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CHARACTERIZATION OF LANDRACES FOR STRONG CULM TRAITS AND QUALITY PARAMETERS IN RICE (*Oryza sativa* L)

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ABSTRACT

The study focuses on the screening of traditional rice landraces to identify lines with robust culm traits and superior grain quality parameters. Thirty-four (*Oryza sativa* L.) landraces were obtained from farmers to analyse the physicochemical and culm traits along with three checks CO51, Habataki and Paiyur 1. Out of 34 landraces fifteen (*Oryza sativa* L.) genotypes along with three checks (Co 51, Paiyur 1, Habataki) were raised in three replications to analyse the culm traits. Twelve parameters of quality traits and 4 parameters of culm traits were evaluated based on standard protocal. Signiûcant variations ($p<0.05$) were found in all the traits evaluated. Substantial variation was evident in the mean expression for thousand grain weight (ranged from 8.88g to 32.7g) and kernel length breadth ratio (ranged from 1.7 to 3.5). Among the 34 genotypes Athur kichadi samba, Navarai, Poongar, Anaikomban, Mapillaisamba, Kullakar shows superior performance for kernel length before cooking, kernel breadth before cooking, kernel length after cooking, kernel breadth after cooking, linear elongation ratio and gelatinization temperature. The genotypes *viz.*, Athur kitchadi samba, Bhavani, Arubatham kuruvai exhibits higher mean values for thousand grain weight, grain length, grain breadth and grain length breadth ratio. Hence, based on the performance the genotypes Athur kitchadi samba, Anaikomban, Kullakar, Poongar, Mapillaisamba showed high mean performance for thousand grain weight and most of the traits studied. Fifteen genotypes were analysed for four culm traits *viz.*, Culm length, Number of internodes, Internode length and Culm thickness, two genotypes Poongar and Mapillaisamba shows highest values for all the culm traits studied. Among 34 landraces, Poongar and Mapillaisamba shows superior performance in both culm and quality traits. Consequently, these two genotypes can be utilized in breeding programme for further improvement of quality and culm traits.

Key words : Rice, Culm traits, Quality traits, Mean performane.

Introduction

Rice (*Oryza sativa* L) is life. Rice is the staple food of over half the world's population and it is probably the world's most diverse cereal crop. Rice is the predominant dietary energy source in Asia and the Pacific, North and South America and Africa. Rice provides 20% of the world's dietary energy supply. Increasing grain yield is important to meet the global demand for major crops, which is expected to increase at least until 2050 (Ray *et al*., 2013). In the 1960s, as a result of semi-dwarf 1 (*sd1*) gene being introduced into rice, plant height was reduced, and since then, lodging-resistant varieties have been developed and are widely used. It has also been suggested that semi-dwarf varieties have reduced culm strength and plant biomass compared to the original variety.

Lodging can affect grain yield and quality in cereal crops including rice (*Oryza sativa* L). To achieve both high biomass production and lodging resistance, the breeding of new cultivars with strong culms is a promising strategy. However, a little is known about the diversity of culm strength in temperate japonica rice and underlying genetic factors.

The preference, choice and the economy of rice (*Oryza sativa* L.), largely depend on its physicochemical and cooking properties, which are found to be superior for landraces than modern varieties (Pokhrel *et al*., 2020).

Therefore, breeding for quality has to be emphasized together to combine all factors and to bring out fine grains rice fetching optimum price, which will be easily within the reach to the rural consumers. The quality rice is decided by its high milling, good appearance, cooking, nutrition and organoleptic traits (Pushpa *et al*., 2019), which are the most important component for the Asian customers who mainly consume rice. Cooking and organoleptic qualities are known to be directly related with some physicochemical properties of endosperm such as amylose content, protein content and pasting viscosity.

The landraces or germplasm are valuable as they possess a huge treasure of genetic material, which is the base for future variety development programmes. In agriculture system the importance of landraces can never be denied because improvement in existing variety depends upon desirable genes which are possibly present in landraces and wild varieties (Holden *et al*., 1993).

