Indian Journal of Traditional Knowledge
Vol. 15(2), April 2016, pp. 321-329

Indigenous knowledge of traditional landraces in rice (*Oryza sativa* L.) *in situ* conservation of Tamil Nadu, India

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Received 23 March 2015, revised 27 July 2015

Rice (*Oryza sativa* L.) is one of the important food crop and main source of nourishment for more than one half of the world population. Medicinal landraces like *Navara* is highly nutritive and are rich in minerals like potassium, sodium, calcium, micronutrients, *viz.* iron and zinc. The present investigation was carried out in the Department of Plant Breeding and Genetics at Agricultural College and Research Institute, Madurai during 2012–2014. High yielding released variety of Tamil Nadu used for standard check ADT 43 along with four different medicinal landraces of rice collected from different areas of Kerala and Tamil Nadu, *viz. Navara, Kavuni, Veeradangan* and *Kathanellu* were used. By improving the strain of these traditional medicinal rice varieties, scientists hope to make it stronger to withstand the onslaught of climate and ensure higher output.

Keywords: Indigenous land races, Medicinal properties, Indigenous conservation

IPC Int. Cl.[8]: A61K 36/00, A01, A01G 9/00, A01G 16/00, A23B, A01N 3/00

Rice is the life and the prince among cereals as this unique grain helps to sustain two thirds of the world's population. More than half of the world's population relies on it for its energy, fiber and antioxidant, vitamins and minerals essentials for life. In addition to being a stable and nutritive food, it has a medicinal value too, which was clearly recognized by the medicine systems centuries ago. The traditional rice varieties represents the gene pool for valuable traits and there is an urgent need for the collection of such varieties increasing erosion of the changing land use pattern and introduction of high yielding varieties rice. In India, the medicinal value of rice have been documented in the Charaka Samihita (700 BC) and the Samhita (400 BC) in the ailments such as diarrhea, vomiting, fever, chest pain, wounds and burns. India's production is 89.13 million ton with the productivity of 2130 kg/ha. *Laicha* rice of Chattisgarh and '*Navara*' rice of Kerala are the medicinal rice varieties that had been evidently treating diseases like chronic gastritis and peptic ulcer for a long time. The '*Bhat moori*' of Tamil Nadu which cures anemia and enhances blood circulation in women after child birth, contains folic acid which helps in the assimilation of dietary iron. *Parmai-sal* of West Bengal has special nutritive properties for strength, *Kabiraj-sal* of Orissa is fed to convalescing patients to quicken the recovery[1]. Considering that the highest antioxidant activity due to the presence of polyphenols in red rice than in white rice, red rice offer great hope for health conscious consumers. Loss of nutrients resulting from milling and polishing determines the amount of nutrients removed[2]. Against this backdrop, rice holds promise as a medicinal and health food. In the attempts are being under taken in all parts of rice growing countries to improve the productivity through high yielding varieties and hybrids to develop suitable nutritive varieties for targeted environments. Attempts were made to documents the knowledge on different aspects such as morphological, nutritive, biochemical and cooking qualities in traditional landraces of rice along with cultivated high yielding varieties of rice.

Materials and methods

An investigation was carried out in the Department of Plant Breeding and Genetics at Agricultural College and Research Institute, Madurai during 2012 – 2014 with 10 parents and 6 F_1 hybrids. Six high

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yielding released varieties of Tamil Nadu, *viz. ADT 39, ADT 43, ADT 45, ASD 16, TPS 4* and one IRRI variety *IR 72* were used as female parents and 4 indigenous traditional and nutritional landraces of rice collected from different areas of Tamil Nadu and Kerala, *viz. Veeradangan, Kavuni, Navara* and *Kathanellu* were used as male parents were raised in Randomized Block Design with three replication (Table 1). The indigenous rice varieties were collected from the farmer's field and direct interviews on the agricultural practices, and understanding nutritional and medicinal values of the varieties recorded. The various morphological, floral characteristics of all the collected varieties have been recorded with the name of the respective varieties of the tribal farmers of the respective places. Measurement of different physical, agronomic and morphological characteristics of these collected at different stages of growth was recorded. Seedling stage to up to harvest morphological descriptors of land races of rice presented as per the Standard Evaluation System (SES) descriptor suggested by IRRI[3] (Table 2; Figs. 1-5). Floral traits measured during flowering stage and during the time of harvest biochemical and grain quality characters analysed during harvested and threshed products. Six F_1 hybrids, *viz. IR 72 x Veeradangan, ADT 39 x Kavuni, ADT 45 x Kavuni, ADT 43 x Navara, ADT 16 x Navara* and *TPS 4 x Katha nellu* were analysed for single plant yield.

