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Grain Nutritional Traits Analysis in Native Rice Landraces of Tamil Nadu

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ABSTRACT: Rice is an edible starchy cereal grain. Large part of the world population depends on rice for their daily carbohydrate needs. Locally cultivated rice landraces are excellent source for protein, fibre and ash. But nutritional studies in these landraces were abended in earlier days due to emphasis on developing high yielding new rice varieties and most of the landraces were long duration in nature (> 145 days) as compared to varieties (110 – 130 days).In this study an experiment was conducted to study the nutritional properties *viz.*, grain protein content, crude fibre and ash content in 60 native rice landraces. The standard methods developed by AOAC (2000) were followed in proximate analysis in rice grains. Analysis of variance and variability studies revealed that high variability between the genotypes for all three characters. High PCV, GCV and high heritability (h^2) coupled with high genetic advance as percentage of mean (GAM) indicates that these characters are more influenced by genetic makeup of individual genotype than environment. Hence, selection can be practiced for the improvement of these characters. Among 60 genotypes, grain protein content ranged between 6.95 % (Saysree) to 12.46 % (Norungan) with a mean value of 9.68 % in milled rice. Low protein content (<8.0%) was observed in 17 genotypes, sixteen genotypes exhibited moderate protein content (8-10%) and 27 genotypes registered high protein content (>10%). A significant difference was observed for crude fibre content in milled rice which ranged between 0.26% (Karuthakar) and 2.3% (Valan) with a mean fibre content of 0.93% was obtained. Among the landraces studied, highest ash content was registered in Revathi (1.51%) followed by Karuppu kavuni (1.47), Pome (1.42%). Genotype Sanga samba exhibited lowest ash content (0.50%) followed by Rasakadam (0.51%). The average ash content observed to be 0.95%.In this study genotypes Kattu vanipam, Poongar, Palkichadi, Karuppu Kavuni, Kaivara samba, Barma Kavuni, Lalmati and Sivappu malli registered high grain protein along with high crude fibre and ash content. The results generated by proximate analysis provide necessary information in identifying superior locally cultivated landraces, which can be used in future breeding programmes to develop varieties with high protein, fibre and ash content.

Keywords: Protein analysis, Fibre, Landraces, Ash content, Nutritional traits, Rice

INTRODUCTION

Rice brings life and helps to sustain two thirds of the world's population. Rice is one of the dominant crops among cereals grown around the world. Asia and South East Asia are the biggest rice producer, accounting for 90% of the world's production and consumption of rice (Cherie *et al.* 2019). It is considered as the main staple food for more than half of the world's population.

Rice research in the country has mainly focused on developing rice varieties with better yield and pest or disease resistance. Most of rice varieties developed has less grain protein and fibre content as compared to other cereals sorghum, oats and rye. The availability of high grain protein, fibre and ash content was exhibited by locally cultivated rice varieties. The state of Tami Nadu is one among the important biodiversity repositories of rice in the country. Brown rice has more grain protein, fibre and ash content than the milled rice and considered as more nutritious (Fernando, 2013). Presence of high fibre helps in absorption of digested food and high ash content indicates the presence of higher levels of mineral composition.

In previous studies nutritional analysis was mainly focused on developed varieties, this leads to deserting locally cultivating landraces. Hence, in this study importance is given to landraces. The availability of diversity for grain nutritional characters is higher in landraces, but most of the studies on local landraces have focused on their varietal characteristics. Not

much emphasis has been given to the nutritional qualities of these landraces except for a few specialty rice varieties *viz., Karuppu kavuni* and *Mappillai samba.* In this context, a study was undertaken to compare the nutritional composition of 60 different rice landraces cultivated in the state of Tamil Nadu and to reveal their potential towards nutritional enhancement.

MATERIALS AND METHODS

A. Plant materials

The experiment was conducted during *Kuruvai* 2020 (June to September) at Tamil Nadu Rice Research Institute, Aduthurai. The experiment includes 60 locally cultivated rice landraces grown all over Tamil Nadu (Table 1). Seedlings at 25 days old were transplanted in the main field with a spacing of 20×20 cm. All the recommended agronomic practices were followed. All the grain samples were harvested at physiological maturity stage and moisture content kept at optimum condition (10-12%). After four months, the grains of 60 genotypes were used for nutritional quality analysis in two replicates.