Materials and Methods

The experimental plant material utilized for the study were collected from local organic farmers of Dharmapuri and Krishnagiri district of Tamil Nadu. The details of landraces collected are provided in the Table 1. The experiment was conducted in the division of Genetics and Plant Breeding, Adhiyamaan College of Agriculture and Research, Hosur, Tamil Nadu. A total of 34 landraces along with 3 checks used for physiochemical traits and out of 34 landraces 15 landraces with 3 checks were used for culm traits. The crop was planted in a Randomized Block Design (RBD) with three replications. The recommended agronomic practices and plant protection measures were carried out. The observations were recorded from five randomly selected plants from each replication. Twelve parameters of quality traits *viz*., thousand grain weight, grain length, grain breadth, grain length breadth ratio, kernel length before cooking, kernel breadth before cooking, kernel length after cooking, kernel breadth after cooking, length breadth ratio after cooking, linear elongation ratio, breadth wise expansion ratio, gelatinization temperature were observed based on standard evaluation system (IRRI, 1996). Gelatinization temperature (GT) was assessed indirectly as the alkali spreading value (ASV) of hulled kernels as per the modified procedure. Physical grain quality parameters were measured using a Vernier caliper. Four parameters of culm traits *viz*., culm length, number of internodes, internode length and culm thickness were observed based on standard evaluation system.

Statistical analysis

The mean values of the quality traits and culm traits were subjected to analysis for analysis of variance and mean performance of genotypes.

Results and Discussion

Analysis of variance

To understand the extent of genetic variation in the accessions, the analysis of variance for 34 landraces and

Table 1 : List of landraces used for the study.

	Landraces for physicochemical traits				Landraces for culm traits
1	Thuyamalli	20	Kuliyadichan	1	Kaalabaath
2	Savulusamba	21	Pokkirisamba	2	Mappillai samba
3	Mysore malli	22	Melagusamba	3	Attur kichidi samba
4	Thirunelveli kichidi	23	Karunguruvai	4	Salem sannam
5	Kullakar	24	Arubatham kuruvai	5	Pokkirisamba
6	Sorna masoori	25	Vaikarai samba	6	Karudan samba
7	Bhavani	26	Pichaavarai	7	Karunguruvi
8	Navarai	27	Karunguruvi	8	Chinnar
9	Attur kichidi samba	28	Karudan samba	9	Kuliyadichan
10	Manavari kar nel	29	Madumuzhungi	10	Poongar
11	Kalludayan	30	Mappillai samba	11	Arubatham kuruvai
12	Senguruvi	31	Rathasaali	12	Kaalanamak
13	Poongar	32	Kaalabaath	13	Mysore malli
14	Karuppukavuni	33	Kallurundai	14	Thulasivasanai seeraga samba
15	Anaikombar	34	Kaalanamak	15	Sorna masoori
16	Thulasivasanai seeraga samba	35	CO-51	16	CO-51
17	Rathinakudi	36	Paiyur 1	17	Paiyur 1
18	Ottadayan	37	Habataki	18	Habataki
19	Salem sannam				

Table 2 : Analysis of variance.

Source	Df	TGW	GL	GW	GLBR	KLBC	KBBC	KLAC	KBAC	KLBR	LER	BER	GT
Treatment	179	2867.94*	59.89*	7.38*	14.58*	34.47*	10.04*	30.30*	7.97*	13.62*	0.48*	0.89*	93.63*
Error	358	160.74	2.69	0.98	1.904	1.686	1.039	4.72	1.48	3.28	0.08	0.97	1.61

*Significant at 5% level.

