ANALYSIS OF RICE GRAIN QUALITY OF INDIGENOUS ORGANIC RICE VARIETY – KAPPAKAR


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ABSTRACT

Organically grown indigenous rice variety kappakar was analyzed for its physical, milling (raw and parboiled), cooking and physicochemical properties. The evaluation of the physical (seed dimensions, bulk density, 1000 gram weight), milling (husk percentage, shelling breakage, polish percentage, broken rice percentage, heard rice yield, paddy moisture content and rice moisture content), cooking (optimal cooking time, cooked rice volume, cooked rice dimension, elongation ratio and index, aroma taste and texture) and physicochemical (amylose content, gelatinization temperature, gel consistency, water uptake and viscosity) were analyzed using standard procedures. The results of the study indicate that kappakar belongs to a long bold rice variety. In terms of milling properties parboiled rice was better than raw milled rice. Kappakar rice had satisfactory cooking and physicochemical properties. Hence, is ideal for common consumption or to produce other processed products such as rice flakes.

Key words : Rice grain quality, Indigenous organic rice, Physicochemical, Nutrient, Cooking qualities.

INTRODUCTION

Rice is the most important cereal crop in the developing world and is the staple food for over half the world’s population including India (CIKS, 2009). The rice harvesting area in India is the world’s largest. Indian rice cultivation is found in all states, but West Bengal, Uttar Pradesh, Madhya Pradesh, Orissa and Bihar are the major producing states.

The Indian population was about 1 billion people in 2000 and is still growing at a high rate (1.7% per year) (FAO, 2004). According to a report by FAO (2003), the demand for rice in India by this growing population is projected at 128 million tonnes for the year 2012. Although the country exports several varieties of rice, many scientists have expressed concern that current Indian rice production techniques cannot sustain the growing domestic population.

India is a country which had developed a vast and rich agricultural knowledge system. It now finds itself looking for solutions to problems created by the chemical farming methods prevalent today. Improper farming methods and overuse of chemical pesticides and fertilizers have led to severe degradation of huge portions of the country’s arable land. Therefore, with scarcity of land, increasing cereal production will require sustainable intensification.

The answer to the problem lies in returning to our roots. Traditional agricultural practices which are based on natural and organic methods of farming offer several effective, feasible and cost-effective solutions.
effective solutions to most of the basic problems farmers face today.

Documentation of these traditional practices is found in scriptures. Vedic and present day literature indicate 2 lakh varieties of which up to 130 varieties have been conserved by the Centre for Indian Knowledge System (CIKS, 2009). These traditional varieties have certain special characteristics such as pest resistance, medicinal properties and so on. This coupled with the fact that there is a paucity of published data on quality of these indigenous varieties further highlights the need for this study.

Kappakar is one such traditional rice variety which is usually cultivated in clayey soil as a dry sown crop during the Samba season (July – January). The duration of this crop is 5 months. This variety can tolerate drought and can also withstand floods. The incidence of pest attack is quite low. 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 Indian fermented products such as idli, dosa. (Vijayalakshmi et al., 2007).

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

MATERIALS AND METHODS

The organically grown traditional rice sample kappakar was obtained from Centre for Indian Knowledge Systems, Chennai. The rice was grown during the samba season (July – January) by dry sowing and transplantation method of cultivation with crop duration of 150-160 days. The moisture content of the grain at the time of harvest was 12%. The organic manures used were vermicompost, compost, azospirillum, phosphobacterium, panchagavya (a mixture of cows milk, ghee, curd, cow dung and urine) and sunn hemp. The sample for the experiments was chosen by random sampling method. The study was conducted from August 2009 - February 2010.

Physical characteristics of kappakar rice

Seed dimensions: Length, breadth and length-breath ratios were determined by using millimetre scale. Ten rice grains were placed length-wise (with their respective ends, germ or distal), breadth-wise (with their respective sides, dorsal, ventral touching each other), on a flat plane surface along a millimetre scale. Cumulative length and breadth were noted and averaged. The length-breath ratio was calculated by the equation mentioned below.

\[
\text{Length to width ratio (L/B) = } \frac{\text{Average cooked rice length, mm}}{\text{Average cooked rice breadth, mm}}
\]

Thousand grain weight: The thousand grain weight was determined by means of a digital electronic balance having an accuracy of 0.00 g. To evaluate the thousand grain weight, 100 randomly selected grains from the bulk sample were averaged.

