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COMPARATIVE ANALYSIS OF VARIABILITY AND CORRELATIONS BETWEEN QUALITY COMPONENTS IN TRADITIONAL RAINFED UPLAND AND LOWLAND RICE

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ABSTRACT

Analysis of the variability and correlations in gora (Group I) and medium/lowland (Group II) rices revealed similar variability patterns in both the groups. However, the correlations were variable in both groups. A consistent trend of associations for hulling, milling, head-rice recovery, kernel size and shape were observed in both the groups. Alkali value and amylose content exhibited differential pattern of association with grain size, shape and milling characteristics. The cooking quality attributes showed highly variable associations with physico-chemical properties of the rice grain. Nevertheless, the relationships between water uptake and amylose content, cooked kernel length and kernel elongation, and kernel size and shape were observed in both the groups. Study indicated to use different selection criteria for combining cooking quality attributes with physico-chemical characteristics under upland and lowland situations.

Key words: Rice, quality traits; correlation, variability.

Landraces, an important genepool, which could be useful in cultivar development programme, hence their conservation and evaluation is foremost. Reports on extent of variation and diversity in the quality components of traditional rainfed rice cultivars and identification of a good number of landraces as potential donors for the rice quality improvement programme are already available [1, 2]. The present study aims at investigating the comparative pattern of variability and correlations between quality components in the traditional rainfed upland and low/medium land rice cultivars.

MATERIALS AND METHODS

The experimental material consisted of 106 rainfed rice landraces, direct seeded (10 g/m^2) in augmented design in three-row plots 3 m long rows, spaced 20 cm apart during 1988 wet season. The fertilizers N : P_2O_5 : K_2O, were applied @ 40:20:20 kg/ha. A composite sample of 20 random plants was taken for recording data on various quality traits. The characters studied and the analytical methods used were as described earlier [1] other statistical parameters were estimated as per the standard methods.

RESULTS AND DISCUSSION

The landraces were first grouped according to their agroecological adaptability. Group I included 53 rainfed upland rice cultivars from the plateau region of Bihar (gora rices) and Group II was represented by 53 rainfed medium/lowland types of indigenous origin. The variations and correlations of quality traits were analyzed in each group separately and also after pooling both the groups (Group III), to know the influence of adaptation to different agroecological conditions.

VARIABILITY PATTERN

The coefficients of variation (CV) indicated that in both groups head-rice recovery, alkali value and water uptake varied substantially but the magnitude for water uptake was higher in Group II only while for other two characters was higher in Group I (Table 1). In both groups, only raw and cooked kernel length showed appreciable differences, otherwise the extent of variation for the remaining traits was similar (Table 1). The lowest variation was for hulling and milling recovery. The results confirm our earlier observation that the pattern of variation in quality traits is not much influenced by the ecotypic differences [1]. Predominance of certain combinations in quality traits is probably due to the regional quality preference resulting in farmer's selection rather than agroecological adaptation.

Table 1. Comparative variability in quality traits among three groups of rice genotypes

Character	Coefficient of variability (%)		
	Group I (upland)	Group II (lowland)	Group III (pooled)
Hulling (%)	3.4	3.4	3.4
Milling (%)	3.6	3.6	3.6
Head-rice yield (%)	23.1	21.8	22.4
Kernel length (mm)	5.9	9.0	7.6
Kernel breadth (mm)	7.1	7.4	7.3
L:B ratio	10.3	14.5	12.6
Alkali value	32.6	22.3	29.5
Amylose content (%)	6.2	6.6	6.4
Water uptake (ml)	17.1	21.8	19.8
Volume expansion	4.4	4.9	4.7
Cooked kernel length (mm)	7.9	9.4	8.6
Kernel elongation	6.6	6.1	6.3