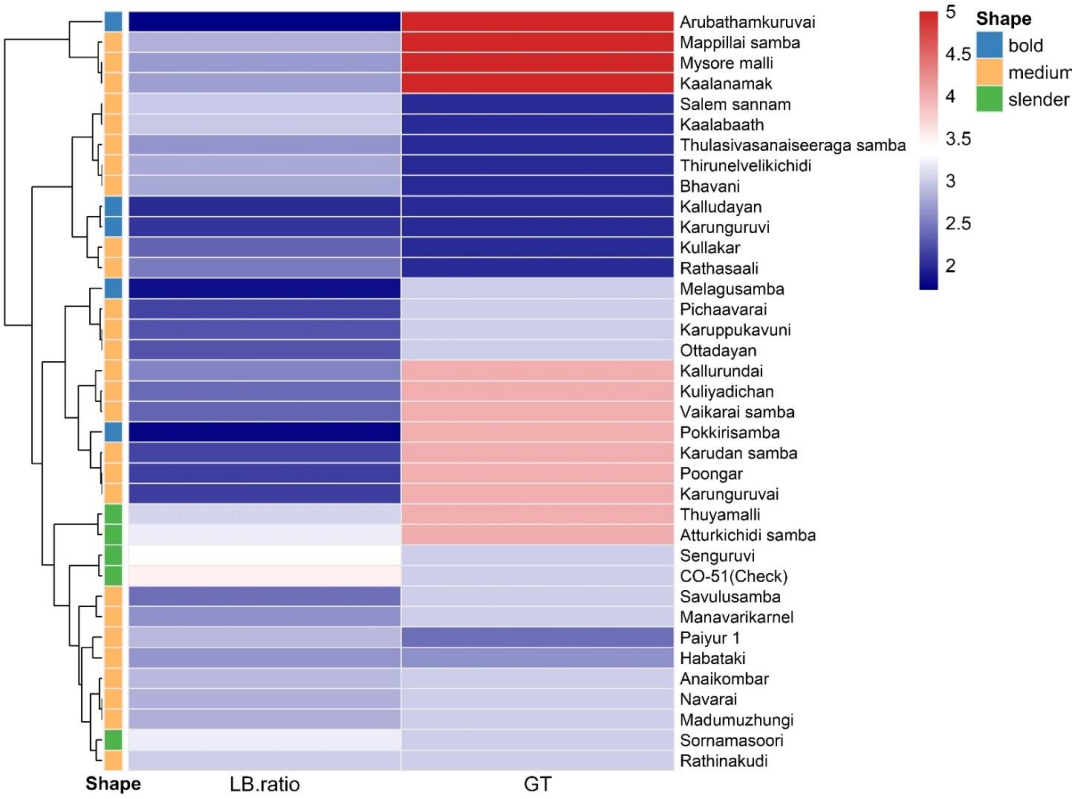

Fig. 1 : Cluster heatmap for categorization of Rice landraces.

three check varieties was computed for 12 physio chemical characters. The analysis of variance revealed significant differences for all the characters under study which indicated the existence of adequate variability among the accessions to improve different characters including thousand grain weight and kernel length breadth ratio. A significant difference for thousand grain weight and linear elongation ratio has been reported by Himanshu Ekka *et al. (*2016).

The data recorded on five randomly selected plants in each accession. The mean values were subjected to statistical analysis as per Federer (1977) was recorded in order to assess the variability among the landraces.

Mean performance of genotypes for physio chemical traits

The mean performance 35 landraces with respect to 12 quality traits were presented in Table 2. The *per se* performance of thousand grain weight ranged from 8.88g (Thulasi vasanai seeraga samba) to 32.7g (Senguruvi), 19 genotypes were shown significantly greater values than the mean of 20.70g. The mean performance of grain length had the range from 5.25mm (Pokkiri samba) to 8.95mm (Bavani), 18 genotypes were found to have significantly greater values than grand mean of 7.60mm. The recorded grain breadth ranged from 2.0 mm (Thusalivasanai seeraga samba) to 3.15mm (Karuppu kavuni), 14 genotypes were found to be significantly greater values than grand mean. The trait length breadth ratio had the range from 1.7 (Pokkiri samba) to 3.5 (Bavani), 13 genotypes were found to have significantly greater values than grand mean 2.58. The trait Kernel length before cooking had the range from 3.61mm (Pokkiri samba) to 6.56mm (Navarai), 22 genotypes were found to have significantly greater values than grand mean 5.676. The trait Kernel breadth before cooking had the range from 1.54mm (Kalabath) to 2.98 mm (Kalludaiyan), 17 genotypes were found to have significantly greater values than grand mean 2.23. The trait Kernel length after cooking had the range from 4.10mm (Pokkiri samba) to 7.25mm (Navarai and Maanavari Kar Nel), 17 genotypes were found to have significantly greater values

