Study on Physicochemical and Nutritional Quality of Kavuni Rice Flour

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ABSTRACT

Kavuni rice (Oryza sativa L.) is a specialty rice variety with black bran covering the endosperm. The rice endosperm, which is translucent with gray to almost black color, turns deep purple when cooked. It is usually higher in gluten, takes longer time to cook, and is stickier than white rice. Kavuni rice is a potential source of protein, fat, starch, total and reducing sugar compounds. In this study, we investigated the physiochemical and nutritional properties of Kavuni rice among the other pigmented rice varieties. A significant increase on moisture content was noticed in rice flour from all treatments. Compared contain low moisture content was noticed in Kavuni rice from other pigment rice varieties. The highest protein content was noticed in market red rice market variety compared lowest content in white rice (ASD 16). The significant variation was observed in the fat content from TPS-1, Kavuni rice, ASD-16 and market red rice variety with respect to fat content. The reducing sugar content significantly variation was not absorbed between market red rice and kavuni rice but they different significant from kavuni rice and ASD-16 white rice variety. The significant variation was absorbed in total sugar content between all rice flour varieties. The highest starch content was noticed in white rice –ASD 16 and lowest in Market red rice variety (T1) in both period under study. The fatty acid composition was analysed using Gas Chromatography. The fatty acids were oleic acid, linoleic acid, palmitic acid and stearic acid. Linoleic, and oleic acid were found to be the major fatty acids followed by palmitic acid. Arachidonic was present in both black rice and market red rice varieties (T3), while it was not deductible in the white rice -ASD 16.

Key words Kavuni rice flour, Physiochemical property, fatty acid composition

According to Aydin, et al., 2010 the protein content of milled rice includes limited quantity of protein, but still it is regarded as an essential food stuff to high amino acids. Juliano (1998a) reported that protein is the second highest constituent of the milled rice. It makes a fundamental contribution to nutritional quality. Among the cereals, the protein of rice is one of the most nutritious and is biologically the richest by virtue of its true digestibility (88 per cent) and relatively better net protein utilization (NPU) (Rai, 2009).

The brown rice protein content of 17,587 cultivars maintained at international Rice Research Institute (IRRI) ranged from 4.3 to 18.2 per cent with a mean of 9.5 per cent. Mean brown rice protein of “japonica” rices was higher than that of indica rices, with means of 11.8 per cent and 9.8 per cent respectively and coefficients of variation of 16 per cent and 21 per cent (Gomez, 1999). Protein content of brown rice varied from 7.1 per cent to 15.4 per cent in weight depending on cultivars (Tanaka, 1997).

Kang, et al., 2011 evaluated that the physicochemical properties and palatability of rice from six elite varieties in Korea (Chucheongbyeo, Saechucheongbyeo, Mihyangbyeo, Hitomebore, Nampyeongbyeo, and Ilpunbyeo) were analyzed. All samples, which contained 17–18 g/100 g rice starch amylose, belong to low-amylose rice group. Hitomebore variety showed abundant amount of essential amino acids, highest palatability score (82.9), and lowest mineral content. The rice samples contained relatively similar concentrations of saturated (21–24 g/100 g rice) and unsaturated (75–78 g/100 g rice) fatty acids. Starch, the nutritional reservoir in rice exists in two different forms amylose, the unbranched type of starch with glucose residues with 1-4 linkage and amylopectin, the branched form with 1-4 and 1-6 cross linkage made up the remaining of the starch (Aberg, 1994).

Nicolic, et al, 2008 studied the fatty acids composition, with an emphasis on total saturated and total unsaturated fatty acid wheat-rice flour mixture (70:30 w/w). The results showed that wheat-rice flour mixture had better fatty acids composition with higher content of stearic, arachidic, lignoceric, oleic and phthalic acid compared to wheat flour. As, wheat flour do not contain myristic, arachidic, lignoceric
and linolenic acids, rice flour addition made fatty acids profile richer. Total polysaturated fatty acids were at a higher rate (58.34%) than monounsaturated fatty acids (20.28%) in wheat-brown rice flour mixtures.

MATERIALS AND METHODS

Moisture:

The moisture content of the sample was estimated by hot air oven method as per the procedure referred by AOAC (1995). The sample was dried at 1100°C. The drying was continued till a constant reading was obtained. The moisture was expressed as percentage.

