anhydrous sodium sulfate. Three extractions were performed on each sample, and extracts were concentrated on a rotary evaporator and analysed using Gas chromatography (Tava and Bocchi, 1999).

**Taste:** Sensory evaluation of the cooked rice varieties was carried out by 20 untrained taste panelists in a special room prepared for the purpose. They were instructed to taste the rice samples and to rinse their mouth after each sample taste (Albert et al., 2007).

**Gelatinization temperature:** Gelatinization temperature is estimated by the extent of alkali spreading and clearing of milled rice soaked in 1.7% KOH at room temperature or at 39°C for 23 hours (Little et al, 1958).

**Amylose content:** Rice grains were ground to pass through 100 mesh sieve. A sample of 100 mg was weighed accurately into 50 ml Erlenmeyer flask and 1 ml of 95% ethanol and 9 ml of 1N NaOH added. The sample was heated for 10 min in a boiling water bath to gelatinize the starch, cooled and transferred with several water washings into a 100 ml volumetric flask, brought up to volume with water and mixed well. Starch solution (5 ml) was pipetted into a 100 ml volumetric flask, 1 ml of 1N acetic acid and 2 ml of iodine solution (0.2 g of iodine and 2 g of potassium iodide in 100 ml of aqueous solution) added. The solution was made up to volume with distilled water, shaken and allowed to stand for 20 minutes. Absorbance of the solution at 620 nm was measured with a spectrophotometer.

**RESULTS AND DISCUSSION**

**Physical Characteristics:** The results of the physical parameters analysed for the organic indigenous variety Neelam Samba has been presented and discussed below.

The thousand grain weight of Neelam Samba paddy and brown rice was analyzed and was found to be 24.5g and 20.6 g respectively. This parameter is a useful index to measure the ‘ milling outturn’. It helps to determine the relative amount of dockage or foreign material in a given lot of paddy. From the above results, it was found that both the varieties had a decrease in weight from paddy to rice, and this is due to the removal of bran from the paddy. The 1000 grain weight of Neelam Samba was found to have less amount of dockage than the other variety.

The surface area of Neelam Samba paddy was found to be 2166.50mm²/g whereas for rice it was found to be 1589.01mm²/g. Analysis of length, breadth and thickness of Neelam Samba (Paddy) revealed that the length was 7.9mm; breadth was 3.5mm and 2mm of thickness. The length and breadth ratio was calculated and it was found to be 2.3 while for milled rice the length was 5.9mm, 2.8mm breadth and 2.1mm thickness. The length breadth ratio was noted as 2.1. According to these results, Neelam Samba is classified as short bold variety (IRRI, 2009).

The angle of repose of Neelam Samba was found to be 40.7°. The angle of repose is directly

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brown Rice</th>
<th>Milled Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whiteness (%)</td>
<td>Transparency (%)</td>
</tr>
<tr>
<td>Neelam Samba</td>
<td>11.4</td>
<td>0.30</td>
</tr>
</tbody>
</table>
dependent on the moisture content of the grain. Moisture content of Neelam Samba was 9%. At a moisture content level of 20%, the angle of repose for paddy will be greater than for dry paddy at 9% moisture content. The angle of repose determines the maximum angle of pile of grain in the horizontal plane and is important in the filling of a flat storage facility (Mohsenin, 1980).

Colour of this variety was analysed and it was observed that brown rice had 11.4% of whiteness and 0.3% of transparency whereas, milled rice had 28.6% whiteness and 0.79% transparency (Table 1).

The sun check value of Neelam Samba was found to be 4.4%. The moisture content was found to be 9%, hence the sun check value for this variety would be relatively higher due to its decreased moisture content. Increased sun check results in grain cracking, which deters the grain quality and decrease the market value and consumer acceptability.

**Nutrient analysis:** Nutrient content of Neelam Samba was analyzed and the results are shown in Table 2. The starch content of the paddy was higher than milled rice samples. This may be due to starch gelatinization which makes the grains to expand, thus filling up the surrounding air spaces. Starch reassociation, increase in reducing sugars, change in molecular size and partial dextrinization of starch have been known to occur during parboiling. The protein content of the rice was observed to be 8.75 g/100g of the sample. This was comparable to nutritive value of raw hand pound rice. The milled rice samples have lower fat (0.64%) content than the raw paddy (20.8%) samples. This may be attributed to the higher percentage of bran present in the paddy which contributes to the overall fat content. Similar results were observed in case of fiber with milled rice sample containing 0.3% while paddy sample contained 7%.

**Cooking quality:** The dominant factors which describe the consumer liking in many countries of the world are grain whiteness, shape, amylose content, gelatinization temperature, aroma and other cooking properties (Rice quality workshop, 2003). The results of the cooking properties analyzed in this study are presented in Table 3.

