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Radha P
Assistant Professor, Department of Biochemistry, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam, Tamil Nadu, India

A Gurusamy
Professor, Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

Corresponding Author:
Radha P
Assistant Professor, Department of Biochemistry, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam, Tamil Nadu, India

Physicochemical and cooking characteristics of pigmented traditional rice varieties

Radha P and A Gurusamy

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Abstract
Traditionally, every variety of rice has had agricultural and food significance. The particularities of the varieties do not end with the paddy plants, duration, seasonality, etc. The grains also have their unique features. They have specific nutritive, cooking and eating qualities. To study the physicochemical and cooking characteristics of traditional rice popular brown rice varieties were collected from Pudukkottai, Sivagangai (Karaikudi) and Perambalur districts of Tamil Nadu. From the collected samples, five rice varieties namely Kaatuyaanam, Karuppukavuni, Karunguruvai, Mapillaisamba and Kuruvaikalanchiyam were selected for the study. Certain unique features of the rice were characterized out by the physical, thermal and cooking characteristics of brown rice varieties. Physical characteristics such as test weight, kernel length, and breadth and L/B ratio, seed grade were assessed. Thermal characteristics such as water uptake, volume expansion ratio and alkali spreading value were also assessed. The traditional rice varieties were found to exhibit good Phyico-chemical and thermal characteristics revealing their high grain quality.

Keywords: Brown rice, physicochemical, thermal characteristics

Introduction
Traditional rice genetic resources in India are reported to harbour vast amount of genetic diversity including medicinal properties and aroma (Das and Oudhia, 2003) [5]. These traditional varieties are potent sources for various agronomic traits as well as many bioactive non nutrient components (Crozier *et al*., 2009) [4]. Traditional coloured rice varieties are known to be rich in dietary fibre, resistant starch, minerals, carotenoids, flavonoids and polyphenols and consumption of grains of these pigmented rice varieties help in improving human health (Rao *et al*., 2010) [9]. The bioactive phytochemicals and micronutrient components from these traditional rice varieties as dietary supplements are expected to play a major role in attenuating the incidence of non-communicable diseases *viz*., cardiovascular diseases, diabetes, cancer and stroke (Vichapong *et al*., 2010) [10]. Though traditional rice is known for its medicinal and health benefits in other countries, the knowledge regarding the importance of pigmented rice is lacking behind in India. In this context an attempt was made to study the physicochemical and cooking characteristics of selected traditional brown rice varieties of Tamil Nadu, India.

Materials and Methods
Traditional rice varieties namely Kattuyaanam, Karuppukavuni, Karunguruvai, Mapillai samba and Kuruvaikalanchiyam were collected from Pudukkottai, Sivagangai (Karaikudi) and Perambalur districts of Tamil Nadu. The collected paddy varieties were brought to laboratory and stored at room temperature till analysis. Selected samples were analysed for the following characteristics.

Physicochemical characteristics
Thousand grain weight (g)
Fully matured well textured 1000 grains from each variety were subjected to test weight and expressed in grams.

Milling Percentage

Hundred grams of samples were cleaned and subjected to de husking. The de husked rice was weighed and the milling percentage was calculated (Anonymous 2004) [2].

$$\text{Milling percentage} = \frac{\text{Weight of de husked rice}}{\text{Weight of paddy sample}} \times 100$$

Kernel Length, Breadth and L/B ratio

Ten randomly selected whole kernels of rice were taken and length of each grain was measured by placing on a micro-scale. Breadth of each grain was measured using a Vernier Calliper. The average of ten such observations was taken for final reading of length and breadth of rice kernels. The L/B ratio was calculated by dividing the average length by the average breadth of rice kernel (Bhattacharjee and Kulkarni, 2000) [3].

Thermal characteristics

Water uptake (ml/100g)

Two gram of rice sample was taken into a large test tube containing 10ml distilled water. The rice was cooked by placing the test tube in water bath at 77ºC for 35 minutes. The contents of the test tube were transferred into a filtration flask, and the volume of unabsorbed water was measured. The amount of water absorbed by sample was determined by subtracting the unabsorbed water volume from the original volume of water added (10ml). Apparent water uptake on cooking (ml/100g rice) was calculated by multiplying the absorbed water volume by 50.

Volume expansion ratio (VER)

Two gram of rice sample was taken in a graduated test tube and 5ml distilled water was added. Cooking was carried out by placing the test tube in water bath at 72ºC for 45 minutes and the volume of the cooked rice was measured. The volume expansion ratio of rice after cooking was calculated in terms of original volume.

Alkali Spreading Value (Little *et al*., 1958; Juliano, 2010) [7, 6].

Ten millilitres of two per cent potassium hydroxide solution was taken in a small glass petri-dish and six whole milled grains of rice were placed in the dish, spaced evenly. The petri-dishes were covered and left undisturbed for 23 hrs at the room temperature. The extent of disintegration of kernel due to alkali was rated visually based on a seven point numerical spreading scale as under

Alkali Spreading Value/Scale

1. Kernel not affected
2. Kernel not swollen
3. Kernel swollen, collar incomplete and narrow
4. Kernel swollen, collar complete and wide
5. Kernel split or segmented, collar complete
6. Kernel dispersed, merging with collar
7. All kernel dispersed and intermingled

Alkali Spreading Value/Scale	Classification	Gelatinization Temperature
6 - 7	High	Low
4 - 5	Medium	Medium
3	Low, Medium	High, Medium
1 - 2	Low	High

Results and Discussion

The results of the study conducted to compare the physical, chemical and thermal characteristics of traditional brown rice varieties are discussed below:

Physicochemical characteristics

Data pertaining to test weight and milling characteristics of the traditional rice varieties are presented in Table 1.