Table 3 : Mean performance for physiochemical traits.

Genotypes	TGW	GL	GB	GLBR	KLBC	KBBC	KLAC	KBAC	LBR AC	LER	BER	GT
Thuyamalli	15.49	7.95*	2.55*	3.11*	6.1*	2*	7.65*	2.52	3.04	1.25	1.26	4*
Savulusamba	22.67*	8,00*.	2.95	2.71	5.45	2.25	6.45	2.15*	3.00	1.18	0.95*	3
Mysore malli	18.34	7.38	2.69	2.74	5.37	2*	6.85	2.45	2.80	1.27*	1.22	6*
Thirunelveli kichidi	16.55	7.37	2.07*	3.56*	5.38	1.93*	7.05	2.45	2.88	1.31*	1.26	3
Kullakar	22.91*	8.34*	2.78	3.00*	5.95*	2.52	7.45*	2.11*	3.53*	1.25	0.83*	3
Sorna masoori	15.38	7.75	2.40*	3.22*	6.13*	1.91*	7.15	1.92*	3.72*	1.17	1*	3
Bhavani	23.72*	8.95*	2.5*	3.58*	6.52*	2.33	7.6*	2*	3.8*	1.17	0.85*	3
Navarai	21.42	6.70	2.4*	2.79	6.565*	2.25	7.25*	2.2*	3.29*	1.10	1*	4*
Attur kichidi samba	16.22	8.05*	2.55*	3.15*	5.74	1.79*	7.55*	2.1*	3.59*	1.31*	1.17	4*
Manavari kar nel	22.93*	8.15*	2.95	2.76	5.78	2.20	7.25*	2.45	2.96	1.25	1.11	3
Kalludayan	25.09*	7.75	3.00	2.58	5.95*	2.98	7.05	2.50	2.82	1.18	0.83*	2
Senguruvi	32.75*	6.25	2.4*	2.60	5.95*	1.75*	7.85*	2.2*	3.56*	1.31*	1.25	3
Poongar	25.08*	7.97*	3.07	2.60	5.98*	2.82	7.05	2.78	2.54	1.18	1.01*	4*
Karuppukavuni	24.30*	8.9*	3.15	2.83	6.52*	2.90	8.25*	2.90	2.84	1.26*	1*	3
Anaikombar	24.69*	7.9*	2.90	2.72	5.9*	2.045*	7.75*	2.40	3.22*	1.31*	1.17	4*
Thulasivasanai seeraga samba	8.89	5.74	2*	2.87	4.27	1.6*	5.90	1.91*	3.09	1.38*	1.19	3
Rathinakudi	15.14	7.84*	2.31*	3.39*	5.82*	1.93*	7.45*	2.2*	3.39	1.28*	1.13	4*
Ottadayan	21.71*	7.50	2.95	2.54	5.95*	2.65	7.7*	2.75	2.80	1.29*	1.03*	4*
Salem sannam	16.69	7.95*	2.55*	3.11*	5.42	1.81*	6.70	1.9*	3.52*	1.24	1.03*	3
Kuliyadichan	30.21*	8.57*	3.33	2.57	6.05*	2.65	7.8*	2.95	2.64	1.28*	1.19	5*
Pokkirisamba	12.72	5.25	2.90	1.81	3.61	2.04*	5.10	2.65	1.92	1.41*	1.19	4*
Melagusamba	16.17	5.90	2.70	2.19	4.10	2.25	5.65	2.85	1.98	1.37*	1.29	3
Karunguruvai	21.11	7.39	2.82	2.62	5.32	2.51	6.95	2.80	2.48	1.30*	1.11	4*
Arubatham kuruvai	23.06*	8.00*	3.15	2.54	4.45	2.60	7.2*	2.50	2.88	1.61*	0.99*	5*
Vaikarai samba	29.68*	8.65*	2.85	3.03*	6.37*	2.73	7.00	2.45	2.86	1.10	0.89*	5*
Pichaavarai	21.94*	7.75	2.80	2.77	5.94*	2.73	7.00	2.35	2.98	1.18	0.86*	4*
Karunguruvi	23.31*	7.69	3.13	2.46	5.64	2.73	6.95	2.80	2.48	1.23	1.02*	3
Karudan samba	23.07*	5.84	2.65*	2.20	5.84*	2.25	6.80	2.15*	3.16	1.16	0.98*	4*
Madumuzhungi	26.21*	8.5*	3.10	2.74	6.17*	2.20	7.7*	2.65	2.91	1.25	1.20	4*
Mappillai samba	23.91*	8.55*	2.90	2.94*	6.19*	2.25	8*	2.75	2.91	1.29	1.22	5*
Rathasaali	13.84	6.78	2.74	2.47	5.22	2.09*	6.15	1.9*	3.23*	1.18	0.9*	3
Kaalabaath	11.69	6.43	2.33*	2.76	4.58	1.54*	5.95	1.9*	3.13*	1.30	1.23	2
Kallurundai	25.86*	8.60*	3.10	2.77	5.88*	2.29	7.05	2.50	2.82	1.20	1.09	4*
Kaalanamak	19.53	8.50*	2.70	3.14*	6.27*	2.31	7.25*	2.03*	3.57*	1.16	0.87*	5*
CO-51	17.64	7.55	2.58*	2.92*	6.33*	1.8*	7.9*	1.85*	4.27*	1.25	1.02*	3
Paiyur 1	17.22	7.65	2.25*	3.4*	5.52	1.91*	6.75	2.02*	3.34*	1.22	1.05*	3
Habataki	19.25	7.52	2.98	2.52	5.82*	2.20	6.65	2.25*	2.96	1.14	1.05*	3