Bulk density: The bulk density was determined using a cylindrical container of 0.3m height and 0.2m diameter was filled with grains from a height of 0.15 m from top of the container and the top was levelled. No separate or additional manual compaction was done. The electronic balance was used for weighing and apparent or bulk density, (kg m⁻³), of samples were then defined as the ratio of the mass of bulk sample to the volume of container.

Angle of repose: The filling or static angle of repose, is the angle with the horizontal at which the rice will stand when piled. This was determined using an empty cylindrical mould of 15 mm diameter and 25 mm height. The cylinder was placed at the centre of galvanized iron plate, filled with rice grains and raised gradually until it forms a cone of grain.

Grain hardness test: The rice samples were prepared by cooking 10 g rice samples in a 400 ml beaker with 200 ml distilled water at 100±1°C. A 6-mm diameter ebonite probe was used to compress
a single grain with pre-test and post-test speeds of 1 mm/min and test speed of 0.5 mm/min (Juliano and Bechtel, 1985).

**Milling of rice:** 150g of paddy rice was milled using Satake rice mill as shown in Fig 1. 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.

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

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

**Parboiling process:** A 200 g rice sample placed in a 1-L beaker was added with 600 ml of deionized water preheated at 65°C. The sample was incubated in a water bath at 65°C for 2 h. After soaking, water was drained through a strainer; the soaked sample was transferred into a 400 ml beaker, and autoclaved for 20min at 120°C, 98 kPa for parboiling. The autoclaved sample was spread evenly on a 40×30cm meshed tray and dried in an EMC (equilibrium moisture content) chamber at 25°C and 40% relative humidity until around 12% moisture content.

**Table 1:** Physical properties of kappakar rice.

<table>
<thead>
<tr>
<th>Category As per L:B ratio</th>
<th>Paddy</th>
<th>Brown rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 grain weight (g)</td>
<td>30.3</td>
<td>25.6</td>
</tr>
<tr>
<td>Angle of response (degree)</td>
<td>38.7</td>
<td></td>
</tr>
<tr>
<td>Bulk density (kgm⁻³)</td>
<td>627.15</td>
<td></td>
</tr>
</tbody>
</table>

L-Length; B-Breath; T- Thickness; L: B-Length and breadth ratio.

**Table 2:** Raw Milling and Parboiled Milling Performance of Kappakar Rice.

<table>
<thead>
<tr>
<th>Raw kappakar rice</th>
<th>Parboiled kappakar rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Husk%</td>
<td>23.72</td>
</tr>
<tr>
<td>SB%</td>
<td>9.00</td>
</tr>
<tr>
<td>Polish%</td>
<td>7.0</td>
</tr>
<tr>
<td>PRY%</td>
<td>67.46</td>
</tr>
<tr>
<td>Broken%</td>
<td>46.25</td>
</tr>
<tr>
<td>HRY%</td>
<td>36.26</td>
</tr>
<tr>
<td>PMC%</td>
<td>8.7</td>
</tr>
<tr>
<td>RMC%</td>
<td>9.2</td>
</tr>
<tr>
<td>PRY% - Polished rice yield percentage; SB% - shelling breakage percentage; HRY% - Head rice yield percentage; PMC% - Paddy moisture content percentage; RMC% - rice moisture content percentage.</td>
<td></td>
</tr>
</tbody>
</table>
Cooking characteristics and cooked rice texture

**Optimal cooking time:** The optimal cooking time was determined by cooking the rice in excess water. Twenty rice grains were cooked on an electric heater (98°C), removing few grains at intervals, pressing them between two glass slides, and noting the time at which the opaque core just disappears.

