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Genetic variability of nutritional and cooking quality traits in bold grained rice

R. Chakraborty, S. Chakraborty*, B.K. Dutta and S.B. Paul

Department of Biotechnology, Assam University, Silchar-788011, Assam

ABSTRACT

The present experiment was conducted on 47 bold grained rice genotypes with two locally recommended high yielding check varieties namely Ranjit and Monohar Sali of Barak Valley, Assam to assess the genetic variability, correlation and coheritability for five nutritional and seven cooking quality characters. In the present investigation, high heritability associated with high genetic advance was found in the cooking quality traits viz. alkali digestion value, cooked rice kernel length, cooked rice kernel lengthwise elongation ratio and water absorption (%) and in the nutritional character total soluble sugar content. These characters were predominantly governed by additive gene action. High heritability along with moderate genetic advance was observed in the cooking quality characters like gel consistency, cooked rice kernel breadth and in the nutritional characters like total soluble protein content and amylose content. High heritability with low genetic advance was recorded for starch content and amylopectin content. This indicated that these characters were mostly governed by non-additive gene action. There was a strong inherent association among total soluble protein content and other nutritional and cooking quality traits.

Key words: *bold grained rice, nutritional quality, cooking quality, genetic variability*

Bold grained rice is traditionally grown in Assam and consumed by hard working people doing hard physical work for their taste and fulness of belly for a long time. They are low yielders. Good quality bold grained rice is a long pending demand for the physically hard working people. Most of the cultivated modern high yielding varieties are medium and fine grained. Keeping the desire of the hard working people, the characterization of traditional bold grained rice in terms of nutritional qualities is very essential for further genetic improvement. The assessment of genetic variability in a gene pool is the pre-requisite of a successful breeding programme.Estimates of genetic and phenotypic correlation among various traits show the possibility of improvement of a character through selection on other character. In the present investigation, forty seven local bold grained rice genotypes of Barak valley, Assam along with two check varieties namely Ranjit and Monohar Sali were undertaken to asses the magnitude of genetic variability and estimation of correlation in five nutritional and seven cooking quality characters.

MATERIALS AND METHODS

The experimental material consisted of 47 bold grained rice genotypes collected from different parts of Barak valley zone, Assam, along with two recommended high yielding check varieties namely Ranjit and Monohar Sali. The experiment was conducted in randomized block design with three replications during wet season 2006. Freshly harvested samples from 49 rice genotypes were collected. The grains of each replicate were dehusked carefully before drying at 40°C, powdered and stored in a plastic bag sealed thoroughly before analysis of different nutritional characters. The nutritional characters were determined as follows, total soluble protein content was determined following Lowry's method (Lowry *et al.* 1951), Starch content was determined after removal of total soluble sugar from the sample by extraction with hot aqueous ethanol (80%). The starch content was determined by Anthrone reagent method (Sadasivam and Manickam, 1996), Amylose content (Sadasivam and Manickam, 1996), Amylopectin content was determined by subtracting the value of amylose content from that of starch content and v). Total soluble sugar content was determined by Anthrone reagent method (Sadasivam and Manickam, 1996). The different cooking quality traits were determined by the methods as follows, Alkali digestion value by the method of Little *et al*. 1958, gel consistency based on the method described by Cagampang *et al*. 1973, cooked kernel length, cooked kernel lengthwise elongation ratio, cooked kernel breadth, cooked kernel breadth wise elongation ratio and water absorption (%) were determined by Juliano and Perez, 1984. The data generated from three replications on nutritional and cooking quality traits were subjected to analysis of variance and covariance (Panse and Sukhatme, 1978). Genotypic and phenotypic correlation coefficients were estimated following the method of AI-Jibouri *et al*. (1958). Coheritability between two characters was calculated according to the method suggested by Nei (1960).

RESULTS AND DISCUSSION

The analysis of variance for all the twelve characters showed significant difference among the genotypes by the estimation of genotypic coefficient of variation (GCV) in relation to their respective phenotypic coefficient of variation (PCV). The difference between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was very small for all the biochemical characters (Table 1). This narrow difference between GCV and PCV implied low environmental influence on the nutritional and cooking quality characters and the predominant role of genetic factors on the expression of these characters. Vivekanandan and Giridharan (1998) reported closeness between GCV and PCV for all the cooking quality traits indicating higher resistance to environmental influence. High GCV and PCV were found for the cooking quality characters like water absorption (%) followed by alkali digestion value. The high GCV for these traits signifies the scope for selection to develop superior genotypes. Das *et al*. (2007) also observed very high PCV and GCV for the characters like water uptake and alkali digestion value.

