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Quality Assessment and Evaluation in Traditional Landraces of Rice (*Oryza sativa*)

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Author's contribution

This work was carried out in collaboration among all authors. All authors read and approved the final Manuscript.

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ABSTRACT

After the Green Revolution, the increase in the choice of modern varieties at the expense of landraces has become a major cause of varietal loss. 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. This study aimed to evaluate 13 traditional rice landraces *viz.,* Anaikomban, Bhavani, Karuthakkar, Bommi, Kaivara samba, Vadan samba, Kudavazhai samba, Sembalai, Valaguru, Kuzhiadichan, Kallundai, Sigappu Anai komban and Vaalan, assessing the variability for grain physiological and cooking quality characters which aim to promote the revival of old landraces. Variability studies were carried out to study the extent of variability for different physiological and cooking quality characters *viz.,* grain length, grain breadth, grain L/B ratio, grain length before cooking, grain length after cooking, grain breadth before cooking, grain breadth after cooking, grain L/B ratio before and after cooking, linear elongation ratio, cooking time, alkali spreading value, water uptake and water absorption by weight. The analysis of variance revealed significant differences among the landraces for all the characters studied except alkali spreading value, water absorption by weight and water uptake. High GCV and PCV were recorded for traits like 100 grain weight, L/B ratio before cooking, L/B ratio after cooking and alkali spreading value. Moderate GCV and PCV recorded for traits *viz*., cooking time, grain elongation ratio, length before cooking, length after cooking, grain breadth before cooking and grain breadth after cooking. It indicates the availability of abundant variability present in rice landraces. Low GCV and PCV were recorded for traits like hulling percentage, water uptake. High heritability and high genetic advance as percent of mean were observed for the characters viz., Alkali spreading value, water absorption by weight, L/B ratio before cooking, L/B ratio after cooking, breadth after cooking and length after cooking, length before cooking, breadth before cooking, water uptake. Moderate heritability and moderate genetic advance as per cent of mean were observed for the characters *viz*., hulling percentage and 100 grain weight. Hence selection of these characters useful for quality improvement.

Keywords: Heritability and genetic advance; landraces; quality and variability.

1. INTRODUCTION

Rice (*Oryza sativa*) is a key staple food crop that provides food for around 60% of the World's population as it is produced seasonally and consumed annually. Rice cultivation in India Extends from 8º to 35º N latitude and from sea level to as high as 3000 meters mean sea level. Rice crop need a hot and humid climate. It is best suited to regions which have high humidity, prolonged sunshine and an assured supply of water. In India, Rice covers an area of about 46.5 million hectares with production 135.5 to 138 million metric tons and productivity of 2.85 tonnes/ha. In Tamilnadu, Area under rice cultivation is about 22.05 lakh hectare with production of 7.85 million metric tonnes and productivity of 2.74 t/ha. In Tamilnadu, the grain type preferred by the consumers is Medium slender (Zhou et al. 2007).

"Grain production development has been the primary goal of plant breeders for several decades, but demand for high-quality rice has increased in recent years as people's living standards have gradually improved" (Rathi et al., 2010). "As a result, improving rice grain quality attributes has become a major issue in rice breeding programs in order to suit consumer preferences and market demand. Both domestic and international markets depend greatly on rice quality" (Unnevehr et al., 1992). Rice variations with good milling parameters, good appearance quality, good cooking and eating parameters can be termed as better grain quality rice varieties, increasing rice's entire economic worth.

Quality is defined as the product's acceptability or compatibility for a particular end use. The physical, physiological and biochemical aspects of grains make up their grain quality attributes (Sattari *et al.,* 2015). The physical and material characteristics of a rice grain can be described by its quality, which may be inherited or acquired. Size, shape, uniformity and general appearance are examples of physical quality characteristics (Cruz and Khush, 2006; Sellappan et al., 2009); kernel shape and L/B ratio are significant characteristics when evaluating grain quality (Rita and Sarawgi, 2008). Another group of characteristics that are directly related to cooking and eating quality are the amylose content (Ward et al., 2006), gelatinization temperature (gel consistency and cooked rice texture (Meullenet et al.,2000, Premkumar R et al., 2016).