**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 (>425 ml) (Naveeda and Jamuna, 2007).

**Cooked rice dimension:** Cooked rice dimensions were determined same as by using millimetre scale. Ten cooked grains were placed length-wise (with their respective ends, germ or distal), breadth-wise (with their respective sides, dorsal, ventral touching each other), on a flat plane surface along a millimetre scale. Cumulative length and breadth were noted and averaged. The length-breath ratio was calculated by the equation mentioned below (Juliano et al., 1990).

\[
\text{Length to width ratio (L/B)} = \frac{\text{Average cooked rice length (mm)}}{\text{Average cooked rice breath (mm)}}
\]

**Elongation ratio and index:** Rice was cooked in excess water. Two grams rice was cooked with 50 ml water in a 100 ml beaker placed on a cook top stove. Elongation ratio is the ratio of mean of cooked and raw grain and elongation index is the ratio of mean length to width ratio of cooked and raw grains (Juliano and Perez, 1984).

**Aroma:** The aroma of rice was assessed after cooking 20-30 grains for 10 minutes with 50ml water covered 50ml test tube in boiling water bath and cooling. The aroma was rated as strong, moderate, slight or absent.

**Taste:** The taste of cooked *kappakar* rice was assessed using 25 semi trained panellists with a 9 point hedonic scale test.

**Textile:** Texture profile analysis (TPA) of cooked rice was performed using a texture analyzer (TA-XT2, Texture Technologies Corp., Scarsdale, NY) with a 5 kg load cell using a two-cycle compression. Cooked rice (12 g) was moulded into a block using a cylindrical container (2.5 cm diameter \( \times \) 1.0 cm depth) for testing. The cooked rice sample was compressed to 60% with a rod-type probe (2.5 cm diameter \( \times \) 15 cm length) at a speed of 1.7 mm/sec. Hardness and stickiness were determined from the two-cycle curves using Texture Export for Window (Stable Micro Systems, Godalming, UK) (Jung, 2001).

**Physico chemical parameters:** The amylose content, protein content, and gelatinization temperature were determined by standard methods. Gel consistency was determined by Cagampang et al (1997). The Rapid Visco Analysis, water uptake and aroma were determined according to methods by Zhongli Pan, (2007).

**Nutrient analysis:** The protein, crude fiber, crude fat content of *kappakar* was estimated by standard AACC methods.

**RESULTS AND DISCUSSION**

**Physical Properties**

**Seed dimensions:**

The length, width, thickness and L:B ratio was found to be 8.7 mm, 3.2 mm, 2.2 mm and 2.7 respectively for paddy and 6.5 mm, 2.9 mm, 1.9 mm and 2.3 respectively for brown *kappakar* rice. As per the L: B ratio *kapakkar* rice belongs to long bold rice variety.

<table>
<thead>
<tr>
<th>Table 3: Cooking Characteristics of Kappakar Rice.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal cooking time (min)</td>
</tr>
<tr>
<td>Cooked rice volume (ml/10g)</td>
</tr>
<tr>
<td>Cooked rice (mm) Length (L)</td>
</tr>
<tr>
<td>Breath (B)</td>
</tr>
<tr>
<td>L:B</td>
</tr>
<tr>
<td>Elongation Ratio</td>
</tr>
<tr>
<td>Elongation Index</td>
</tr>
<tr>
<td>Aroma</td>
</tr>
<tr>
<td>Taste</td>
</tr>
</tbody>
</table>
**Thousand grain weight:**

The thousand grain weight of the paddy and the brown rice was found to be 30.3g and 25.6g respectively. The thousand grain mass of the paddy was higher than that of the brown rice due to the dehusking process.

**Angle of response**

Angle of response of *kappakar* rice was 38.7°.

**Bulk density:**

The bulk density of *kappakar* rice was 627.15 kgm⁻³. According to Muramatsu et al. (2007), the bulk density of brown rice varied from 775 to 910 kgm⁻³, when the moisture content decreased from 30.1 to 14.9 %.

**Milling performances of *kappakar* rice: Husk percentage and shelling breakage**

Husk percentage of raw and parboiled *kappakar* rice had similar values of 23.72% and 23.10% respectively as shown in table 2. Husk is the inedible outermost layer of the rice kernel which is removed from the paddy by the process known as dehusking to obtain brown rice. Low de-husking efficiency is maintained for achieving the lowest possible shelling breakage from the machine.