Results and discussion

The traditional rice varieties collected from the study area found to posses generally high nutritional value and some of them are medicinal important. Variation in plant height, floral traits kernel colour and grain size of the nutritionally valuable indigenous rice varieties were observed. The colour of the seed coat in indigenous rice varieties is red, deep red, brown and black. The deep red and long size of the varieties is more medicinal and high nutritive value according to the old age experience of the farmers of the tribal belt of Tamil Nadu and Kerala. Similar results were reported by[4]. This result was further conformed by during the present investigation of research work programme. Red and black rice are considered more nutritious and have been found to be rich in iron, zinc calcium, magnesium and minerals. Among the six F_1 hybrids studied, based on *per se* performance for single plant yield and number of productive tillers per plant. The results on mean performance of land races, cultivated rice varieties and F_1 hybrids studies.

Analysis of variance for biometrical, floral and nutritional characters revealed significant differences among the genotypes for characters studied indicating the existence of significant amount of variability for the characters. The mean values indicated considerable variation for all biometrical characters (Table 3). Modern rice cultivars have been developed through the hybridization of elite lines and subsequent selection for yield and quality traits, which resulted in a loss of useful genes to combat biotic and abiotic threats. Traditional rice varieties, or landraces, have a high level of genetic heterogeneity compared to modern cultivars[5]. Among the parents, *Kavuni* (112.40 days) was the late flowering and *TPS 4* (66.00 days) was the early flowering genotype. The parental genotypes, *TPS 4* (66.00 days), *Navara* (68.20 days), *Veeradangan* (75.40 days), *ADT 43*

Table 1—Details of parents

Sl. No.	Genotype	Pedigree / source	Duration (days)
		Female parents (Improved cultivars)	
1.	*IR 72*	IR 19661-9-2-3 x IR 15795-199-3-3 x IR 9129-209-2-2-2-1.	95-100
2.	*ADT 39*	*IR 8* x *IR 20*	120-125
3.	*ADT 45*	*IR 50* x *ADT 37*	105-115
4.	*ADT 43*	*IR 60* x *W Ponni*	110-115
5.	*ASD 16*	*ADT 31* x *CO 39*	115-120
6.	*TPS 4*	*TS 29* x *ASD 16*	110-115
		Male parents (Indigenous traditional land races)	
7.	*Veeradangan*	Orunooranvayal, Kanyakumari,Tamil Nadu	100-110
8.	*Kavuni*	Chettinadu,Tamil Nadu	125-135
9.	*Navara*	Palaghat, Kerala	90-100
10.	*Kathanellu*	Orunooranvayal, Kanyakumari, Tamil Nadu	105-115