2. MATERIALS AND METHODS

The present investigation was carried out in the Department of Plant Breeding and Genetics, Adhiparasakthi Agricultural College, Kalavai during June to September 2024. The seed materials of Rice landraces used in the present study were collected from farmer's field during RAWE programme (Table 1). The experimental material comprised of thirteen land races . The details of the Landraces are furnished in Table 1 and Fig. 1. The experimental material consisted of 13 indigenous landraces of rice (*Oryza sativa* L.) carried out during *Kharif*, 2024 in a Completely Randomized Block Design with two replications for physiological and cooking quality traits (Sivasubramanian & Madhava 1973).

Observations on grain characteristics *viz.,* kernel length, kernel breadth, kernel L/B ratio were recorded from 10 randomly selected kernels. Required quantities (100 g) of harvested seeds were used to record the hulling percentage, which were properly cleaned before starting the experiment. Hulling percentage was computed as below.

Hulling percentage $=\frac{Weight\ of\ rough\ rice}{Weight\ of\ brown\ rice} x\ 100$

The brown rice obtained after dehulling was passed through Satake Grain Testing Mill (Type – TM 05) for 45 seconds to obtain uniformly 7-8 per cent polish. The weight of polished rice was recorded. Milling percentage was calculated as below

Milling percentage = $\frac{Weight\ of\ rough\ rice}{Weight\ of\ milled\ rice}$ x 100

The milled samples were sieved to separate whole kernels from the broken ones. Full rice and three-fourth kernels were taken as whole milled rice for computation (Panse, & Sukhatme 1985). Head rice recovery (HRR) was calculated in percentage as below.

Head rice recovery = $\frac{Weight\ of\ rough\ rice}{Weight\ of\ whole\ milled\ rice} x100$

The polished rice samples were analysed after three months of ageing for the six quality traits *viz.,* kernel length after cooking, kernel breadth after cooking, linear elongation ratio, breadth wise expansion ratio, water uptake and volume expansion ratio by recording observations from 10 randomly selected kernels in the laborator (Murthy and Govindaswamy, 1967). Alkali spreading value was calculated following the method suggested by Little et al. (1958). Analysis of variance was carried out as suggested by Panse and Sukhatme (1967), GCV and PCV were carried out as per the methods suggested by Burton (1953,1952). Heritability (BS) and Genetic Advance were estimated by using the formula suggested by Allard (1960) and Johnson et al. (1955) respectively.

Fig. 1. Collection of 13 landraces used in this study

Table 1. List of rice landraces

S.No	Land Races	Description	Duration(Days)
1	Anaikomban	Long ,slender and soft texture	130
2	Bhavani	Short grain,Drought tolerant	120-125
3	Karuthakkar	High anthocyanin content	120
4	Bommi	Short grain,Drought tolerant	110-120
5	Kaivara samba	High anthocyanin and antioxidants	120
6	Vadan samba	Short grain,Drought tolerant	155-160
7	Kudavazhai samba	Rich in antioxidants and fiber	130
8	Sembalai	High yield,drought tolerant	115
9	Valaguru	Medium glycemic index	120
10	Kuzhiadichan	Drought tolerant,Short grain	120
11	Kallundai	Reddish brown and short grain	110
12	Sigappu Anai komban	Reddish pink,short grain	125
13	Vaalan	Low in glycemic index	160

Table 2. Analysis of variance

Source of variation	df	Grain before cooking			Grain after cooking			HP	WAW	ASV	CT	GER
		GL (mm)	GB (mm)	L/B ratio	GL (mm)	GB (mm)	L/B ratio					
Treatment	12	0.015*	0.001*	0.399*	0.024*	0.005*	0.139*	41.20*	0.007	1.654	3.172*	0.028*
Error	13	0.001	0.001	0.019	0.004	0.003	0.011	0.475	0.004	0.500	6.654	0.001
Total	25											