The shelling breakage of raw and parboiled *kappakar* rice were 9% and 3% respectively as shown in table 2. Shelling breakage occurs during the dehusking process. It can be inferred that parboiling results in reduced shelling breakage. This might be because on parboiling the husk splits and shelling becomes easier (FAO 1989). On the other hand prolonged parboiling has been found to result in high breakage.

**Polish Percentage**

The polish percentage of raw and parboiled *kappakar* rice were estimated to be 7.0% and 4.2% respectively as shown in Table 2. The degree of polishing was decreased when the rice was parboiled because polishing of rice becomes more difficult on parboiling (FAO 1989). Rice is polished to remove the bran from the kernel. An increase in the polish% causes a subsequent increase in the whiteness of rice and decrease in the milling yield. Bhashyam and Srinivas (1984) reported that 2% increase in degree of polish lead to 4% increase in breakage.

**Polished rice yield%**

The polished rice yield percentage (PRY%) of raw and parboiled *kappakar* rice were 67.46% and 73.20% respectively as shown in Table 2. The PRY% of parboiled rice increased by 5.44% when compared to raw rice.

**Broken rice %:**

Broken rice percentage of raw and parboiled *kappakar* rice were 46.25% and 0.35% respectively as shown in Table 2. The results showed that there was a decrease in the percentage of broken parboiled rice by 45.9%. This was because parboiling toughens the grain and reduces the

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**Table 4 : Correlation Coefficients among Cooking Characteristics of Kappakar Rice.**

<table>
<thead>
<tr>
<th>Property</th>
<th>Gruel loss</th>
<th>Elongation index</th>
<th>Elongation ratio</th>
<th>L:B</th>
<th>Breadth</th>
<th>Length</th>
<th>Cooked rice volume</th>
<th>Optimal cooking time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal cooking time</td>
<td>0.5</td>
<td>-0.188</td>
<td>0.981</td>
<td>-0.090</td>
<td>0.5</td>
<td>1</td>
<td>0.981</td>
<td>1</td>
</tr>
<tr>
<td>Cooked rice volume</td>
<td>0.327</td>
<td>0</td>
<td>1</td>
<td>0.999</td>
<td>0.5</td>
<td>0.981</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>0.5</td>
<td>-0.188</td>
<td>0.981</td>
<td>-0.090</td>
<td>-0.907</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breadth</td>
<td>1</td>
<td>-0.944</td>
<td>0.327</td>
<td>-0.907</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L:B</td>
<td>-0.907</td>
<td>0.995</td>
<td>0.099</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elongation ratio</td>
<td>0.327</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elongation index</td>
<td>-0.9449</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gruel loss</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
amount of breakage during milling. Hence parboiling is a good conserving method to reduce rice breakage.

Clement and Seguy (1994) found that long and tiny rice kernel varieties were more susceptible to breakage during the milling process as compared to wide short kernels. Whereas, kappakar rice belongs to long bold variety of rice. This might be one of the reasons for broken rice percentage.

**Head rice yield (HRY):**

The HRY of raw and parboiled kappakar rice were 56.26% and 72.95% respectively as shown in Table 2. The HRY increased to 36.69% on parboiling. Similar result was reported by Patindol et al. (2008) were the HRY of the rice improved on parboiling. Dipti et al. (2002) reported that a quality rice variety should have HRY of at least 70%. Hence the results obtained for HRY of parboiled kappakar rice was 72.95% which is satisfactory.

**Moisture content (MC):**

The paddy moisture content (PMC) and rice moisture content (RMC) of raw kappakar rice were 8.7% and 9.2% respectively. Similarly PMC and RMC of parboiled kappakar rice were 12.1% and 13.0% respectively. The PMC of raw kappakar rice increased by 3.3% on parboiling. And the RMC of raw rice increased by 3.8% in parboiled kappakar rice. The optimum range of MC for paddy at the time of milling was 12-14%. The PMC had a significant effect on rice breakage, HRY and MRY and insignificant effect on shelling breakage (Afzalinia et al., 2004). Hence increase in the moisture content during parboiling might reduce the milling yield of rice.