Test weight (g)

Grain weight provides information about the size and density of the grain. Based on the 1000 grain weight, rice varieties were classified as bold, medium and slender type. The 1000 grain weights that fall in the range 25-27g were classified as bold type and below 24g as medium grain type. Three tested brown rice varieties namely, Kaatuyanam, karuppukavuni and mapillaisamba were considered as bold type whereas karunkuruvai and Kuruvaikalanchiyam were considered as medium grain type.

Milling yield (%)

Milling recovery is reported to depend on grain shape and appearance, which has direct effect on the percentage of hulling, milling and head rice recovery. Among the different traditional rice varieties studied, significantly the highest milling yield was recorded in Kaatuyanam (77.11%) followed by Mapillaisamba (72.93%) and the lowest milling yield was recorded in Kuruvaikalanchiyam (59.63%).

Table 1: Classification of traditional rice varieties

S. No	Rice Varieties	1000 grain weight (g)	Grain type	Milling yield (%)
1	Kaatuyanam	25.03	Bold grain	77.11
2	Karuppukavuni	25.03	Bold grain	60.43
3	Karunguruvai	24.71	Medium grain	66.85
4	Mapillaisamba	27.71	Bold grain	72.93
5	Kuruvaikalanchiyam	17.93	Medium grain	59.63

Kernel Length, Breadth and L/B ratio

The **length** and **width** of a rice grain are important attributes that determine the class of the rice. Grain size and shape are the first criteria for rice quality that breeders consider in developing new varieties for release for commercial production (Adair *et al.*, 1966) [1]. Kernel length of traditional varieties varied from 5.7 to 6.6mm. Mapillaisamba exhibited the highest value and Kuruvaikalanchiyam registered the lowest value. Kernel breadth ranged from 2.0 to 3.6mm in which Mapillai samba showed the maximum value (3.6mm). Kernel L/B ratio of the five traditional rice varieties varied widely from 1.68 to 3.15. Karuppukavuni recorded the highest L/B ratio of 3.15 and lowest of 1.68 was recorded with variety Kuruvaikalanchiyam.

Table 2: Physical characteristics of traditional rice varieties

S. No	Rice Varieties	Kernel Length (mm)	Kernel Breadth (mm)	Kernel L/B ratio
1	Kaatuyanam	6.5	2.9	2.24
2	Karuppukavuni	6.3	2.0	3.15
3	Karunguruvai	5.9	2.9	2.03
4	Mapillaisamba	6.6	3.6	1.83
5	Kuruvaikalanchiyam	5.2	3.1	1.68

Thermal characteristics

Though cooking and eating characteristics of rice are mostly determined by the nutrient composition of rice, especially

content and structure of starch components, certain thermal characteristics are employed as specific criteria to predict the cooking and processing characteristics of rice. These parameters are reported to correlate well with the chemical composition and also with the cooking quality of rice (Pillaiyar, 1979) [8].

Data on various thermal characteristics of five traditional varieties is presented in Table 3. Water uptake capacity of rice is related to tenderness, stickiness and palatability of cooked rice. The table indicates the water uptake and volume expansion ratio (VER) of the traditional rice varieties.

Table 3: Thermal characteristics of traditional rice varieties

Rice varieties	Water uptake (ml/100g)	Volume Expansion Ratio (VER)
Kaatuyanam	900	3.6
Karuppukavuni	850	3.4
Karunguruvai	750	3.6
Mapillaisamba	660	3.8
Kuruvaikalanchiyam	620	3.4

Water uptake (ml/100g) of the traditional rice varieties varied between 620 to 900ml. Kaatuyaanam exhibited the maximum and Kuruvaikalanchiyam the lowest water uptake. Mapillai samba exhibited the maximum volume expansion ratio (3.8) and the least VER of 3.4 was expressed by Karuppukavuni and Kuruvaikalanchiyam.

Alkali spreading value

Alkali spreading value test permits classification of rice into high, intermediate and low gelatinization types.

Table 4: Alkali spreading value/scale and predicted gelatinization temperature of traditional rice varieties

Rice variety	Alkali spreading value/Scale	Classification	Gelatinization temperature
Kaatuyanam	3.5	Medium	Medium
Karuppukavuni	5.5	High	Low
Karunguruvai	5.0	Medium	Medium
Mapillaisamba	4	Medium	Medium
Kuruvaikalanchiyam	4	Medium	Medium

Among the traditional rice varieties studied, all the four varieties are having medium alkali spreading value and gelatinization temperature except karuppukavuni which is having high alkali spreading value and low gelatinization temperature.

Conclusion

In the present study physical, chemical and cooking characteristics were evaluated for 5 traditionally cultivated brown rice varieties. All the tested varieties showed good physical, chemical and thermal characteristics revealing high grain quality, which could be used in rice breeding programmes and biotechnological research for further improvement of rice.

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