Protein:

Protein was analyzed by available nitrogen in the sample by micro kjeldahl method. Hundred milligram of sample was transferred into the digestion flask along with two grams of copper sulphate and 80 mg of selenium oxide as catalyst and 15 ml of concentrated sulphuric acid was added and digested until the solution became colourless (from the catalyst prepared only a pinch was used for digestion). The digested sample was transferred into a 100 ml volumetric flask and made up with distilled water. A known aliquot was transferred into the distillation flask. Ten ml of saturated sodium hydroxide solution was added to the test solution in the apparatus. The solution was distilled and the ammonia evolved was collected in a beaker containing boric acid placed at the tip of the condenser. The solution was titrated against standard acid till the appearance of the violet colour, the end point. The same procedure was repeated for reagent blank. The nitrogen content of the sample can be obtained by this method. The nitrogen value was multiplied by a factor 6.25 to give the crude protein content of the sample. (Ma and Zuazaga, 1942).

Fat:

The fat content of the sample was estimated by the method described by Cohen, 1917. The lipid in the sample was extracted with petroleum ether (60-80°C) in soxplus apparatus for two hours. Then the solvent was evaporated and the remaining residue was weighed. The fat content was expressed as percentage.

Starch:

The starch content was analysed by a method described by Sadasivam and Manickam, 2008. The sample (0.5g) was extracted with 80 per cent ethanol to remove sugars. Residue was repeatedly extracted with hot 80 per cent ethanol to remove sugars completely. The residue was dried over a water bath and 5 ml of water and 6.5 ml of 52 per cent perchloric acid were added and extracted at 0°C for 20 minutes. The supernatant and made up to 1 ml with water and 4 ml of anthrone reagent was added, heated for 8 min, cooled and read the OD at 630 nm in a spectrophotometer.

A standard graph was prepared using serial dilution of standard glucose solution. From the graph, glucose content of the sample was obtained and multiplied by a factor of 0.9 arrive the starch content.

Reducing sugar and total sugar:

The content of the sample were determined by the Shaffer Somogyi micro method described by Mc Donald and Foley, 1960. 10 gram of rice was powdered and 100 ml of distilled water was added and then clarified with neutral lead acetate. Excess lead was removed by adding potassium oxalate. The volume was then made up to 250 ml. An aliquot of this solution was titrated against a mixture of Fehling’s solution A and B using methylene blue as indicator. The reducing sugar was expressed in percentage.

From the clarified solution used for the estimation of reducing sugar, 50 ml was taken and boiled gently after adding citric acid and water. It was later neutralized with NaOH and the volume was made upto 250 ml. An aliquot of this solution was titrated against Fehling’s solution A and B. The total sugar content was expressed in percentage.

Fatty acid composition:

The fatty acid composition of the selected rice varieties was analysed by the solvent extraction method by Cohen, 1917 using the GC method. Lipids were extracted from black Kavuni rice, white kavuni rice, white kavuni rice and red rice flour by Soxhlet apparatus for 8 hrs using hexane. The extract were concentrated and stored at 4°C, until use. The fatty acid methyl esters were analysed by gas chromatography with flame ionization detector, using BP21 column. The conditions of the analysis were; injector temperature 220°C, detector temperature 230°C and column temperature 180°C and nitrogen carrier gas at a flow rate of 1.0 ml per min. Identification of fatty acids was based on the retention times of methyl esters of standard fatty acids.
RESULTS AND DISCUSSION

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Reducing Sugar</th>
<th>Total Sugar</th>
<th>Starch</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_0$</td>
<td>11.58±0.02</td>
<td>8.72±0.03</td>
<td>2.86±0.01</td>
<td>2.35±0.03</td>
<td>2.38±0.01</td>
<td>73.43±0.04</td>
</tr>
<tr>
<td>$T_1$</td>
<td>12.03±0.04</td>
<td>8.44±0.02</td>
<td>3.42±0.02</td>
<td>0.92±0.01</td>
<td>1.73±0.02</td>
<td>74.21±0.04</td>
</tr>
<tr>
<td>$T_2$</td>
<td>11.42±0.02</td>
<td>7.98±0.01</td>
<td>3.03±0.02</td>
<td>1.82±0.07</td>
<td>2.68±0.02</td>
<td>75.21±0.05</td>
</tr>
<tr>
<td>$T_3$</td>
<td>12.01±0.02</td>
<td>9.21±0.04</td>
<td>2.35±0.03</td>
<td>2.43±0.04</td>
<td>2.14±0.02</td>
<td>72.38±0.03</td>
</tr>
</tbody>
</table>

