RESEARCH ARTICLE

Study of Physicochemical, Cooking and Nutritional Properties of Selected Traditional Rice Varieties of Tamil Nadu

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ABSTRACT

The study has been undertaken to investigate the physico-chemical, cooking and nutritional qualities of selected traditional rice varieties of Tamil Nadu. Significant variations ($p<0.05$) were observed among the twelve traditional rice varieties for all the characters except hulling percentage. Among the varieties, the highest hulling out-turn was found in Poonkar (90.0 %) and the lowest was found in Anaikomban (84.0 %). The milling out-turn was ranged from 74.0 % to 80.0 %. Head Rice Recovery (HRR) varied from 50.0 % to 75.0 %. The kernel length was highest in Kullakar (6.3 mm) and lowest (4.2 mm) in Milagu samba and Thulasi vasa samba. Kernel breadth was ranged between 1.4 – 2.5 mm. Based on length/breadth ratio, the variety Thanga samba obtained slender grain type whereas all other varieties obtained medium grain type. The Kernel length after cooking ranged from 6.5 mm (Thulasi vasa samba) to 9.8 mm (Poonkar). The volume expansion ratio ranged from 4.6 in Sorna masuri to 3.7 in Poonkar and Kullakar. Gel consistency ranged from 46.0 - 135.0 mm. The Gelatinization Temperature (GT) was determined based on alkali spreading value and the rice varieties Milagu samba, Kuzhiadichan and Thulasi vasa samba have obtained intermediate GT values whereas other varieties evaluated showed high to intermediate GT. Intermediate amylose content is considered to be the best from the cooking point of view. Varieties Anaikomban (20.1 %), Garudan samba (20.4 %), Poonkar (20.7 %) and Sorna masuri (23.2 %) were identified with intermediate amylose content. Highest protein (10.40 %), iron (15.8 mg kg^{-1}) and zinc (20.5 mg kg^{-1}) content were recorded in the varieties Poonkar, Thuaiya malli samba and Kullakar respectively, making them nutritionally superior among the tested varieties. There is a growing global demand for rice varieties with good quality characteristics. This study provides immense information on varieties with superior physico-chemical, cooking and nutritional characteristics which could be used to meet those demands.

Keywords: *Rice; Traditional varieties; Physicochemical; Cooking; Nutritional properties*

INTRODUCTION

Rice (*Oryza sativa* L.) serves as a staple food crop for nearly half of the global population (Zhang *et al.,* 2020). In India, it is cultivated over an area of 45 million hectares with annual production of 122.27 million tonnes and productivity of 2713 kg ha^{-1} (Annual report on Agriculture, 2021-22). In Tamil Nadu, it occupies one-third of the total area under the crops in the entire state (Tamil Nadu Salient Statistics on Agriculture, 2021). Impressive growth in rice production and productivity has been achieved in recent times. However, a major challenge in rice production today is to achieve the coordination of high yield and good grain quality. Rice grain quality is a complex trait that is defined by several characteristics including hulling, milling, physical, chemical, cooking and nutritional value. It has a high influence in processing, marketing and consumption of grain. Although modern rice varieties are known to show high yield and had biotic and abiotic stress resistance, their grain quality was not meeting the requirements of the consumers. As a result, improvement in rice grain quality has become one of the focuses in rice breeding around the world.

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Traditional rice varieties, otherwise called 'heritage rice' have been grown and consumed since ages and played an important role in ensuring food and nutritional security of local communities. They have been used in Ayurveda system since ancient times in order to treat different diseases like diarrhoea, fever, vomiting, haemorrhage, improve eyesight, vocal clarity, fertility, due to its higher nutritive and medicinal value (Deepa *et al*., 2008; Hegde *et al*., 2013). Tamil Nadu was one among the biggest repositories of traditional rice varieties once. However, due to introduction of high yielding varieties in 1960's has led to disappearance of thousands of local rice varieties. With the involvement of environment-concerned farmers, scientists and awareness of the benefits of traditional rice among the people, traditional rice varieties are experiencing a renaissance in the state. Evaluating and identifying traditional rice varieties that have better physicochemical properties would not only help in fulfilling today's requirement of quality grains but also in stabilizing the unparalleled diversity of these varieties from eroding. Keeping in view of the above facts, an investigation was undertaken with the objective to assess and evaluate physicochemical, cooking and nutritional characteristics of selected traditional varieties of Tamil Nadu