Significant @5% level

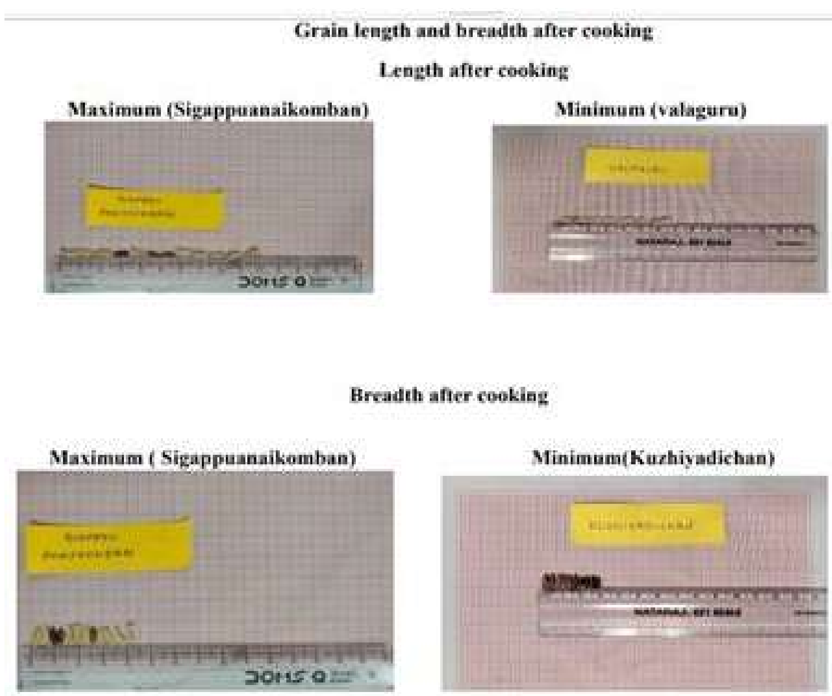
3. RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the medicinal landraces and cultivated varieties for all the characters studied except alkali spreading value, water absorption by weight, water uptake suggesting that significant genetic variation present in the material. The results were presented in Table 2.

Based on mean performance the Rice landraces namely, Anaikomban, Sigappuanaikomban, Karuthakar, Kalundai were observed best for most of the characters hundred grain weight, grain length after cooking, grain length before cooking, grain breadth before and after cooking, L/B ratio before and after cooking, cooking time. The landraces valaguru has least performance for the characters namely, hulling percentage, hundred grain weight, grain length before and after cooking, L/B ratio before cooking, cooking time and alkali spreading value (Table 3 and Fig. 2).

Table 3. Best and least performing landraces for different quality traits

Observation	Maximum	Minimum
Hulling percentage	Valan (84.6%)	Valaguru (67.4%)
Hundred grain weight	Karuthakar, Kalundai	Valaguru (22g)
Grain length before cooking	Anaikomban (0.7 cm)	Valaguru (0.44 cm)
Grain breadth before cooking	Kalundai (0.28 cm)	Bhavani (0.21 cm)
L/B Ratio before cooking	Sigappu anaikomban (3.36)	Valaguru (1.76)
Grain length after cooking	Sigappu anaikomban (0.99 cm)	Valaguru (0.46 cm)
Grain breadth after cooking	Sigappu anaikomban (0.44 cm)	Kuliyadichan (0.27 cm)
L/B ratio after cooking	Kuliyadichan (2.7)	Kalundai(1.8)
Water absorption by weight	Bhavani (0.52g)	Sigappu anaikomban (0.32g)
Cooking time	Karuthakar (81.5 min)	Valaguru (35.5 min)
Water uptake	Valan (3ml)	Bhommi (1ml)
Grain elongation ratio	Anaikomban (1.9)	Bhavani (1.9)
Alkali spreading value	Kalundai (5- intermediate)	Valaguru (1-low)