SED 0.0093 0.0115 0.0062 0.0213 0.0053 0.0102
CD (0.05) 0.0228** 0.0281** 0.0153** 0.0520** 0.0129** 0.0249**

$T_0$ – Red rice (TPS1)  $T_1$ – Kavuni rice  $T_2$ – White rice (ASD 16)  $T_3$ – Market red rice

The moisture content in various pigmented rice from four treatments. Initially, the moisture content of the rice from four treatments varied from 12.01 per cent ($T_1$) to 11.42 per cent ($T_2$). A significant increase on moisture content was noticed in rice flour from all treatments. Compared $T_2$ low moisture content was noticed in rice from $T_1$, $T_2$ and $T_3$.

The protein content in rice from flour treatments varied from 7.98 to 9.21 per cent. The highest protein content was noticed in market red rice variety ($T_1$) and lowest in white rice (ASD 16) from $T_2$. Significant variation was observed in the protein content of rice from different treatments during study period.

The fat content in rice from four treatments varied from 2.86 to 3.42 per cent. The highest fat content was noticed in rice flour from $T_1$ and the lowest in rice flour from $T_0$ initially during the study. The significant variation was observed in the fat content from $T_0$, $T_1$, $T_2$ and $T_3$ with respect to fat content.

Reducing sugar content in rice from four different treatments during study and it is compared to control ($T_0$), rice flour from $T_1$, $T_2$ and $T_3$ and had higher percentage of reducing sugar initially during study. The reducing sugar content of various treatments and it is varied from 0.92 to 2.43 per cent. Initially significant variation was not absorbed between $T_1$ and $T_3$ in reducing sugar but they different significant from $T_1$ and $T_2$ variety.

Total sugar content in rice flour from different treatments during study and compared to control ($T_0$) and

![Physiochemical Properties](image)

Fig.1. Physiochemical properties of Kavuni rice
Fig. 2. Fatty acid composition of kavuni rice flour

T₀ - Red rice (TPS-1)  T₁ - Kavuni rice  T₂ - White rice (ASD 16)  T₃ - Red rice market variety

Fig. 3. Fatty acid composition of kavuni rice flour

T₁ - Kavuni rice  T₂ - White rice (ASD -16)  T₃ - Red rice market variety
rice from $T_1$, $T_2$ and $T_3$ had higher percentage of initial study. The reducing sugar content in rice flour varied from 0.92 to 2.35 per cent. Initially the significant variation was absorbed between all rice flour varieties.

Starch content in various rice flour samples and the control is initially, the starch content in rice flour from different treatments varied from 75.21 to 72.38 per cent. The highest starch content was noticed in white rice – ASD 16 ($T_2$) and lowest in Market red rice variety ($T_3$) in both period under study. The significant difference in starch content was noticed in market red rice ($T_2$) and white rice (ASD 16) rice flour.

The fatty acid composition (figure 2) was analysed using Gas Chromatography. The fatty acids were oleic acid (18:1), linoleic acid (18:3), palmitic acid (16:0) and stearic acid (18:0). Linoleic (18:2), and oleic acid (18:1) were found to be the major fatty acids followed by palmitic acid (16:0). Arachidonic (20:4) was present in both black rice ($T_1$) and market red rice varieties ($T_3$), while it was not deductible in the white rice - ASD 16 ($T_2$).

There were significant difference among both pigmented rice and local market rice varieties for all the parameters studied. Moisture, protein, fat, reducing sugar and total sugar components were better among the varieties than local market variety. However, the pigmented rice varieties studied exhibited nutritional superiority especially protein, fat, starch, reducing sugar and total sugar contents. Many of them also had fairly acceptable physicochemical properties like favorable fatty acid contents among the all rice varieties. This research provides valuable information that can be used in the physiochemical and nutritional quality of various rice flour varieties.

**LITERATURE CITED**


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