Table 3 continued...

Table 3 continued...

Grand mean	16.29	6.96	2.94	2.59	5.06	2.48	6.61	2.62	2.80	1.20	1.19	3
SD	5.31	0.93	0.31	0.44	0.69	0.37	0.68	0.33	0.43	0.08	0.14	1
SEM	0.87	0.15	0.05	0.07	0.11	0.06	0.11	0.05	0.07	0.01	0.02	0

** Significant at 0.01%

TGW	Thousand grain weight (g)	KLBC	Kernel length before cooking	KLBR	Kernel length breadth ratio
GL	Grain length (mm)	KBBC	Kernel breadth before cooking	LER	Linear Elongation ratio
GB	Grain breadth(mm)	KLAC	Kernel length after cooking	BER	Breadth expansion ratio
GLBR	Grain length breadth ratio	KBAC	Kernel breadth after cooking	GT	Gelatinisation temperature

Table 4 : Mean performance for culm traits.

S. no.	Genotypes	Culm length`	No. of internodes	Internode length	Culm thickness
1	Madumulugi	24*	1	1.66*	12
2	Aanaikomban	22.16*	1.66	2.23*	11.66
3	Maapilai samba	24.16*	1.33	1.83*	13.67*
4	Sornamasuri	22.33*	2.33*	0.96	13.66*
5	Thooyamalli	19.6	2*	2.25*	15.5*
6	Bavani	23.5	2*	0.43	12.67
7	Poongar	27.25*	3*	2.25*	15
8	Mysore malli	18.34	2.33*	1.83*	10.67
9	Salem sannam	20	2*	0.7	13.67*
10	Karunkuruvai	21.16	3*	1.46	8.93
11	Thirunelveli kichadi	21.67	1.67	0.93	12.33
12	Karunkuruvi	22.33*	2.33*	3*	17.33*
13	Kaalabath	22.4*	1.66	0.83	11
14	Karuppu kavuni	18.83	1.3	1.07	11
15	Vaikarai samba	22.6*	1.6	1.43	11
	Grand total	330.35	29.33333	22.9	190.1
	Grand mean	22.02	1.95	1.52	12.67