Table 2—Descriptors of nutritive and medicinal landraces of rice

S.No.	Descriptors	Landraces			
		Veeradangan	*Kavuni*	*Navara*	*Kathanellu*
1.	Seed source	Orunooranvayal, Kanya kumari, Tamil Nadu	Chettinadu, Tamil Nadu	Wayanad, Kerala	Orunooranvayal, Kanya kumari, Tamil Nadu
2.	Country	India	India	India	India
3.	Variety group	Indica	Indica	Indica	Indica
4.	Seedling height (at 5 leaf stage) (cm)	27.85-30.54	30.34-35.15	28.00-30.10	27.50-31.00
5.	Leaf length(below the flag leaf) (cm)	40.45-45.00	58.34-60.20	48.25-52.50	43.75-47.85
6.	Leaf width(cm)	0.50-1.00	0.85-1.45	0.40-0.75	0.55-1.50
7.	Blade pubescence	Intermediate	Intermediate	Intermediate	Intermediate
8.	Blade colour	Green	Purple margin	Green	Green
9.	Basal leaf sheath colour	Green	Purple	Green	Green
10.	Flag leaf angle	30°-45°	45°	90°	30°
11.	Ligule length (cm)	0.80 - 1.20	1.80 - 2.35	1.00 -1.50	0.80 -1.00
12.	Ligule colour	Yellowish green	Purple	White	Yellowish green
13.	Ligule shape	Partially clefted	Fully clefted	Cleft	Half clefted
14.	Collar region	Green	Purple	Green	Green
15.	Auricle colour	Whitish	Pale green	Whitish	Whitish
16.	Days to 50% flowering	76	109	68	87
17.	Plant height (cm)	112.42	122.80	101.85	101.03
18.	Culm habit	Open	Semi erect	Open	Open
19.	Culm length	Short	Short-intermediate	Short	Short
20.	Culm number	24.62	23.35	24.48	12.66
21.	Culm angle	Erect	Erect	Erect	Erect
22.	Culm diameter (mm)	15.87-18.65	18.00-20.50	15.50-20.00	14.23-18.33
23.	Internode colour	Green	Green	Green	Green
24.	Panicle length (cm)	22.39	25.60	22.22	20.76
25.	Panicle type	Semi erect	Spreading	Erect	Erect
26.	Secondary branching	Sparse	Sparse	Sparse	Sparse
27.	Panicle exsertion	Well exserted	Well exserted	Moderately exserted	Moderately exserted
28.	Panicle axis	Slightly drooping	Droopy at maturity	Semi upright	Semi upright
29.	Panicle shattering	Low	Very low	Low	Low
30.	Panicle threshability	Intermediate	Difficult	Intermediate	Intermediate
31.	Awn	Absent	Absent	Absent	Absent
32.	Apiculous colour	Purple	Purple	Green	Green
33.	Stigma colour	Purple	Purple	Green	Green
34.	Lemma and palea colour	Brown furrows	Purple furrows	Black	Black
35.	Sterile lemma colour	Straw colour	Purple	Straw colour	Straw colour
36.	Sterile lemma length	Short	Short	Short	Short
37.	100 grain weight (gm)	2.55	2.31	2.23	2.34
38.	Kernel length (mm)	5.52	5.10	5.54	5.16
39.	Kernel width (mm)	2.63	5.10	5.54	5.16
40.	Seed coat colour	Brown	Purple	Brown	Brown
41.	Scent	Non scented	Non scented	Non scented	Non scented
42.	Maturity (days)	100-110	125-135	90-100	105-115
43.	Chlorophyll content (mg/gm)	0.89	1.23	1.39	0.91
44.	Single plant yield (gm)	35.46	27.94	25.80	35.15

Fig. 1—Morphological appearance of different landraces varieties of rice

Fig. 2—Different medicinal rice landraces used in cultivation

(75.80 days) and *ASD 16* (76.40 days) showed significantly lower values than the grand mean value. Among the hybrids, *ADT 39 x Kavuni* (109.68 days) was the late flowering and *ADT 43 x Navara* (69.72 days) was the early flowering. The hybrids, *ADT 43 x Navara* (69.72 days), *ASD 16 x Navara* (70.72 days) and *IR 72 x Veeradangan* (78.04 days) showed significantly lower values than the grand mean value. With regard to plant height among the parents, *Kavuni* was found to be the tallest (138.13 cm) and the *TPS 4* (74.96 cm) was the shortest. The parents, *TPS 4* (74.96 cm), *ADT 43* (85.18 cm), *IR 72* (85.65 cm), *Kathanellu* (87.97 cm),

Fig. 3—Panicles of rice landraces

Fig. 4—Seed coat dehusked rice variation of land races in rice

Fig. 5—Cooked rice of landraces

ADT 45 (92.28 cm) and *ASD 16* (94.80 cm) showed significantly lower values than the grand mean value. Maximum plant height among the F_1 hybrids was recorded by *ADT 39 x Kavuni* (122.95 cm) and minimum by *TPS 4 x Kathanellu* (85.82 cm). The two hybrids, *TPS 4 x Kathanellu* (85.82 cm) and *ASD 16 x*

Table 3—Mean performance of parents and F_1 hybrids for biometrical traits in rice