MATERIAL AND METHODS

The field experiment was conducted during rabi season of 2021 at wetland farms of Tamil Nadu Agricultural University, Coimbatore. The experimental site is located in the western agro climatic zone of Tamil Nadu at 11 °N latitude, 77 °E longitude and at an altitude of 426.72 m above mean sea level. The varieties *viz*., V_1: Athur Kichili samba, V_2: Garudan samba, V_3: Illuppaipoo samba, V_4: Milagu samba, V_5: Poonkar, V_6: Sorna masuri, V_7: Thuaiya malli samba, V_8: Thanga samba, V_9: Kuzhiadichan, V_{10}: Kullakar, V_{11}: Anaikomban, V_{12}: Thulasi vasa samba were selected based on crop duration. Fourteen days old seedlings were transplanted in randomized block design with three replications and organic package of practices were followed for crop cultivation. The rough rice (Paddy) was harvested at physiological maturity stage, threshed, cleaned and dried in hot air oven up to 12-14 % moisture content. All the laboratory analysis was carried out in the laboratory of Tamil Nadu Rice Research Institute, Aduthurai. The data obtained were then subjected to statistical analysis as suggested by Gomez and Gomez (1984).

Hulling & Milling percentage

The rice kernels were dehulled using laboratory dehuller. After cleaning and weighing the dehusked kernels (brown rice), hulling percentage was calculated. The dehusked kernels were polished to remove bran and milling percentage was calculated.

Head Rice Recovery (HRR)

Head rice or milling recovery is the estimate of head rice with more than 2/3rd size and expressed as percentage. Head rice recovery was calculated by using the standard formula

$$\text{Head rice recovery} = \frac{\text{weight of head rice}}{\text{weight of rough rice}} \times 100$$

Kernel length and breadth, length/breadth ratio before cooking: Kernel length and breadth of ten milled rice per replication were measured by means of graph sheet and expressed in millimeter (mm). Length by breadth (L/B) ratio was then calculated from the obtained data by dividing the length by breadth. The shape of the grain was classified according to the classification adopted by IRRI (1996).

Kernel length and breadth after cooking: Milled head rice was cooked for the minimum cooking time as described by Singh *et al.* (2005). The cooked rice was placed on a blotting paper to drain the excess water. Length and breadth of ten cooked rice grains was measured in three replications and mean was reported in mm.

Linear elongation ratio and Breadth wise expansion: Linear elongation ratio (LER) was obtained by dividing the length of cooked rice to length of milled rice (Juliano and Perez, 1984). Breadth wise expansion (BWER) ratio was determined by dividing the mean breadth of cooked rice to mean breadth of milled rice.

Volume expansion ratio: Volume expansion ratio of cooked rice was determined by water displacement method. A five gram of milled rice was taken in a measuring cylinder containing 15 mL of water. The initial increase in volume after adding five gram of water was noted (Y) and soaked for 10 minutes. Increase in volume before cooking was measured (Y-15). The soaked rice was cooked for 20 minutes on a water bath at 90°C. Then all the cooked rice was placed in a 100 mL measuring cylinder containing 50 mL of water and the increase in volume of cooked rice was measured (X). Later, the volume expansion ratio was calculated by dividing the volume of cooked rice (X-50) by volume of uncooked rice (Y-15).

Gelatinization Temperature (GT) and Alkali Spreading Value (ASV): Duplicate sets of six whole milled kernels without cracks were placed in a petri plate containing 10 mL of 1.7 % potassium hydroxide (KOH) solution. The kernels were carefully arranged in the petri plate to provide space between kernels and incubated at room temperature for 23 hours to allow spreading of the kernels. After 23 hours, the appearance and disintegration of kernels were rated visually based on point numerical spreading scale (Table 1). Gelatinization temperature was estimated based on alkali spreading value of milled rice as per IRRI (1996).

Gel Consistency (GC): Gel consistency was analyzed based on the method described by Cagampang *et al*. (1973). 50 mg of milled rice flour was weighed in duplicate into the test tubes. To this 0.2 mL of 95 % ethanol containing 0.025 % thymol blue and 2 mL of 0.2 N KOH were added. Contents were mixed using a Vortex Genie mixer with speed set at 6. The test tubes were covered with glass marbles in order to prevent steam loss and to reflux the samples. The samples were cooked in a vigorously boiling water bath for 8 minutes to make the contents reach 2/3rd of the height of the tube. The test tubes were removed from the water bath and kept at room temperature for 5 minutes. The tubes were cooled in an ice water bath for 20 minutes and laid horizontally on a table lined with millimeter graph paper. The total length of the gel was measured in millimeters from the bottom of the tube after one hour. Based on the length of the gel, the rice was categorized into (a) Very flaky rice grains with hard gel consistency (length of gel, 40 mm or less); (b) Flaky rice grains with medium gel consistency (length of gel, 41 to 60 mm); (c) Soft rice grains with soft gel consistency (length of gel, more than 61 mm).