B. The proximate analysis

The grains of collected rice varieties were subjected to the proximate analysis of grain protein, crude fibre and ash content in duplicate with standard methods (AOAC. 2000). The grain protein content was determined following the micro Kjeldahl method using KELPLUS automatic nitrogen estimation System (Fig. 1). Percentage of nitrogen (N) was calculated using the following equation. Nitrogen (%) = {(S – B) × N × 0.014 × D× 100} × (weight of sample × V), Where D = Dilution factor, T = Titration value = (S – B), W = weight of sample, 0.014 = Constant value. Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25. Thus, crude protein (%) = % of N × 6.25.

Table 1: List of rice landraces used in the study.

Sr. No.	Genotypes	Location
1.	Adukan	Tamil Nadu
2.	Altera	Tamil Nadu
3.	Anai komban	Tamil Nadu
4.	Athira	Tamil Nadu
5.	Athur kichadi	Tamil Nadu
6.	Bhavani	Tamil Nadu
7.	Burma Kavuni	Tamil Nadu
8.	Chennellu	Tamil Nadu
9.	Chinkini Kar	Tamil Nadu
10.	Chithrai kar	Tamil Nadu
11.	Garudan samba	Tamil Nadu
12.	Kaivara samba	Tamil Nadu
13.	Kalanamak	Tamil Nadu
14.	Kandasali	Tamil Nadu
15.	Karuppu Kavuni	Tamil Nadu
16.	Karuthakar	Tamil Nadu
17.	Kattai kar	Tamil Nadu
18.	Kattu ponni	Tamil Nadu
19.	Kattu vannipam	Tamil Nadu
20.	Kavuni nel	Tamil Nadu
21.	Kichali samba	Tamil Nadu
22.	Kudavarghai	Tamil Nadu
23.	Kuttala Samba	Tamil Nadu
24.	Lalmati	Tamil Nadu
25.	Manda maranellu	Tamil Nadu
26.	Manjal ponni	Tamil Nadu
27.	Manvilayan	Tamil Nadu
28.	Mappillai samba	Tamil Nadu
29.	Melaki	Tamil Nadu
30.	Mysore malli	Tamil Nadu
31.	Nammahuar	Tamil Nadu
32.	Norungan	Tamil Nadu
33.	Ottadam	Tamil Nadu
34.	Palkichadi	Tamil Nadu
35.	Pome	Tamil Nadu
36.	Poongar	Tamil Nadu
37.	Rajalakshmi	Tamil Nadu
38.	Rajamannar	Tamil Nadu
39.	Rasakadam	Tamil Nadu
40.	Rathasaali	Tamil Nadu
41.	Revathi	Tamil Nadu
42.	Salem samba	Tamil Nadu
43.	Samba masanam	Tamil Nadu
44.	Sanga samba	Tamil Nadu
45.	Saysree	Tamil Nadu
46.	Sembalai	Tamil Nadu
47.	Sivappu Kavuni	Tamil Nadu
48.	Sivappu malli	Tamil Nadu
49.	Soora kuruvai	Tamil Nadu
50.	Sowttara samba	Tamil Nadu
51.	Sugandni samba	Tamil Nadu
52.	Thailand Kavuni	Tamil Nadu
53.	Thanga samba	Tamil Nadu
54.	Thengai poo samba	Tamil Nadu
55.	Thirupathisaram	Tamil Nadu
56.	Thodipaliyan	Tamil Nadu
57.	Uppu mulagai	Tamil Nadu
58.	Vaalan	Tamil Nadu
59.	Varppu kudachan	Tamil Nadu
60.	Vasura mundan	Tamil Nadu

Fig. 1. Crude protein analysis using KELPLUS distillation system.

The bulk of roughage in food is referred as the fibre and is called crude fibre. Crude fibre refers to the residue of a sample that is remaining insoluble after treating with dilute acid and alkali solutions. Milled sample was dried, defatted with ethanol acetone mixture and then the experiment was carried out using the standard method as described in AOAC (2000) method No. 32-10, sing FIBRA PLUS automatic fibre estimation System. During estimation process sample is subjected to acid (1.25% H_2SO_4) and alkali (1.25% NaOH) digestion. At the end of the process, we get ash as an end product. Thus, the difference in weight of the sample before and after ash gives the weight of crude fibre. The crude fibre can be calculated by using following formula, Crude fibre (%) = IW – FW / WS × 100. IW = Initial weight, FW = Final weight, WS = Weight of the sample.