Source	Days to 50 % flowering	Plant height (cm)	Number of Productive tillers per plant	Panicle length (cm)	Number of filled grains per panicle	Hundred grain weight (gm)	Single plant yield (gm)
			Female parents				
IR 72	83.20	85.65*	13.00	23.39	118.10	2.31	32.99
ADT 39	96.00	98.32	14.60*	24.67	107.34	1.84	27.47
ADT 45	81.80	92.28*	12.20	23.76	124.70*	1.99	30.70
ADT 43	75.80*	85.18*	12.00	23.65	128.40*	1.96	29.22
ASD 16	76.40*	94.80*	12.40	23.88	114.32	2.64*	33.29
TPS 4	66.00*	74.96*	12.20	23.94	107.64	2.33	30.16
			Male parents				
Veeradangan	75.40*	112.79	15.20*	22.75	97.01	2.55*	35.46*
Kavuni	112.40	138.13	10.20	26.35*	121.98*	2.33	27.94
Navara	68.20*	97.01	11.40	22.53	101.52	2.23	25.80
Kathanellu	88.80	87.97*	13.60	23.48	113.24	2.34	35.15
			F_1 hybrids				
IR 72 x *Veeradangan*	78.04*	97.63	16.20*	24.90	112.22	2.69*	44.80*
ADT 39 x *Kavuni*	109.68	122.95	14.12*	24.75	127.00*	2.13	38.54*
ADT 45 x *Kavuni*	103.00	112.62	14.36*	27.60*	130.67*	2.18	39.09*
ADT 43 x *Navara*	69.72*	95.16	12.20	22.54	113.65	2.29	34.09
ASD 16 x *Navara*	70.72*	94.81*	15.04*	23.61	110.21	2.49*	33.71
TPS 4 x *Kathanellu*	81.08	85.82*	14.24*	23.58	109.65	2.35	34.81
Grand mean	83.52	98.51	13.31	24.09	114.89	2.29	33.33
SE	1.06	1.79	0.23	0.43	1.82	0.04	1.02
CD (5 %)	3.08	5.16	0.66	1.25	5.24	0.10	2.94

Navara (94.81 cm) registered significantly lower values than the grand mean value. The undesirable characters of these landraces were tall growing, late flowering and lodging type. Among the ten parents studied, *Kavuni* recorded the lowest number of productive tillers per plant (10.20) while *Veeradangan* (15.20) showed the highest number of productive tillers per plant. The female parent *ADT 39* (14.60) registered significantly higher values for this trait. In F_1 hybrids it ranged from 12.20 (*ADT 43 x Navara*) to 16.20 (*IR 72 x Veeradangan*). The hybrids, *viz. IR 72 x Veeradangan* (16.20), *ASD 16 x Navara* (15.04), *ADT 45 x Kavuni* (14.36), *TPS 4 x Kathanellu* (14.24) and *ADT 39 x Kavuni* (14.12) were found to be significant.

Among the male parents *Kavuni* (26.35 cm) had the longest panicle length and *Navara* (22.53 cm) had the shortest panicle length. None of the female parents showed significant values for panicle length. Among the F_1 hybrids *ADT 43 x Navara* (22.54 cm) had the lowest panicle length while *ADT 45 x Kavuni* (27.60 cm) was with highest panicle length. Among the 10 parents the highest mean value for number of filled grains per panicle was observed in *ADT 43* (128.40) and *Veeradangan* (97.01) recorded minimum number of filled grains per panicle. *ADT 43* (128.40) and *ADT 45* (124.70) exhibited significantly superior values for this trait. Among the hybrids, *ADT 45 x Kavuni* (130.67), *ADT 39 x Kavuni* (127.00) recorded significant values. Among the F_1 hybrids, highest number of filled grains per panicle was recorded by *ADT 45 x Kavuni* (130.67) and the lowest by *TPS 4 x Kathanellu* (109.65).

For the 100 grain weight, among the parents *ASD 16* registered the highest 100 grain weight (2.64 gm) while, *ADT 39* was found to be the low (1.84 gm). *ASD 16* (2.64 gm) and *Veeradangan* (2.55 gm) registered significantly higher values for this trait. Among the hybrids, the maximum hundred grain weight was recorded by *IR 72 x Veeradangan* (2.69 gm) and the minimum value by *ADT 39 x Kavuni* (2.13 gm). Among the F_1 hybrids, *IR 72 x Veeradangan* (2.69 gm) and *ASD 16 x Navara* (2.49 gm) have showed significance over their grand mean value (2.29 gm). Among the parents, *Veeradangan* was found to be high yielder (35.46 gm)

and *Navara* was the low yielder (25.80 gm). Among the parents, none of the female parents showed significant values for single plant yield. Among the F_1 hybrids maximum single plant yield was recorded in *IR 72 x Veeradangan* (44.80 gm) and minimum in *ASD 16 x Navara* (33.71 gm). Among the F_1 hybrids, *IR 72 x Veeradangan* (44.80 gm), *ADT 45 x Kavuni* (39.09 gm) and *ADT 39 x Kavuni* (38.54 gm) and showed significance over the grand mean value (33.33 gm). Overall mean performance when compared among hybrids for important yield characters and single plant yield and dwarf plant height and early flowering three hybrids, *viz. IR 72 x Veeradangan, ADT 39 x Kavuni* and *ADT 45 x Kavuni* were found to be the best.