Amylose: Modified method of Juliano (1971) was followed for determining amylose content. 100 mg of rice flour of each variety was taken in a volumetric flask, 1 mL of ethanol (95 %) and 9 mL of sodium hydroxide (1 N) were added to it. The contents were heated in a boiling water bath to gelatinize the starch. After cooling for 1-hour, distilled water was added and volume was made up to 100 mL. From the starch solution, 5 mL was taken in a 100 mL volumetric flask, 1 mL of acetic acid (1 N) and 2 mL of freshly prepared iodine solution were added and the volume was made up with distilled water. The contents were shaken well and allowed to settle for 20 minutes before absorbance was read at 620 nm. The rice varieties were classified based on their amylose content into waxy (0-2 %), very low (3-8 %), low (9-19 %), intermediate (20-25 %) and high (>25 %).

Protein: Modified Lowry's method given by Hartree, 1972 was used for estimating total protein content. One gram of sample from each variety was macerated with 50 mL of 0.1 M phosphate buffer using pestle and mortar and centrifuged at 4000 rpm for 20 minutes. The supernatant was collected for protein estimation by discarding the pellet. 0.2 mL of extracted sample was taken in a test tube and the volume was made up to 1 mL with distilled water. 5 mL of alkaline copper sulphate solution was added to it and incubated at room temperature for 10 minutes followed by 0.5 mL of Folin-Ciocalteau reagent was added. The contents were mixed well and incubated at room temperature in dark for 30 minutes. The absorbance was measured at 660 nm in a spectrophotometer.

Iron and zinc content: Iron and zinc content in brown rice samples were estimated by Energy Dispersive X-Ray Fluorescence Spectrometry (ED-XRF) method.

RESULTS AND DISCUSSION

Hulling percentage

Hulling is one of the crucial steps in processing paddy. If the hulling percentage increases, then the recovery of rice also increases. Eighty percent or more are the preferable hulling characteristics for rice (Rita and Sarawgi, 2008). In the present study, the hulling percentage has not varied significantly among the traditional varieties (Table 2). All the varieties have performed better by registering hulling percentage of more than 80 %. The variety Poonkar (90 %) recorded the highest hulling percentage followed by Illuppaipoo samba (89 %) and Kullakar (88 %). The lowest hulling percentage was recorded in Anaikomban (84 %).

Milling percentage

Milling percentage is the measure of whole and broken rice from the hulled rice after removing bran layers. It is one of the important industrial quality aspects of rice. Among the varieties evaluated, the highest milling percentage of 80 % was recorded in Sorna masuri, Thuaiya malli samba, Thanga samba. The lowest milling percentage (73 %) was recorded in Garudan samba (Table 2).

Head Rice Recovery

Head Rice Recovery (HRR) is the proportion of rice that retained at least two-thirds of its length after milling. For a new rice variety to be released, the variety should have at least 55 % HRR. Hence, HRR is a crucial attribute by which new varieties are selected for release. Although HRR is affected by postharvest processing conditions that the variety goes through, the amount of head rice is primarily determined by the genetics of a variety (Lapis *et al*., 2019). In the present investigation, the variety Thanga samba showed highest HRR of 75 % (Table 2). However, it was on par with Thulasi vasa samba (72 %) and Milagu samba (70 %). The next best varieties were Anaikomban (63 %) and Athur Kichili samba (55 %). The variety Garudan samba showed the lowest HRR of 50 %.

Kernal length and breadth before cooking

Based on standard evaluation system for rice (IRRI, 1996), 10 varieties *viz.,* Athur Kichili samba, Garudan samba, Illuppaipoo samba, Poonkar, Sorna masuri, Thuaiya malli samba, Thanga samba, Kuzhiadichan, Kullakar, Anaikomban were grouped to medium grain length (5.51 - 6.60 mm) and two varieties *viz.*, Milagu samba and Thulasi vasa samba were grouped to short grain length (≤5.50 mm). Both grain length and breadth were highly significant among the varieties. The kernel breadth ranged between 1.4 – 2.5 mm (Table 2).