The ash content was estimated by following the methodology developed by AOAC (2000) method No. 08-01.

The ash content in each rice flour sample was estimated by keeping samples in a muffle furnace at a temperature 550°C till white grey residue is obtained.

C. Statistical and variability analysis

Analysis of variance and variability studies were carried out to check the amount of variation and nature of traits present in the genotypes for protein, crude fibre and ash content. Variability analysis was done based on method suggested by Burton (1952) for calculation of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). Broad sense heritability (h^2) was calculated as per method suggested by Hanson *et al.* (1956). Similarly, method suggested by Johnson *et al.* (1955) was used for the calculation of genetic advance (GA). PCV, GCV, heritability and genetic advance were analysed using TNAUSTAT-Statistical package developed by Manivannan, (2014).

RESULTS AND DISCUSSION

Variability refers to the differences existing among the individuals of a population. It is due to the differences either in the genetic constitution of the individual plants or in the environment in which they are grown. The analysis of variance exhibited significant difference among 60 rice landraces for all three characters (Table 2). This suggested that there were inherent genetic differences among the genotypes.

The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) may provide an idea about the magnitude of variability. Moderate PCV and GCV observed for the grain protein content indicating that this trait is less affected by the environment (Table 3). Similar results were obtained by Shashidhara *et al.,* (2019) for grain protein content. High PCV and GCV observed in crude fibre and ash content indicates that these characters are under the influence of genetic control (Table 3). Hence, these characters can be relied upon and simple selection can be practiced for further improvement.

Heritability is a good index of the transmission of characters from parents to offspring (Falconer, 1960). Heritability along with genetic advance as percentage of mean (GAM) helps in effective selection of a particular trait. In this experiment all three characters *viz.*, grain protein content, crude fibre and ash content registered high heritability and high GAM (Table 3).

Table 2: Analysis of variance for nutritional properties.

SOURCE	Mean Sum of Squares		
	Protein (%)	Crude fibre (%)	Ash (%)
Replication	0.1009	0.0025	0.0007
Treatment	4.9158**	0.4943**	0.1767**
Error	0.0255	0.0007	0.0005
S.E.	0.1130	0.0190	0.0160
C.D.(1%)	0.4203	0.0706	0.0595
CV(%)	1.6554	2.8489	2.3597

*, ** Significance at 5 and 1 per cent level, respectively

Table 3: Variability analysis in landraces for nutritional properties.

Sr. No.	Mean	GV	PV	GCV	PCV	h^2	GA	GAM
Protein	9.6535	2.4451	2.4706	16.1981	16.2825	98.9663	3.2045	33.1952
Crude fibre	0.9424	0.2468	0.2475	52.7150	52.7919	99.7088	1.0219	108.4347
Ash	0.9580	0.0881	0.0886	30.9801	31.0698	99.4232	0.6096	63.6346