The mean values indicated considerable variation for all floral traits under study revealing scope of development of more pollen shed in the surface of the stigma reliable good self pollination (Table 4). Among the ten parents studied, the highest mean values for anther length was observed in *Kavuni* (1.661 mm) and *IR 72* (1.317 mm) recorded minimum anther length. Among the female parent *TPS 4* recorded significant value of 1.472 mm. Among the hybrids, maximum anther length was recorded by *ADT 43 x Navara* (1.574 mm) and the minimum by *ASD16 x Navara* (1.368 mm). The hybrids, *ADT 43 x Navara* (1.574 mm) and *TPS 4 x Kathanellu* (1.447 mm) registered significantly higher values than the grand mean values. With regard to anther breadth, among the parents *IR 72* (0.396 mm) showed maximum anther breadth while *Veeradangan* (0.227 mm) showed minimum anther breadth. The parental genotypes, *IR 72* (0.396 mm), *ADT 45* (0.394 mm), *TPS 4* (0.369 mm) and *ASD 16* (0.368 mm) showed significantly higher values than the grand mean value. Considerable variation for the floral traits under study revealed the scope for more pollen shed on the surface of the stigma for good self pollination. The maximum anther length in male parents was recorded by *Kavuni* followed by *Kathanellu.* Increase in pollen quantity and pollen shedding which respectively depends on the anther length and breadth which enhance the percentage of cross pollination (or) self pollination as the case may be. This was in parallel with the findings of

Table 4—Mean performance of floral traits and pollen fertility in F_1 generation along with parents

Source	Anther length (mm)	Anther breadth (mm)	Stigma length (mm)	Stigma breadth (mm)	Style length (mm)	Style breadth (mm)	Ovary length (mm)	Ovary breadth (mm)	Pollen fertility (%)
Female parents									
IR 72	1.317	0.396*	0.594	0.175	0.356	0.072	0.678*	0.398*	92.29
ADT 39	1.324	0.273	0.623	0.241	0.848*	0.081	0.454	0.384*	94.96
ADT 45	1.355	0.394*	0.581	0.163	0.354	0.066	0.304	0.215	95.02
ADT 43	1.425	0.327	0.433	0.563*	0.516*	0.096	0.382	0.275	94.77
AST 16	1.372	0.368*	0.584	0.239	0.309	0.140*	0.526*	0.353*	93.08
TPS 4	1.472*	0.369*	0.705*	0.253	0.443	0.051	0.351	0.284	92.06
Male parents									
Veeradangan	1.434*	0.227	0.713*	0.152	0.387	0.060	0.627*	0.352*	93.18
Kavuni	1.661*	0.363	0.757*	0.194	0.554*	0.071	0.335	0.215	95.17
Navara	1.444*	0.304	0.573	0.027	0.417	0.066	0.335	0.350*	87.17
Kathanellu	1.484*	0.311	0.675	0.181	0.424	0.090	0.492	0.332*	94.09
F_1 hybrids									
IR 72 x *Veeradangan*	1.375	0.331	0.703*	0.171	0.465	0.075	0.449	0.386*	76.24
ADT 39 x *Kavuni*	1.404	0.299	0.929*	0.363*	0.599*	0.071	0.433	0.342*	94.20
ADT 45 x *Kavuni*	1.384	0.183	0.702*	0.129	0.532*	0.071	0.480	0.287	94.07
ADT 43 x *Navara*	1.574*	0.281	0.736*	0.203	0.532*	0.081	0.472	0.310	90.17
ASD 16 x *Navara*	1.368	0.301	0.654	0.243	0.554*	0.058	0.643*	0.323	87.12
TPS 4 x *Kathanellu*	1.447*	0.318	0.847*	0.113	0.335	0.076	0.355	0.243	92.14
Grand mean	1.427	0.315	0.676	0.213	0.477	0.077	0.457	0.316	92.86
SE	0.002	0.026	0.002	0.075	0.015	0.012	0.031	0.007	0.256
CD (5 %)	0.006	0.080	0.009	0.227	0.156	0.039	0.095	0.022	0.772