L/B ratio (Raw rice)

Grain shape and size are important drivers of consumer acceptance. Based on the length by breadth ratio, grains were grouped according to the classification provided by IRRI, 1996. Accordingly, 11 varieties *viz.,* Athur Kichili samba (2.80), Garudan samba (2.59), Illuppaipoo samba (3.00), Milagu samba (3.00), Poonkar (2.40), Sorna masuri (2.95), Thuaiya malli samba (3.00), Kuzhiadichan (2.39), Kullakar (2.63), Anaikomban (2.43) and Thulasi vasa samba (2.47) had obtained medium grain type and one variety *viz*., Thanga samba (3.24) had obtained slender grain type (Table 2).

Kernel length and breadth after cooking

Generally, an increase in length and breadth of rice grains would be observed due to absorption of water during cooking. However, a length-wise increase without an increase in breadth is a desirable characteristic in high quality premium rice (Hossain *et al*., 2009). Among the varieties tested, Poonkar (9.8 mm) had the longest grain length after cooking and the shortest was recorded in Thulasi vasa samba (6.5 mm) (Table 2). The grain breadth after cooking was minimum in Thulasi vasa samba (2.5 mm) and maximum in Kullakar (3.5 mm).

Linear elongation ratio after cooking

Linear elongation ratio is an important quality parameter for cooked rice. If rice elongates length wise, it gives a finer appearance. Out of 12 varieties studied, Milagu samba (1.76) showed the highest elongation ratio (Table 2). However, it was comparable with Thanga samba (1.73), Sorna masuri (1.70) and Thuaiya malli samba (1.67). High breadth wise expansion is not a desirable quality attribute as it gives a coarse look. Least breadth wise expansion was seen in Poonkar (1.28) which was statistically on par with Athur Kichili samba (1.30), Anaikomban (1.30), Garudan samba (1.35) and Illuppaipoo samba (1.37).

Volume Expansion Ratio (VER)

Volume expansion ratio gives the extent of water absorbed during cooking (Oko *et al*., 2012). The higher the VER, more will be the quantity after cooking; less will be the energy content per unit volume. In the present study, the variety Sorna masuri registered the highest volume expansion ratio (4.6) than all other varieties except Thuaiya malli samba (4.4) and Illuppaipoo samba (4.3). The least VER of 3.7 was observed in Poonkar and Kullakar (Table 2). The perception of VER varies with people. It is perceived as a characteristic of low-quality rice by the elite class whereas it is seen as an economical way to feed the family by the lower income group.

Alkali Spreading Value (ASV) and Gelatinization Temperature (GT)

Alkali digestion is yet another indicator of cooking quality of rice (Tian *et al..,* 2009). Alkali spreading value ranged from 2.0 (low) to 4.0 (intermediate) of the tested varieties (Table 2). The intermediate alkali digestion varieties are the widely preferred by the consumers across the world since this kind of cooked rice is soft and flaky (Hossaina *et al*., 2009). In the present study, the intermediate ASV was recorded in Milagu samba, Kuzhiadichan and Thulasi vasa samba.

The time required for cooking is determined by the gelatinization temperature. The higher the gelatinization temperature, longer the time rice takes to cook (Alaka *et al*., 2015). GT of a variety can be indexed by its alkali digestion value (Gulam *et al*., 2015). Accordingly, three varieties viz., Milagu samba, Kuzhiadichan, Thulasi vasa samba had obtained intermediate GT, eight varieties viz., Athur Kichili samba, Garudan samba, Poonkar, Sorna masuri, Thuaiya malli samba, Thanga samba, Kullakar, Anaikomban had obtained high to intermediate GT and one variety *viz*., Illuppaipoo samba had obtained high GT (Table 2). Rice varieties with intermediate GT are preferred all over the world and high GT are the least preferred as the rice becomes excessively soft when overcooked, elongate less and remains undercooked under standard cooking procedure (Singh *et al*., 2000).

Gel consistency (mm)

The Gel consistency test was developed to screen cooked rice for its texture. The gel consistency of rice varieties studied varied between soft and medium (Table 2). Among the twelve traditional varieties, ten varieties namely Garudan samba (63 mm), Kullakar (76 mm), Poonkar (85 mm), Thanga samba (86 mm), Anaikomban (92 mm), Thulasi vasa samba (102 mm), Kuzhiadichan (123 mm), Sorna masuri (125 mm), Illuppaipoo samba (135 mm) exhibited soft gel consistency and two varieties namely Athur Kichili samba (46 mm) and Thuaiya malli samba (58 mm) exhibited medium gel consistency. Rice with soft gel consistency cooks more tenderly and remains soft whereas rice with hard gel consistency hardens faster after cooking (Oko *et al*., 2012).