CORRELATION ANALYSIS

PHYSICO-CHEMICAL TRAITS

The hulling, milling and head-rice recovery appeared to be interrelated irrespective of the groups and this association was also reflected in the combined analysis. Similar results were also reported by several workers [3–5]. But Richharia and Seetharaman [6] found that head rice yield was independent of total milling recovery. Kernel length and breadth showed variable relationships with hulling and milling recovery. In Group I there was no association of kernel length with hulling and milling recovery but kernel breadth showed positive and significant relationship with these two traits. On the other hand, in Group II, kernel length had significant association with hulling and milling recovery while there was no relationship with kernel breadth (Table 2). This pattern of correlations in groups I and II did not change even in the pooled analysis. Kernel shape (L:B) had no relationship with hulling and milling recovery. Several earlier reports indicated that hulling and milling recovery were independent of grain size and shape [5, 7, 8].

Table 2. Correlation coefficients between physico-chemical traits of rice grain in three groups

Characters	Group	Correlation coefficient value (r)						
		amylose content	alkali value	L:B ratio	kernel breadth	kernel length	head-rice recovery	milling recovery
Hulling recovery	I	0.32*	0.14	−0.18	0.45**	0.22	0.63**	0.98**
	II	−0.15	0.27	0.18	0.11	0.35*	0.28*	0.98**
	III	0.08	0.18	0.03	0.27**	0.29**	0.56**	0.98**
Milling recovery	I	0.32*	0.10	0.15	0.40**	0.22	0.60**	
	II	−0.16	0.27	0.16	0.08	0.32*	0.44**	
	III	0.10	0.17	0.03	0.26**	0.27**	0.50**	
Head-rice recovery	I	0.40**	0.22	0.26	0.01	0.41**		
	II	0.07	0.19	0.29*	−0.15	0.27		
	III	0.22*	0.17	0.27*	−0.07	0.29**		
Kernel length	I	0.18	0.12	0.70**	−0.16			
	II	−0.08	0.36**	0.86**	−0.38**			
	III	0.02	0.19*	0.81**	−0.29**			
Kernel breadth	I	0.03	0.06	−0.81**				
	II	0.05	0.04	−0.78**				
	III	0.04	0.09	−0.79**				
L:B ratio	I	0.08	−0.03					
	II	−0.06	0.21					
	III	−0.01	0.06					
Alkali value	I	0.03						
	II	−0.41**						
	III	−0.09						

*, **Significant at 5% and 1% levels, respectively.

The relationships of amylose content with hulling (r = 0.32), milling (r = 0.32) and head-rice yield (r = 0.40) were significantly positive only in Group I. However, it was observed that hulling, milling and head rice yield were not influenced by amylose content [4, 5]. Similarly, kernel length was positively correlated with head rice yield in Group I, whereas in Group II kernel shape had positive association with head rice yield (Table 2). Although negative relationships of head rice recovery with kernel length and shape have been reported earlier [4, 9, 10], the positive associations of head rice yield with kernel length in Group I and with shape in Group II in the present investigation could be due to predominance of genotypes with medium type kernels as suggested by the mean kernel length in Group I (5.62 $\pm$ 0.05 mm) and lack of genotypes with slender or excessive slenderness or bold grains (mean L:B ratio was 2.28 $\pm$ 0.05) in Group II. The excessively slender or bold grain genotypes have been reported to break more easily during milling causing low head rice yields than the medium grain types [9, 11, 12].

The kernel length and breadth exhibited similar pattern of association with L:B ratio in all the groups. However, kernel length had significant negative correlation with kernel breadth only in Group II, which was also negative but nonsignificant in Group I. Significant negative association between kernel length and breadth [13–15] or lack of association [5, 16] between these two traits were reported earlier. Chauhan [16] also observed positive association between kernel length and breadth in F_2 populations. The L : B ratio had significant positive correlation with kernel length but significant negative association with in all the three groups. Alkali value, which is an indirect measurement of gelatinization temperature, showed significant negative relationship with amylose content (r = –0.41) only in Group II. Variable associations between these traits were reported earlier [4, 17, 18]. Group II and pooled analysis showed significant positive association between alkali value and kernel length.