Mahalingam *et al*.[6]. The maximum anther breadth was recorded by *IR 72* followed by (1973) *ADT 45*. More anther length and breadth, high pollen fertility, indicate more pollen grain production which facilitate in high degree of self pollination there by increasing the number of filled grains per panicle. The similar findings were a reported by Virmani & Athwal[7]. Among the 10 parents studied, *Kavuni* (0.757 mm) recorded maximum stigma length while *ADT 43* (0.433 mm) recorded minimum stigma length. The parental genotypes, *Kavuni* (0.757 mm), *Veeradangan* (0.713 mm) and *TPS 4* (0.705 mm) showed significantly higher values than the grand mean. Among the hybrids, *ADT 39 x Kavuni* (0.929 mm) recorded maximum stigma length and *ASD 16 x Navara* (0.654 mm) recorded the minimum stigma length. Four F_1 hybrids, *TPS 4 x Kathanellu* (0.847 mm), *ADT 43 x Navara* (0.736 mm), *IR 72 x Veeradangan* (0.703 mm) and *ADT 45 x Kavuni* (0.702 mm) showed significantly higher values than the grand mean value.

Among the parents, *ADT 43* (0.563 mm) recorded maximum stigma breadth and *Navara* (0.027 mm) recorded minimum stigma breadth. None of the male parents showed significant values for stigma breadth. Among the hybrids, *ADT 39 x Kavuni* (0.363 mm) recorded maximum stigma breadth and *TPS 4 x Kathanellu* (0.113 mm) recorded the minimum stigma breadth. None of the hybrids showed significant values other than *ADT 39 x Kavuni*. Stigma of sufficiently larger size is known to facilitate better for effective self pollination. The hybrid *ADT 39 x Kavuni* registered maximum stigma length and *ADT 43* recorded the highest stigma breadth. Stigma of sufficiently large size is known to facilitate better exsertion and hence effective interception of air-borne pollen. Similar report reported by Sheeba *et al*. (2006)[8].

Among the parents *ADT 39* (0.848 mm) showed the maximum style length and *ASD 16* (0.309 mm) showed minimum style length. The parental genotypes, *ADT 43* (0.516) and *Kavuni* (0.554) showed significantly higher values than the grand mean value. F_1 hybrids ranged from 0.335 (*TPS 4 x Kathanellu*) to 0.559 mm (*ADT 39 x Kavuni*). Three hybrids, *viz. ASD 16 x Navara* (0.554 mm), *ADT 45 x Kavuni* (0.532 mm) and *ADT 43 x Navara* (0.532) were found to be significant. The style breadth ranged from 0.051 (*TPS 4*) to 0.140 mm (*ASD 16*) among the parental genotypes. Among the hybrids, it ranged from *ASD 16 x Navara* (0.058 mm) to *ADT 43 x Navara* (0.081 mm). None of the male parents and F_1 hybrids showed significant values for style breadth. Among the ten parents, *IR 72* (0.678 mm) recorded maximum and *ADT 45* (0.304) recorded the minimum ovary length. The parental genotype, *ASD 16* (0.526 mm) and *Veeradangan* (0.627 mm) recorded significantly higher value than the grand mean value. Among the hybrids, *ASD 16 x Navara* (0.643 mm) recorded maximum ovary length and *TPS 4 x Kathanellu* (0.355 mm) recorded lowest. None of the other hybrids showed significant values. Maximum ovary breadth among the parents was recorded by IR 72 (0.398 mm) and minimum by two parents, *viz. ADT 45* and *Kavuni* (0.215 mm). Six parents, *viz. IR 72* (0.398 mm), *ADT 39* (0.384 mm), *ASD* 16 (0.353 mm), *Veeradangan* (0.352 mm), *Navara* (0.350 mm) and *Kathanellu* (0.332 mm) showed significantly higher values. Two hybrids *IR 72 x Veeradangan* (0.386 mm) recorded maximum ovary breadth followed by *ADT 39 x Kavuni* (0.342 mm). Minimum was recorded by *TPS 4 x Kathanellu* (0.243 mm). The pollen fertility ranged from 87.17 (*Navara*) to 95.17 % (*Kavuni*) among the parental genotypes. Among the hybrids, the range was from 76.24 (*IR 72 x Veeradangan*) to *ADT 39 x Kavuni* (94.20) %. All the parents and F_1 hybrids showed high pollen fertility.