Amylose

Amylose content is considered to be the major determinant of cooking, eating and pasting properties of a rice variety (Asghar *et al*., 2012). In the study, low amylose content was recorded in Thulasi vasa samba (13.3 %), Illuppaipoo samba (14.4 %), Kuzhiadichan (16.3 %), Milagu samba (17.4 %) and Athur kichili samba (18.5 %). Intermediate amylose content was observed in Anaikomban (20.1 %), Garudan samba (20.4 %), Poonkar (20.7 %) and Sorna masuri (23.2 %). High amylose content was recorded in Kullakar (25.2 %) and Thanga samba (27.1 %) (Table 3). Low amylose cultivars are soft and sticky on cooking while high amylose cultivars are hard and non-sticky. Intermediate amylose cultivars are soft and do not become sticky upon cooking, hence widely preferred by the consumers (Ali *et al*., 2015).

Protein

Protein deficiency is predominant in rice consuming population since rice contains less protein content of 6 to 8 % (Nandini, 2013). Preferring varieties with high protein content would definitely pay the way to increase in protein intake among the population. Protein content varied significantly among the traditional rice varieties (Table 3). The highest protein content of 10.40 % was recorded in Poonkar which was statistically on par with Milagu samba (9.70 %), Kullakar (9.54 %), Illuppaipoo samba (9.40 %) and Kuzhiadichan (9.13 %). The lowest protein content (6.16 %) was observed in Thuaiya malli samba.

Iron

Rice is a poor source of essential micronutrients particularly iron (Bouis and Welch, 2010). Identifying varieties containing higher amounts of bioavailable iron would improve iron nutrition in regions where iron deficiency is common. Among the varieties analyzed for iron content, the variety Thuaiya malli samba (15.8 mg kg^{-1}) registered significantly higher iron content than all other varieties (Table 3). It was followed by Thulasi vasa samba (13.7 mg kg^{-1}). Varieties Illuppaipoo samba (11.9 mg kg^{-1}), Anaikomban (10.9 mg kg^{-1}), Kullakar (10.7 mg kg^{-1}), Milagu samba (10.7 mg kg^{-1}), Thanga samba (10.3 mg kg^{-1}), Poonkar (9.0 mg kg^{-1}) also had higher iron content in the range of 9-11 mg kg^{-1}. Therefore, these traditional varieties must be given more attention by the rice breeders to use in their hybridization programmes.

Zinc

Zinc is an essential micronutrient that people need to stay healthy. It is crucial for immune system to work properly. Rice is the main source of zinc intake in Asian countries (Arsenault *et al*., 2010). Availability of adequate zinc in rice would help to maintain the health of the people. In the present study, varieties were screened for zinc content and found that it was ranged from 12 mg kg^{-1} to 20 mg kg^{-1} (Table 3). The highest zinc content of 20.5 mg kg^{-1} was recorded in Kullakar. It was on par with Anaikomban (20.3 mg kg^{-1}), Poonkar (19.7 mg kg^{-1}) and Thuaiya malli samba (19.3 mg kg^{-1}). The lowest zinc content (12 mg kg^{-1}) was noticed in Athur Kichili samba. Wide variation of zinc content among the rice varieties was also reported by Roy and Sharma (2014); Chitra *et al*. (2020).

Table 1. Seven-point scale to measure alkali spreading value and gelatinization temperature

S.No.	Alkali Spreading Value			Gelatinization Value	
	Nature of the kernel after treating with alkali solution	Interferance	Scale	Interferance	GT
1	Kernel not affected	Low	1	High	75-79
2	Kernel swollen	Low	2	High	75-79
3	Kernel swollen with collar incomplete and narrow	Low to intermediate	3	High to intermediate	70-74
4	Kernel swollen with collar complete and wide	Intermediate	4	Intermediate	70-74
5	Kernel split or segmented, collar complete and wide	Intermediate	5	Intermediate	70-74
6	Kernel dispersed, merging with collar	High	6	Low	65-69
7	Kernel completely dispersed and intermingled	High	7	Low	65-69

Table 2. Physicochemical and cooking characters of selected traditional rice varieties of Tamil Nadu