This indicates that the traits are under genetic control rather than environment and selection is effective for the improvement of these characters. The nutritional quality of rice depends on the protein content which is the most important character next to starch. Rice contributes 24.1% of dietary protein out of 207.9 grams of rice consumed per day per person (FAOSTAT, 2001). The rice protein is superior because of its unique composition of essential amino acids (Eggum, 1979). The results showed that most of the genotypes exhibited high protein content (>9 %) in milled rice. Protein content of all the landraces ranged between 6.95 % (Saysree) and 12.46 % (Norungan) with a mean value of 9.68 % in milled rice. Among the 60 rice landraces low protein content (<8.0%) was observed in 17 genotypes *viz.,* Saysree, Sugandni samba, Soora kuruvai, Nammahuar, Samba masanam, Pome, Revathi, Uppu mulagai, Thanga samba, Kudavarghai, Rathasaali, Manjal ponni, Thirupathisaram, Manvilayan, Mysore malli, Thengai poo samba and Sanga samba (Table 4). Sixteen landraces *viz.,* Rajamannar, Sowttara samba, Varppu kudachan, Manda maranellu, Valan, Kuttala samba, Adukan, Garudan Samba, Aanai komban, Kattai kar, Vasara mundan, Karuthakar, Kichali samba, Athur Kichadi, Chitrai Kar and Chinkini Kar exhibited moderate protein content (8-10%). Twenty seven genotypes *viz.,* Thailand Kavuni, Chennellu, Kalanamak, Salam samba, Ottadai, Sembalai, Kandasali, Sivappu malli, Kavuni Nel, Sivappu Kavuni, Lalmati, Athira, Bhavani, Rajalakshmi, Altera, Mappillai samba, Barma Kavuni, Melaki, Kattu ponni, Kaivara samba, Karuppu Kavuni, Palkichadi, Poongar, Rasakadam, Kattu vanipam, Thodipaliyan, Norugan registered high protein content (>10%) (Table 4). Similar classification of land races based on protein content was reported by (Aiyswaraya *et al.,* 2017). Studies on protein content in different Indian varieties by Cherie *et al.,* (2019) reported a range from 7.00 to 9.00%. These proteins in rice are very much essential as protein forms basic requirement in cell and tissue repair and development (Devi *et al.* 2015). In another study, Indigenous cultivars of the north eastern hill states of India exhibited high protein content which ranged from 6.14 to 12.07% (Premila Devi *et al.,* 2010). In this experiment higher variation of crude protein content was found in landraces as compared to protein content estimated in most diverse population (F_2) by Shashidhara *et al.,* (2019). This could be an important resource for further study in rice grain nutritional improvement.

Cereals are good source of fibre. Fibre in the food promotes the movement of material through our digestive system. Fibre in brown rice also helps in lower cholesterol, promotes fullness and avoids blood clots. The standard level of fibre present in milled rice is varied from 0.5% to 1.0 % (Oko and Onyekwere, 2010). Processing of paddy milling and parboiling decreases the crude fibre content (Khin Saw and Yee Than, 2019). Cooking rice has influence on the nutritional traits *viz.,* moisture, crude protein, fat, ash and crude fibre contents. Cooking has negative influences on the fibre content since the available fibre content was gradually reduced after cooking. The method of cooking has no significant effect of fibre content (Suman and Boora, 2015). In this study, crude fibre content in milled rice was ranged between 0.26 % (Kauthakar) and 2.3 % (Valan) with a mean fibre content of 0.93%. This range was higher than the range (0.22 to 0.95%) obtained by Devi *et al.,* (2015). In earlier studies, rice varieties developed in Ethiopia exhibited higher level of crude fibre content (1.5-3.3%) in milled rice grains (Cherie *et al.,* 2019). In comparative study of pigmented red rice and non pigmented white rice of Assam landraces showed that red grains exhibited slightly higher level of fibre content (0.90-1.67%) than white grains (0.62-1.43%) (Dasgupta *et al.,* 2018).

Ash is the inorganic residue remaining after the water and organic matter have been removed by heating, which provides a measure of the total amount of minerals within a food. The ash content in rice samples varies among the varieties/local cultivars and degree of milling. Generally, ash content in brown rice(1.20%) is lower than Sorghum (1.40%), oat (1.60%) and rye (1.50%) (USDA. 2016). Even ash content varies between rice hull (13-21%), brown rice (1.0-1.5%), milled rice (0.3-0.9%) and rice bran (6.60-9.90%) (Juliano and Tuano, 2019). Among the 60 rice landraces studied, highest ash content was registered in Revathi (1.51%) followed by Karuppu kavuni (1.47), Pome (1.42%). Genotype Sanga samba exhibited lowest ash content (0.50%) followed by Rasakadam (0.51%). The average ash content observed was 0.95%. The variation in ash content is due to genetic influence on the character. Most of the landraces under study registered with high ash content. Similarly in earlier studies it has been found that ash content in milled rice varieties of Ethiopia was higher (0.6-1.6%) (Cherie *et al.,* 2019). Pillai *et al.,* (2020) registered higher level of ash content (0.9-1.9%) in 13 local varieties of Kerala. In this experiment, ash content exhibited higher level of variability (0.5-1.5%) in the milled rice. Since, ash content and mineral content are mutually related, the genotypes with high ash content can be further used to analyse mineral composition.

Table 4: Nutritional properties of rice landraces used in this study.