The mean values indicated considerable variation for all grain quality and nutritional traits (Table 5).The grain quality characters high hulling percentage (89.11) was exhibited by *IR 72* followed by *ADT 39* (89.10) and *TPS 4* (86.30). *ADT 43* recorded the lowest milling percentage of 64.09 whereas, *IR 72* recorded the highest milling percentage of 77.83 followed by *TPS 4* (76.30), *ADT 39* (74.71) and *Navara* (73.54). Among the 10 parents studied, *Navara* had the highest head rice recovery (68.13 %) and *ADT 39* recorded the minimum of 51.38 with the grand mean of 58.63 %. *IR 72* showed the highest kernel length (6.82 mm) followed by *ADT 45* (5.71 mm) and the lowest kernel length was noticed in *TPS 4* (4.96 mm). *Kathanellu* recorded the maximum kernel breadth of 2.81 mm and the minimum was in *IR 72* (2.01 mm). Significant kernel breadth was recorded in *Veeradangan* (2.63 mm), *TPS 4* (2.62 mm) and *Kavuni* (2.41 mm). *IR 72* recorded the highest kernel L/B ratio (3.39) and the lowest was noticed in *Kathanellu* (1.83).

Table 5—Mean performance of grain quality and nutritional traits in parents

Parents	HP (%)	MP (%)	HRR (%)	KL (mm)	KB (mm)	KLBR	KLAC (mm)	KBAC (mm)	LER	VER	ASV	AC (%)	Ca	(mg/ 100g)	Mg	(mg/ 100g)	Fe	(mg/ 100 g)	Zn	(mg/ g)
Female parents																				
IR 72	89.11*	77.83*	53.19	6.82*	2.01	3.39*	7.50	2.89*	1.10	5.29*	4.66*	21.10	6.61		68.02		0.57		1.36	
ADT 39	89.10*	74.71*	51.38	5.19	2.31	2.25	8.53*	2.90*	1.64*	4.79*	3.66	20.11	6.28		46.14		0.52		1.63	
ADT 45	81.90	66.07	54.67	5.71*	2.07	2.76*	8.52*	2.51	1.49*	4.21	3.66	22.32	7.12		48.12		0.51		0.91	
ADT 43	82.69	64.09	53.51	5.63	2.25	2.50*	6.59	2.70	1.17	4.32	4.33	21.79	6.03		64.33		0.63		1.26	
ASD 16	83.90	72.30	62.16*	5.38	2.02	2.66*	6.70	2.60	1.24	4.10	3.33	20.11	6.22		68.04		0.60		1.33	
TPS 4	86.30*	76.30*	61.82*	4.96	2.62*	1.89	7.57	2.80	1.52*	4.39	4.66*	20.52	6.28		56.11		0.56		1.34	
Male parents																				
Veeradangan	78.30	68.50	56.51	5.52	2.63*	2.09	6.41	2.71	1.16	4.59	3.66	25.09*	8.26*		120.27*		1.61*		2.73*	
Kavuni	79.90	70.10	63.15*	5.10	2.41*	2.11	6.20	2.49	1.21	3.40	4.33	27.19*	12.30*		118.04*		1.32*		2.79*	
Navara	82.35	73.54*	68.13*	5.54	2.36	2.35	6.30	2.90*	1.20	4.90*	3.66	20.12	7.10		92.93*		0.96*		1.68	
Kathanellu	83.14	72.39	61.82*	5.16	2.81*	1.83	6.20	3.00*	1.13	5.39*	3.33	24.59*	9.20*		131.59*		0.77		2.14*	
Grand mean	83.59	71.56	58.63	5.50	2.34	2.38	7.50	2.75	1.29	4.54	3.93	22.29	7.54		81.36		0.80		1.71	
SE	0.72	0.64	0.67	0.09	0.03	0.02	0.12	0.03	0.01	0.06	0.32	0.39	0.16		1.29		0.04		0.15	
CD (5 %)	2.17	1.91	2.01	0.27	0.11	0.08	0.38	0.12	0.05	0.19	0.97	1.18	0.31		3.85		0.13		0.48	