than grand mean 6.07mm. The trait Kernel breadth after cooking had the range from 1.85 mm (CO51) to 2.95 mm (kuliyadichan). A grand mean of 2.36 mm was observed and a total of 17 genotypes had lower kernel breadth after cooking than the grand mean. The trait LB ratio after cooking had the range from 1.54 (Pokkiri samba) to 3.72 (Sorna moosori),13 genotypes were found to have significantly greater values than grand mean 2.631. The trait Linear Elongation Ratio had the range from 0.94 (Navarai) to 1.39 (Thulasi vasanai seeraga samba), 14 genotypes were found to have significantly greater values than grand mean 1.07. The breadth wise expansion ratio had the range from 0.83 (Kullakar and Kalludaiyan) to 1.29 (milagu samba), 20 Genotypes shows low breadth wise expansion ratio than the grand mean 1.06. The trait Gelatinization temperature had the range from 2.00 (Kalludaiyan and Kaalabath) to 5.00 (Mysore malli), 19 were found to have significantly greater values than grand mean 3.00. The studies on mean performance of landraces revealed that the landraces *viz*., Athur kitchadi samba, Bhavani, Arubatham kuruvai exhibits higher mean values for Thousand grain weight, Grain length, Grain breadth and Grain length breadth ratio. Hence, based on the per se performance, the genotypes Athur kitchadi samba, Anaikomban, Kullakar, Poongar, Mapillaisamba showed high mean performance for Thousand grain weight and most of the traits studied. These genotypes can be utilized in breeding programme for further improvement of quality traits.

Mean performance of genotypes for culm traits

The mean performance of 15 landraces and three checks *viz*., CO 51, Paiyur 1 and Habataki were evaluated. Various culm traits were observed and the results are presented in Table 3. The Culm length value varied from 18.83cm (Karuppukavuni) to 27.25cm (Poongar), 9 genotypes showed higher length than the mean 22.02 cm. Number of internodes value varied from 1 to 3 with a mean value of 2. The trait Culm thickness ranged from 0.83 (Kaalabath) to 3.00 (Karunkuruvi), Seven genotypes showed higher culm thickness than the mean value 1.52 mm. The trait Internode length ranged from 8.92 (Karunkuruvai) to 17.33 (Karunkuruvi). Six genotypes showed higher than the mean value of 12.67 cm**.** From the study it has been disclosed that two landraces Poongar and Mapillaisamba shows highest values for all the culm traits studied.

Categorization of landraces based on Kernel length breath ratio and Gelatinisation temperature

Gelatinization temperature (GT) refers to the range of temperature within which starch granules start swelling irreversibly in hot water.GT determines the time taken to cook the rice and it affects the water uptake, volume expansion and linear kernel elongation (Prasad *et al*., 2021). The pasting temperature provides an indication of

Table 5 : Categorization of landraces based on Grain length breadth ratio and Gelatinization temperature.