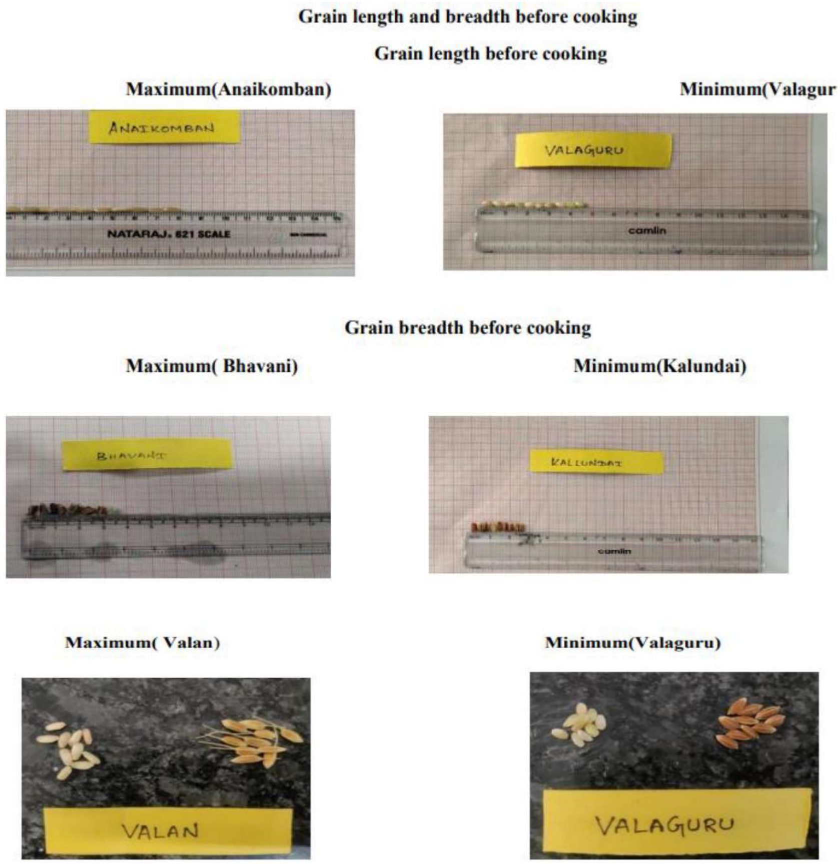


Fig. 2. Best and least performing landraces for different quality traits

3.1 Genotypic and Phenotypic Coefficient of Variance

The degree of genetic variability in landraces can be determined using genetic indices like PCV and GCV. In the experimental material, there was significant phenotypic and genotypic variation for every trait under consideration. The phenotypic coefficient of variation (PCV) values were only a little larger than the genotypic coefficient of variation (GCV), indicating a minimal influence of the environment on the expression of character. High GCV and PCV were recorded for traits like hundred grain weight, L/B ratio before cooking, L/B ratio after cooking and alkali spreading value. Similar results were reported by Allam et al. (2015), Rathi et al. (2019), Longjam and Singh (2019), Chakrabarty et al. (2021) Singh et al. (2020), Vanaja et al. (2006), Sahu et al. (2018). This indicating the existence of significant genetic variation and little environmental effect and hence this scope for selection of these traits would be effective. The characters under studied would have far more potential for genetic improvement through direct selection of these traits for future breeding programme. Therefore, on the basis of phenotype selection can be effective for the improvement of these characters (Juliano & Bechtel 1985, Juliano 1971).

Moderate GCV and PCV for traits like cooking time, grain elongation ratio, length before cooking, length after cooking, grain breadth before cooking and grain breadth after cooking. It indicates the availability of abundant variability present in rice landraces. Low GCV and PCV were recorded for traits like hulling percentage, water uptake. This indicating the presence of low variability for these traits in the present experimental material and therefore little scope for improvement of these traits.

3.2 Heritability and Genetic Advance

High heritability and high genetic advance as per cent of mean were observed for all the characters under studied. The characters *viz*., alkali spreading value, water absorption by weight, L/B ratio after cooking, breadth after cooking and length after cooking, length before cooking, breadth before cooking, water uptake. This was in accordance with the findings of Sanghamitra *et al* (2018), Dhanwani et al. (2013), Elsy et al. (1991), Sahu et al. (2017), Adhikari et al. (2018), Naik et al. (2022), Kumar et al. (2020) and Singh et al. (2020). This indicating the predominance of additive gene action on the trait and as such that trait is likely to respond effectively to phenotypic selection. Moderate heritability and moderate genetic advance as per cent of mean were observed for all the characters under studied. The characters *viz*., hulling percentage and 100 grain weight (Falconer, & Mackey 1996, Ghosh et al. 1971).