Kernel length after cooking was highest in *ADT 39* (8.53 mm) followed by *ADT 45* (8.52 mm) and lowest in *Kavuni* and *Kathanellu* (6.20 mm). Kernel breadth after cooking was highest in *Kathanellu* (3.00 mm) and lowest in *Kavuni* (2.49 mm). Linear elongation ratio was highest in *ADT 39* (1.64 mm) followed by *ADT 45* (1.49 mm) and lowest in *IR 72* (1.10 mm). Significant values were recorded by 3 parents, *viz. ADT 39* (1.64 mm), *ADT 45* (1.49 mm) and *TPS 4* (1.52 mm). Volume expansion ratio was highest in *Kathanellu* (5.39) and lowest in *Kavuni* (3.40). Significant values were recorded in *IR 72* (5.29), *Navara (*4.90) and *ADT 3*9 (4.79). High alkali spreading value was observed in *TPS 4* (4.66) and low in *ASD 16* and *Kathanellu* (3.33). Amylose content was high in *Kavuni* (27.19) and low in *ADT 39* and *ASD 16* (20.11). Significant amylose content was recorded in *Kavuni* (27.19), *Veeradangan* (25.09) and *Kathanellu* (24.59).

With regard to nutritional traits, calcium content was high in *Kavuni* (12.30 mg/100 gm) and low in *ADT 43* (6.03 mg/100 gm). *Veeradangan* (8.26 mg/100 gm) and *Kathanellu* (9.20 mg/100 gm) recorded significantly higher value for calcium content. Among the ten parents, the highest magnesium content was observed in *Kathanellu* (131.59 mg/100 gm) and *ADT 39* (46.14 mg/100 gm) recorded the minimum magnesium content. All the male parents, *viz. Kathanellu* (131.59 mg/100 gm), *Veeradangan* (120.27 mg/100 gm), *Kavuni* (118.04 mg/100 gm) and *Navara* (92.93 mg/ 100 gm) recorded significantly higher value for magnesium content. Iron content was highest (1.61 mg/100 gm) in *Veeradangan* and lowest in *ADT 45* (0.51 mg/100 gm). Three male parents, *viz. Veeradangan* (1.61 mg/100 gm), *Kavuni* (1.32 mg/100 gm) and *Navara* (0.96 mg/100 gm) have recorded significant iron content except *Kathanellu* (0.77 mg/100 gm). With regard to zinc content highest was recorded in *Kavuni* (2.79 mg/100 gm) and lowest in *ADT 45* (0.91 mg/100 gm).

The threat of rice landraces there is an urgent need to develop proper management plan at local regional level to provide good intensives to the farmers to cultivate traditional rice varieties and hybrids in their existing sustainable farming systems and managing *in situ* on farm conservations.

In-situ conservation of the landraces found in the biodiversity for protection of the culture, heritage and socioeconomic structure of the farmers' population of those important landraces in the places for countries. These may be used in hybridization programme to achieve desired segregants for good grain quality with higher yield for improvement for further breeding programme. These indigenous land rice having a lot of potential for various traits and could be used for further improvement for incorporating certain important and valuable traits.

Conclusion

India is home to number of rice varieties that have medicinal properties and that fit the description of a health food in terms of modern as well as olden concepts. There is an urgent need to conserve these varieties that are fast disappearing under the pressure of high yielding varieties. The use of rice genetic resources available at gene banks is an important strategy for incorporating genetic variability into rice breeding programs, which can potentially generate new cultivars with broadened genetic basis and allows new and useful allelic combinations. Crosses to broaden the genetic basis of rice also can promote the preservation of rare alleles that can be incorporated in elite germplasm. The landraces are specific to ecological niches with potential sources of valuable and rare genes and there is a great scope for transferring these genes. The present investigation provides the rice breeders for exploitation of landraces possessing one or more desirable characters mainly, aesthetic, nutritive and grain quality. The use of adapted rice landraces, as the primary source of variation into which desired characters present in modern cultivars are introgressed may be an effective strategy for producing cultivars adapted to difficult production environments. The need of the day is to aggressively market these varieties and promote them through greater public awareness about their importance, especially among the younger generation.

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