S. no.	Genotypes	LB ratio		Gelatinization temperature	
		Mean	Categories	Mean	Category
1	**Thuyamalli**	**3.05**	**slender**	4	Intermediate
2	**Savulusamba**	**2.42**	**medium**	**3**	**Low to Intermediate**
3	Mysore malli	2.68	medium	5	High
4	Thirunelvelikichidi	2.78	medium	2	Low
5	Kullakar	2.36	medium	2	Low
6	**Sornamasoori**	**3.2**	**slender**	**3**	**Low to Intermediate**
7	Bhavani	2.79	medium	2	Low
8	**Navarai**	**2.8**	**medium**	**3**	**Low to Intermediate**
9	**Atturkichidi samba**	**3.2**	**slender**	4	Intermediate
10	**Manavarikarnel**	**2.62**	**medium**	**3**	**Low to Intermediate**
11	Kalludayan	1.99	bold	2	Low
12	**Senguruvi**	**3.4**	**slender**	**3**	**Low to Intermediate**
13	**Poongar**	**2.12**	**medium**	**4**	**Intermediate**
14	**Karuppukavuni**	**2.24**	**medium**	**3**	**Low to Intermediate**
15	**Anaikombar**	**2.89**	**medium**	**3**	**Low to Intermediate**
16	Thulasivasanaiseeraga samba	2.66	medium	2	Low
17	**Rathinakudi**	**3**	**medium**	**3**	**Low to Intermediate**
18	**Ottadayan**	**2.24**	**medium**	**3**	**Low to Intermediate**
19	Salem sannam	2.99	medium	2	Low
20	**Kuliyadichan**	**2.38**	**medium**	**4**	**Intermediate**
21	Pokkirisamba	1.76	bold	4	Intermediate
22	Melagusamba	1.82	bold	3	Low to Intermediate
23	**Karunguruvai**	**2.11**	**medium**	**4**	**Intermediate**
24	Arubathamkuruvai	1.71	bold	5	Intermediate
25	**Vaikarai samba**	**2.34**	**medium**	**4**	**Intermediate**
26	**Pichaavarai**	**2.17**	**medium**	**3**	**Low to Intermediate**
27	Karunguruvi	2.06	bold	2	Low
28	**Karudan samba**	**2.16**	**medium**	**4**	**Intermediate**
29	**Madumuzhungi**	**2.8**	**medium**	**3**	**Low to Intermediate**
30	**Mappillai samba**	**2.81**	**medium**	**5**	**Intermediate**
31	Rathasaali	2.49	medium	2	Low
32	Kaalabaath	2.97	medium	2	Low
33	**Kallurundai**	**2.56**	**medium**	**4**	**Intermediate**
34	**Kaalanamak**	**2.71**	**medium**	**5**	**Intermediate**
35	**CO-51(Check)**	**3.51**	**slender**	**3**	**Low to Intermediate**
36	Paiyur 1	2.89	medium	2.42	Low
37	**Habataki**	**2.64**	**medium**	**2.61**	**Low to Intermediate**

the minimum temperature required to cooking for a given rice sample. Environmental conditions such as high ambient temperature during grain ripening often leads to starch with higher GT (Chemutai *et al*., 2016).

The accessions studied for quality traits has been categorised based on kernel length breadth ratio and gelatinization temperature. Out of 34 landraces and three checks the landrace mysore malli exhibits medium kernel length breadth ratio and high gelatinization temperature, due to its high GT the grain tends to remain intact after cooking. Seven landraces come under the category medium grain with low GT and two landraces *viz*., kalludayan, karunguruvi shows bold grain and low GT, hence these genotypes took more time to cook. The two landraces thuyamalli and attur kichadi samba shows

slender grain with intermediate GT, these two landraces are suitable for cooking. Out of 34 landraces 8 landraces *viz*., poongar, kuliyadichan, karunguruvai, vaikaraisamba, karudansamba, mapillaisamba, kallurundai, kaalamanak and two checks paiyur 1, habataki comes under the category on medium slender grain with intermediate GT and the variety CO 51 comes under slender grain with intermediate GT (Fig. 1), these genotypes took lower time to cook and also the grain type is preferable, which can be further utilize in breeding programme to improve cooking quality parameters

Among 34 landraces, Poongar and Mapillaisamba shows superior performance in both culm and quality traits. Consequently, these two landraces can be utilized in breeding programme for further improvement of crop.

The present study focused on the screening landraces for culm and quality traits. The initial screening aids to identify the range as well as potential landraces for the improvement of the traits. Moreover, further studies are needed to study diversity at genotypic level.

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