Treatments	Hulling (%)	Milling (%)	Head rice recovery (%)	Kernal length (mm)	Kernal breadth (mm)	L/B ratio (Raw rice)	Kernal length after cooking (mm)	Kernal breadth after cooking (mm)	Linear elongation ratio	Breadth wise elongation ratio	Volume expansion ratio	Gel consistency (mm)	Alkali spreading value	Gelatinization temperature
V_1 - Athur Kichili samba	85	79	55	5.6	2.0	2.80	8.5	2.6	1.52	1.30	4.1	46	3	High to intermediate
V_2 - Garudan samba	87	73	50	5.7	2.3	2.59	8.7	3.1	1.53	1.35	4.0	63	3	High to intermediate
V_3 - Illuppaipoo samba	89	76	53	5.7	1.9	3.00	9.3	2.6	1.63	1.37	4.3	135	2	High
V_4 - Milagu samba	87	79	70	4.2	1.4	3.00	7.4	3.1	1.76	2.21	4.1	100	4	Intermediate
V_5 - Poonkar	90	78	54	6.0	2.5	2.40	9.8	3.2	1.63	1.28	3.7	85	3	High to intermediate
V_6 - Sorna masuri	86	80	52	5.6	1.9	2.95	9.5	2.7	1.70	1.42	4.6	125	3	High to intermediate
V_7 - Thuaiya malli samba	85	80	55	5.7	1.9	3.00	9.5	2.7	1.67	1.42	4.4	58	3	High to intermediate
V_8 - Thanga samba	88	80	75	5.5	1.7	3.24	9.5	2.7	1.73	1.59	4.2	86	3	High to intermediate
V_9 - Kuzhiadichan	88	74	53	5.5	2.3	2.39	9.1	3.3	1.65	1.43	4.0	123	4	Intermediate
V_{10} - Kullakar	89	75	52	6.3	2.4	2.63	9.4	3.5	1.49	1.46	3.7	76	3	High to intermediate
V_{11} - Anaikomban	84	74	63	5.6	2.3	2.43	8.0	3.0	1.43	1.30	4.2	92	3	High to intermediate
V_{12} - Thulasi vasa samba	86	79	72	4.2	1.7	2.47	6.5	2.5	1.55	1.47	4.1	102	4	Intermediate
S Ed	2.28	0.69	2.85	0.13	0.10	0.11	0.08	0.06	0.05	0.06	0.16	6.35	0.44	
CD (0.05)	NS	1.44	5.92	0.27	0.20	0.24	0.17	0.12	0.10	0.12	0.32	13.16	0.92	

Table 3. Nutritional properties of selected traditional varieties of Tamil Nadu

Treatments	Amylose (%)	Protein (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})
V_1 - Athur Kichili samba	18.5	8.04	7.5	12.0
V_2 - Garudan samba	20.4	8.40	8.1	18.1
V_3 - Illuppaipoo samba	14.4	9.40	11.9	16.5
V_4 - Milagu samba	17.4	9.70	10.7	17.4
V_5 - Poonkar	20.7	10.40	9.0	19.7
V_6 - Sorna masuri	23.2	7.26	8.0	14.5
V_7 - Thuaiya malli samba	17.3	6.16	15.8	19.3
V_8 - Thanga samba	27.1	6.19	10.3	15.3
V_9 - Kuzhiadichan	16.3	9.13	8.1	16.3
V_{10} - Kullakar	25.2	9.54	10.7	20.5
V_{11} - Anaikomban	20.1	8.25	10.9	20.3
V_{12} - Thulasi vasa samba	13.3	7.99	13.7	17.6
S Ed	1.15	0.53	0.52	0.82
CD (0.05)	2.38	1.10	1.07	1.70

Conclusion

From the results, it is pertinent to note that the selected traditional rice varieties of Tamil Nadu exhibited physicochemical and cooking characters that meet consumer demands and preferences. Hence, these varieties can be further assessed in breeding programmes so that the cultivation of these heritage varieties can be enhanced, agro-biodiversity could be protected. The data obtained from this study will be useful for selecting parents/donors for biofortification related breeding programmes to alleviate malnutrition and to achieve nutritional security.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

This is entirely original work; any work or words of others have been appropriately cited.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There was no conflict of interest in the publication of this content.

Data availability

All the data of this manuscript is included in the MS. No separate external data source is required.

Author contributions

Research fund - ICAR-IIFSR, SM, Idea conceptualization - MS, SM, Experiment - GR, Guidance - MS, SM, Writing original draft - GR, Writing-reviewing &editing - SM, GR.

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