Sl. No.	Genotypes	Protein content (%)	Crude fibre (%)	Ash (%)
1.	Aanai komban	9.75	1.18	1.10
2.	Adukan	9.60	0.73	0.96
3.	Altera	11.22	0.56	0.74
4.	Athira	10.98	0.81	0.86
5.	Athur Kichadi	9.87	0.59	0.80
6.	Barma Kavuni	11.34	1.63	1.30
7.	Bhavani	11.08	0.40	0.67
8.	Chennellu	10.23	1.14	1.15
9.	Chinkini Kar	10.00	1.12	1.19
10.	Chitrai Kar	10.00	0.52	0.84
11.	Garudan Samba	9.71	0.78	0.80
12.	Kaivara samba	11.59	0.89	0.70
13.	Kalanamak	10.25	0.70	0.88
14.	Kandasali	10.60	0.89	1.20
15.	Karuppu Kavuni	11.80	2.02	1.67
16.	Karuthakar	9.84	0.26	0.53
17.	Kattai kar	9.76	0.45	0.64
18.	Kattu ponni	11.59	0.47	0.54
19.	Kattu vanipam	12.00	1.21	1.38
20.	Kavuni Nel	10.81	1.84	1.34
21.	Kichali samba	9.85	0.70	0.70
22.	Kudavarghai	7.73	0.34	0.73
23.	Kuttala samba	9.50	1.32	1.09
24.	Lalmati	10.95	1.18	1.11
25.	Manda maranellu	8.96	0.73	0.88
26.	Manjal ponni	7.77	1.13	1.20
27.	Manvilayan	7.81	0.64	0.70
28.	Mappillai samba	11.28	0.71	0.81
29.	Melaki	11.37	0.71	0.75
30.	Mysore malli	7.85	0.73	0.67
31.	Nammahuar	7.35	0.52	0.70
32.	Norugan	12.46	0.46	0.59
33.	Ottadai	10.29	0.57	0.60
34.	Palkichadi	11.85	1.25	1.08
35.	Pome	7.44	1.91	1.42
36.	Poongar	11.92	0.81	0.89
37.	Rajalakshmi	11.15	0.31	0.53
38.	Rajamannar	8.17	0.4	0.60
39.	Rasakadam	12.00	0.47	0.51
40.	Rathasaali	7.74	0.65	0.75
41.	Revathi	7.58	2.26	1.51
42.	Salam samba	10.28	0.62	0.71
43.	Samba masanam	7.41	1.41	1.21
44.	Sanga samba	7.86	0.46	0.50
45.	Saysree	6.95	1.18	1.04
46.	Sembalai	10.41	0.69	0.70
47.	Sivappu Kavuni	10.93	1.26	1.23
48.	Sivappu malli	10.68	1.84	1.36
49.	Soora kuruvai	7.22	0.74	0.89
50.	Sowttara samba	8.24	1.10	1.20
51.	Sugandni samba	7.14	0.87	0.95
52.	Thailand Kavuni	10.06	1.49	1.29
53.	Thanga samba	7.69	0.81	1.20
54.	Thengai poo samba	7.86	1.36	1.32
55.	Thirupathisaram	7.80	0.88	1.02
56.	Thodipaliyan	12.03	0.32	0.82
57.	Uppu mulagai	7.66	1.58	1.38
58.	Valan	9.25	2.30	1.16
59.	Varppu kudachan	8.60	0.40	0.94
60.	Vasara mundan	9.84	0.97	1.30

CONCLUSION

The results obtained from this study suggested that nutritional characterization of 60 landraces based on grain protein content, crude fibre and ash content exhibited considerable variation among these genotypes. Grain protein and crude fibre content are the major concern as rice nutritional properties. Majority of the entries studied registered high grain protein, moderate fibre and moderate ash content. The genotypes Kattu vanipam, Poongar, Palkichadi, Karuppu Kavuni, Kaivara samba, Barma Kavuni, Lalmati and Sivappu malli registered high grain protein along with high crude fibre and ash content. Since, these genotypes exhibited superiority in all three characters they can be used in breeding programmes for the development of varieties with high nutritive values. The availability of nutritional information in case of locally cultivated landraces is minimum the results obtained in this study enriches the nutritional data base of landraces. This available information can also be utilized in further improving the nutritional strength of high yielding varieties.

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