**Cooking and physicochemical characteristics of raw kappakar rice:**

**Optimal cooking time:**

The cooking time of raw kappakar rice without soaking was 26±1 minutes when cooked in an open pan as shown in Table 3. Traore, (2005) showed that grain with large diameters takes a longer time to cook compared to smaller grains which is comparable to the results obtained for kappakar which is long bold variety.

On correlating optimal cooking time with other cooking properties, it was positively correlated to cooked rice volume, length, breadth, elongation ratio and gruel loss, and negatively correlated to L: B ratio and elongation index as shown in Table 4.

**Cooked rice volume:**

The cooked rice volume of kappakar rice measured 388±7.6 (ml/10g) as shown in Table 3, hence they can be graded as satisfactory. Cooked rice volume was positively correlated to length, breadth, L: B ratio, elongation ratio, elongation index and gruel loss% as shown in Table 4.

**Cooked rice dimension:**

The length of cooked rice was 10±0.1 mm, breadth 4.1±0.1 mm and length-breath ratio 2.41±0.05 mm as shown in Table 3. The length, breadth and length-breath ratio of cooked rice has increased when compared to that of raw rice. As per the L: B ratio kappakar rice belongs to long bold category.

Length of the cooked rice was positively correlated to elongation ratio and gruel loss and negatively correlated to breadth, elongation index and L: B ratio. Breadth was positively correlated to elongation ratio and gruel loss and negatively correlated to L: B ratio and elongation index. L: B ratio was positively correlated to elongation ratio and index and negatively correlated to gruel loss as shown in Table 4.

**Elongation ratio and index:**

The elongation ratio of kappakar rice was 1.5±0.01 and the elongation index was estimated as 1.06±0.02. Anonymous (1997) observed that if

<table>
<thead>
<tr>
<th>Table 5 : Textural Properties.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>SD</td>
</tr>
<tr>
<td>CV</td>
</tr>
</tbody>
</table>

SD – standard deviation; CV – cumulative variance.
rice elongates more lengthwise it gives a finer appearance and if expands breadth wise, it gives a coarse look.

According to the correlation analysis, the elongation ratio was positively correlated to elongation index and gruel loss. And elongation index was negatively correlated to gruel loss as shown in Table 4.

Aroma:

There was no aroma in the *kappakar* rice. This could be because of the absence of eight-base pair in exon 7 of a gene on chromosome 8 that encodes a putative betaine aldehyde dehydrogenase 2 (BAD2). The deletion results in a loss of function of the encoded enzyme and, consequently, 2-AP accumulates in fragrant cultivars. (Champagne, 1997).

Taste:

A sensory analysis of cooked *kappakar* rice was conducted with a panel of twenty five semi trained panellists to assess the taste of the cooked rice sample. From the sensory analysis the taste of cooked *kappakar* rice was assessed and found out to be normal.

Texture:

The textural properties of cooked rice sample are shown in Table 5. Cooked *kappakar* sample was harder and less sticky. The mean hardness was as high as 3045.624±229.9 g with CV 7.548g. The mean stickiness of the cooked rice was -153.504±50.5g with CV -32.890g.

Amylose content:

The total amylose content and insoluble amylose content of *kappakar* rice was found to be 20.7% and 14.3% respectively as shown in Table 6. Based on this amylose content *kappakar* rice can be classified as intermediate AC rice. The amylose content of *kappakar* rice was comparable to that of IR varieties such IR 48 (23.5%) and IR 64 (23.2%).

Gelatinization temperature:

The gelatinization temperature (GT) of *kappakar* rice was found to be 74.58°C as shown in Table 6. Based on this *kappakar* can be classified as intermediate gelatinizing rice

Rice with intermediate or low GT may be preferred because they require less energy to cook. Hence, findings indicate that *kappakar* will require a limited energy to cook.