COOKING QUALITY TRAITS

The good cooking quality trait is judged by the high water uptake, volume expansion, and kernel elongation. It is therefore essential to analyze their associations with the physico-chemical properties of rice grain and among themselves. In this context, the study revealed that kernel length and shape were significantly correlated with cooked kernel length and kernel elongation in Group II. The pooled analysis of both groups did not alter this trend (Table 3). In Group I, kernel length and shape exhibited positive association with cooked kernel length only. In Group III, volume expansion and kernel length were positively correlated (r = 0.210). However, Sivasubramanian et al. [7] and Sood and Siddiq [19] did not observe any relationship of volume expansion with grain size and shape.

The alkali value had significant positive relationship with water uptake (r = 0.48) and cooked kernel length (r = 0.46) in Group II, but it showed significant negative relationship with water uptake in Group I (r = 0.28). Variable associations between these two traits were also reported by [5, 17, 20].

Amylose content showed positive association with cooked kernel length and kernel elongation only in Group I (Table 3). The significant negative correlation between water uptake and amylose content in all the three groups (Table 3) is in agreement with the findings of [17] but contrary to several other reports [5, 19]. The results of the present study suggest that higher the amylose content, lower would be the water uptake. This is an undesirable correlation as low amylose rices are sticky on cooking and less preferred in India.

Water uptake had significant positive relationship with volume expansion, cooked kernel length, and kernel elongation in Group II. Volume expansion in this group was also positively related with cooked kernel length (r = 0.86) and kernel elongation (r = 0.41). Water uptake and cooked kernel length were negatively correlated in Group I (Table 3). Kernel elongation appeared to be independent of amylose content and alkali value, as their associations were nonsignificant. Cooked kernel length, as expected, was highly correlated with kernel elongation in all three groups.

Table 3. Correlation coefficients (r) between cooking quality components and physico-chemical characters of the rice grain in three groups of genotypes

Character	Group	r value			
		kernel elongation	cooked kernel length	volume expansion	water uptake
Kernel length	I	−0.22	0.57**	0.15	−0.34*
	II	−0.28*	0.78**	0.26	0.21
	III	−0.24*	0.71**	0.21*	0.03
Kernel breadth	I	0.21	0.04	0.02	−0.09
	II	0.26	−0.25	0.21	0.20
	III	0.23*	−0.09	0.12	0.08
L:B ratio	I	−0.25	0.33*	0.08	−0.12
	II	−0.30*	0.63**	0.08	0.04
	III	−0.27**	0.51**	0.08	−0.01
Alkali value	I	−0.11	0.00	0.13	−0.28*
	II	0.20	0.46**	0.26	0.48**
	III	0.01	0.17	0.21*	0.02
Amylose content	I	0.29*	0.39**	−0.18	−0.42**
	II	0.03	−0.04	0.18	−0.29*
	III	0.03	0.15	0.04	−0.35**
Water uptake	I	−0.09	−0.32*	0.11	
	II	0.36**	0.44**	0.32*	
	III	0.15	0.14	0.21*	
Volume expansion	I	0.04	0.07		
	II	0.41**	0.86**		
	III	−0.12	0.32**		
Cooked kernel length	I	0.68**			
	II	0.38**			
	III	0.52**			

*,**Significant at 5 and 1% levels, respectively.

These results provide evidence for the agro-ecology-specific correlations between quality components as the pattern of association in the two groups were variable. Further, the studies indicated the need to adopt different methodology in selection for cooking and eating quality. By and large it appears that characters like grain size, shape, hulling, milling and head rice recovery could be improved by similar selection criteria. However, it seems difficult to simultaneously improve alkali value, amylose content, water uptake, kernel elongation and grain dimensions due to the complex nature of associations among these traits.

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