**TABLE 3: Cooking Parameters**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Optimal Cooking Time</td>
<td>21.5±1.2 min</td>
</tr>
<tr>
<td>Average Cooked Rice Volume</td>
<td>373.5±2.29ml</td>
</tr>
<tr>
<td>Average L-B ratio</td>
<td>2.54±0.08</td>
</tr>
<tr>
<td>Elongation ratio</td>
<td>1.8±0.02</td>
</tr>
<tr>
<td>Elongation index</td>
<td>1.05±0.26</td>
</tr>
<tr>
<td>Gruel loss %</td>
<td>7±0.17%</td>
</tr>
<tr>
<td>Gelatinization temperature</td>
<td>77.3±1.7°C</td>
</tr>
<tr>
<td>Gel consistency</td>
<td>24.5±1.2</td>
</tr>
</tbody>
</table>

The mean time taken for cooking ranged from 21.5±1.2 min (Table 3). This may be attributed to the “high” gelatinization temperature observed.

The average cooked rice volume of Neelam Samba is 373.5±2.29ml which is satisfactory. Length and Breadth ratio of Neelam samba was observed to be 2.54±0.08. The elongation ratio of Neelam Samba was found to be 1.8±0.02 and elongation index was found to be 1.05±0.26. Elongation index increased with increase in cooking time. Higher elongation index gives a better appeal and higher acceptability amongst the consumers.

Gruel loss % of the rice was analyzed and found to be 7±0.17%. Juliano and Bachel (1985) and Morris (1990) reported that grains with higher surface area offers increased contact with water and amylose leach out during cooking and higher amylose content is liable to leach out more in to the cooking water. The amylose content of Neelam samba is 22.7% and according to the classification by Juliano and Bachel (1985) is termed as Medium amylose content.

Gelatinization temperature was observed to be 77.3±1.7°C. Gelatinization temperature between 74.5-80.0°C is classified as high by Faruq et al (2004). The gel consistency of Neelam Samba was observed to be 24.5±1.2mm. This result indicated that Neelam Samba forms a hard gel (IRRI, 2009).

Neelam Samba was analysed for aroma and taste and it was observed that aroma in this variety of rice was absent while it had a satisfactory taste.
as indicated in Table 4. The observation can be attributed the possible absence of the volatile compounds such as acetaldehyde, propanal, 2-butaneone, pentanal and hexanol which to contribute aroma to common rice varieties (Aldo, 1999).

TABLE 4: Aroma and Taste characteristics of Neelam samba

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aroma</th>
<th>Taste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neelam Samba</td>
<td>Absent</td>
<td>Normal</td>
</tr>
</tbody>
</table>

The husk percentage in raw milled rice was comparable to that of parboiled rice. Polish percentage of parboiled milled rice was lower in that of raw milled. The head rice milling yield in raw milling of paddy was 31.38 % while in parboiling milling it was 74.4%. It was observed that parboiling increased head rice yield and reduced breakage.

Shelling breakage observed in raw milled rice was 8.3% as compared to 0.35% in parboiled milled rice. Rice kernel breakage during the milling process is affected by different parameters such as paddy harvesting conditions, paddy drying, physical properties of the paddy kernels, the environmental conditions, and the type and quality of the milling system components. Matthews et al. (1970) and Clement and Seguy (1994) found that long and small rice kernels were more susceptible to breakage during the milling process when compared to wide short kernels. Parboiling strengthens the rice grain and hence reduces breakage.

TABLE 5: Milling characteristics

<table>
<thead>
<tr>
<th>Husk %</th>
<th>Polish %</th>
<th>Polished rice yield%</th>
<th>Head rice yield%</th>
<th>Shelling breakage%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>22.8</td>
<td>21.93</td>
<td>7.4</td>
<td>4.1</td>
<td>67.84</td>
</tr>
</tbody>
</table>

A-Raw Milled, B-Parboiled Milled

CONCLUSION

The quality characteristics of traditional organic Indian rice, investigated in this study indicate that Neelam Samba is a short bold grain. It was observed that this rice variety had good cooking and milling characteristics. The milling characteristics analysed indicate that the parboiled Neelam Samba rice has better quality characteristics such as head rice yield and shelling breakage.

This non aromatic rice variety had satisfactory cooking qualities with normal taste characteristics. The gel consistency evaluated indicated that the rice would maintain good grain integrity on cooking. The grain had high gelatinization temperature and medium amylose content. The rice variety indicated good cooked volume and elongation index.

Thus it can be concluded that parboiled Neelam Samba rice was better in terms of total rice yield because of its superior milling characteristics. Milled Neelam Samba rice was found to be acceptable in terms of cooking quality and physicochemical properties.

REFERENCE