Table 4. Variability parameters for grain quality traits in rice

Name of the trait	Mean	PCV (%)	GCV (%)	Heritability (h^2)	Genetic advance as % of mean
Hundred grain weight	29.06	11.18	7.91	50.05	11.53
Hulling Percentage	77.88	9.28	7.03	57.38	10.97
Grain length before cooking (mm)	0.61	14.42	14.08	95.24	28.30
Grain breadth before cooking (mm)	0.24	20.88	19.46	86.82	37.35
L/B ratio before cooking	2.45	25.62	24.60	92.19	48.66
Grain length after cooking (mm)	0.78	14.80	14.61	97.44	29.71
Grain breadth after cooking (mm)	0.34	22.04	18.55	70.79	32.15
L/B ratio after cooking	2.27	24.53	21.33	75.61	38.20
Water absorption by weight (g)	0.41	21.63	17.32	64.10	28.56
Alkali spreading value	3.57	74.81	64.81	86.63	54.12
Cooking time	60.88	7.34	6.22	71.73	10.85
Water uptake	1.57	14.22	13.63	91.74	26.88
Grain elongation ratio	1.33	12.69	11.07	76.17	19.91

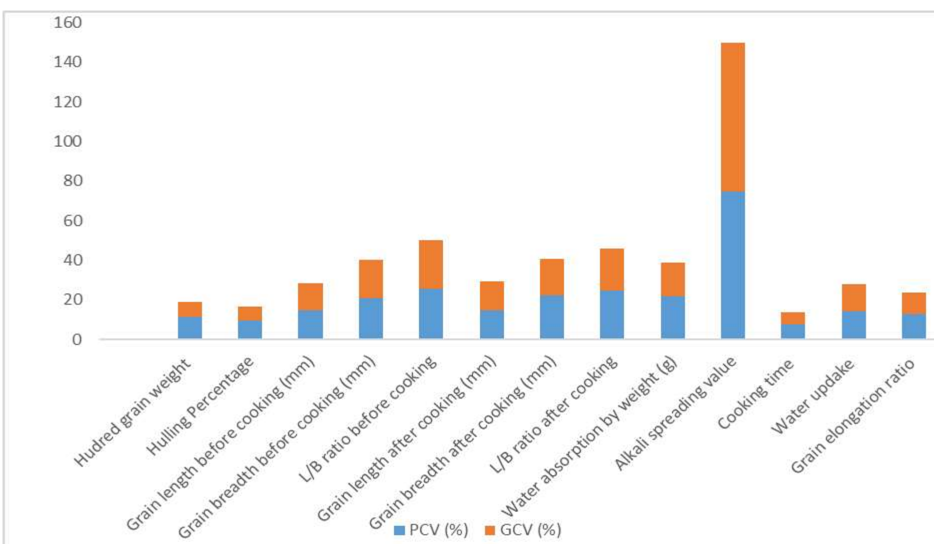


Fig. 3. Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) for grain quality traits in Rice

4. CONCLUSION

From the present study, it can be concluded that the Rice landraces namely *viz*., Anaikomban, Sigappuanaikomban, Karuthakar, Kallundai were observed best for most of the characters hundred grain weight, grain length after cooking , grain length before cooking, grain breadth before and after cooking, L/Bratio before and after cooking, cooking time. Hence selection of these landraces useful for quality improvement. This indicating the existence of significant genetic variation and little environmental effect and hence this scope for selection of these traits would be effective. High GCV and PCV were recorded for traits like hundred grain weight, L/B ratio before cooking, L/B ratio after cooking and alkali spreading value. High heritability and high genetic advance as per cent of mean were observed for the following traits *viz.,* alkali spreading value, water absorption by weight, L/B ratio after cooking, breadth after cooking and length after cooking, length before cooking, breadth before cooking, water uptake. This indicating the predominance of additive gene action on the trait and as such that trait is likely to respond effectively to phenotypic selection.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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