A study by Wickramasinghe and Noda (2008) stated that high quality rice is considered to be soft and slightly moist when cooked. Such qualities are usually provided by starches with intermediate amylose content and moderate gelatinization temperatures. *Kappakar* can therefore be considered as high quality rice.

Water uptake ratio:

The water uptake ratio and the soluble amylose ratio were correlated closely to the alkali score and all these were inversely related to the GT. The water uptake ratio of *kappakar* was found to be 0.16 at 60°C and 0.87 at 98°C. This indicates that the temperature influences water uptake as shown in Fig 2. Water and gelatinization temperature have been related to the swelling behaviour. The swelling of rice grain at the low cooking temperatures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch (%)</td>
<td>72</td>
</tr>
<tr>
<td>Total amylose content (%)</td>
<td>20.7</td>
</tr>
<tr>
<td>Insoluble amylose content (%)</td>
<td>14.3</td>
</tr>
<tr>
<td>Soluble amylose content (%)</td>
<td>6.4</td>
</tr>
<tr>
<td>Gelatinization temperature °C</td>
<td>74.58</td>
</tr>
<tr>
<td>Gel consistency (mm)</td>
<td>23.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Viscosity</th>
<th>Value (cP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Break down viscosity</td>
<td>1211</td>
</tr>
<tr>
<td>Setback viscosity</td>
<td>2051</td>
</tr>
<tr>
<td>Consistency</td>
<td>3262</td>
</tr>
<tr>
<td>Peak viscosity</td>
<td>3517</td>
</tr>
<tr>
<td>Hot paste viscosity</td>
<td>2306</td>
</tr>
<tr>
<td>Cold paste viscosity</td>
<td>5568</td>
</tr>
</tbody>
</table>
(60-75°C) can be attributed to the low gelatinization temperature of starch and the fragility of cell membrane. The swelling at the high temperatures (85-96°C) may be affected by the structure of starch and density of starch in endosperm (Kazuo and Yoichi, 1992).

**Gel Consistency:**

The gel consistency of *kappakar* rice was found to be 23.5 mm which can be classified as hard. IR8 and CO25 rice varieties which are used to make flakes also have a hard gel consistency as stated by Thayumanavan and Sadasivam (1984). Therefore, *kappakar* can also be used for the production of other rice products such as flakes.

**Viscosity:**

The Rapid Visco Analyzer (RVA) values of *kappakar* rice are show in Table 6. An RVA measures the viscosity as the sample is stirred, heated and gelatinized.

The results of Rapid Visco Analyzer (RVA) revealed that the cold paste viscosity had the highest value followed by peak viscosity, consistency, hot paste viscosity, setback viscosity. The least value is for break down viscosity.

**Nutrient analysis:**

The nutrient analysis of *kappakar* revealed to contain 8.08% of protein. This is higher than other rice varieties according to (FAO, 2009). The crude fiber content in bran and rice were found to be 8.5% and 0.3% respectively. The crude fat content of the bran was found to be 21.2%. However through enzymatic treatment of brown rice, oil content decreased to 1.16%.

**CONCLUSION**

This study concludes by stating that indigenous organically grown *kappakar* rice is a long bold variety. The analyzed milling parameters indicate that *kappakar* rice when parboiled had a better polished rice yield and head rice yield when compared to raw milled rice. At the same time it decreased shelling breakage and broken grain percentage. Hence, parboiled *kappakar* rice is better in terms of milling quality. The cooked *kappakar* rice was normal to taste and had a satisfactory cooked rice volume with no aroma.

Physicochemically *kappakar* rice had an intermediate amylose content and gelatinization temperature with a hard gel consistency. The water uptake of the rice increased with the increase in temperature. In terms of the pasting properties, the cold paste viscosity was found to be the highest followed by peak viscosity and the hot paste viscosity.

Therefore, parboiled *kappakar* rice has a better economic value due to its head rice yield. On the other hand raw milled *kappakar* rice was found to be acceptable in terms of its cooking and physicochemical properties. It also has a higher level of protein content when compared to other rice varieties. Thus, organically grown with its minimal amount of negative effects on the environment is ideal for common consumption or to produce other processed products such as rice flakes.

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