In the present investigation, high heritability associated with high genetic advance in percentage of mean was found for the cooking quality traits *viz*. alkali digestion value, cooked rice kernel length, cooked rice kernel lengthwise elongation ratio and water absorption percentage. Das *et al*. (2007) also found high heritability coupled with high genetic advance for the characters

Table 1. Estimates of genetic parameters for nutritional and cooking qualities in bold grained rice genotypes

Characters	Range		Mean	Standard error of mean $SE_{m\pm}$	PCV (%)	GCV (%)	Heritability in broad sense (%)	GA as % of mean
	Maximum	Minimum						
Starch content (g/100g of oven dry sample)	79.88	65.60	72.07	0.03	4.944	4.943	99.98	2.86
Amylose content (g/100g of oven dry sample)	25.62	15.17	21.50	0.03	14.86	14.85	99.97	31.61
Amylopectin content (g/100g of oven dry sample)	84.83	74.38	78.50	0.05	4.074	4.071	99.92	8.39
Total soluble sugar content (g/100g of oven dry sample)	1.20	0.33	0.70	0.01	31.90	31.73	98.77	64.91
Alkali digestion value	6.22	2.01	3.995	0.0091	27.83	27.82	99.92	57.27
Gel consistency (mm)	99.00	60.67	77.68	0.55	15.37	15.33	99.35	31.46
Cooked rice kernel length (mm)	15.74	7.29	10.21	0.22	20.45	20.11	96.70	40.72
Cooked rice kernel length-wise elongation ratio	2.91	1.25	1.78	0.00993	20.63	20.61	99.78	42.40
Cooked rice kernel breadth (mm)	3.53	1.84	2.712	0.0713	16.26	15.61	92.16	30.87
Cooked rice kernel breadth-wise elongation ratio	1.78	1.06	1.357	0.00135	15.107	15.033	99.98	31.11
Water absorption (%)	146.54	31.25	61.77	0.034	41.92	41.91	99.99	86.34
Total soluble protein content (g/100g of oven dry sample)	6.72	4.05	5.60	0.08	12.13	11.88	95.91	23.97

like water uptake and alkali digestion value among twenty promising lowland rice genotypes. Total soluble sugar also reflected high heritability associated with high genetic advance. Breeding method based on progeny testing and mass selection could be useful in improving these traits. High heritability along with moderate genetic advance was observed in the cooking quality characters namely gel consistency, cooked rice kernel breadth and cooked rice kernel breadth wise elongation ratio. Nayak and Reddy (2005) observed high broad sense heritability associated with moderate genetic advance for amylose content in both dry and wet seasons. Das *et al*. (2007) reported high heritability associated with low genetic advance for amylose content. Judicious application of pure line selection may be effective for improving the characters. Lastly, high heritability with low genetic advance was recorded for starch content and amylopectin content. Arulselvi *et al*. (2007) also reported high heritability with low genetic advance for starch content. This indicated that starch content and amylopectin content were predominantly governed by non-additive gene action in bold grained rice.

In the present study, genotypic and phenotypic correlation coefficient along with coheritability of total soluble protein content was studied with other nutritional and cooking quality traits (Table 2). The genotypic correlation coefficient was found to be higher than the corresponding phenotypic correlation coefficient. This indicated a strong inherent association among total soluble protein content and cooking quality traits. Total soluble protein content showed non-significant positive correlation with the characters like total starch content, amylopectin content, alkali digestion value, cooked kernel length, cooked kernel length wise elongation ratio, cooked kernel breadth, cooked kernel breadth wise elongation ratio, gel consistency and water absorption (%) at both genotypic and phenotypic level. Arulselvi *et al*. (2007) reported similar non-significant correlation of total soluble protein content with other characters in sixty-three hybrids and their sixteen parents in pearl millet. Starch content showed highly significant positive correlation with amylopectin content, total soluble sugar content, alkali digestion value and gel consistency at both genotypic and phenotypic level.

Amylose content reflected highly significant positive correlation with cooked kernel length, cooked kernel lengthwise elongation ratio, cooked kernel breadth, cooked kernel breadth wise elongation ratio and water absorption at both genotypic and phenotypic level. Amylopectin content showed highly significant positive correlation with total soluble sugar content, alkali digestion value and gel consistency at both genotypic and phenotypic level. Total soluble sugar content showed highly significant positive correlation with alkali digestion value and gel consistency at both genotypic and phenotypic level. Alkali digestion value showed highly significant positive correlation with gel consistency at both genotypic and phenotypic level. Gel consistency showed highly significant positive correlation with cooked kernel length, cooked kernel lengthwise elongation ratio, cooked kernel breadth, cooked kernel breadth wise elongation ratio and water absorption at both genotypic and phenotypic level. Cooked kernel length showed highly significant positive correlation with cooked kernel lengthwise elongation ratio, cooked kernel breadth, cooked kernel breadth wise elongation ratio and water absorption at both genotypic and phenotypic level. Nayak and Reddy (2005) reported positive correlation of cooked kernel length with water absorption at both genotypic and phenotypic level. Cooked kernel lengthwise elongation ratio showed highly significant positive correlation with cooked kernel breadth, cooked kernel breadth wise elongation ratio and water absorption (%) at both genotypic and phenotypic level. Cooked kernel breadth wise elongation ratio showed highly significant positive correlation with water absorption at both genotypic and phenotypic level.

The estimate of coheritability indicates the efficiency of selection of character pairs. Less environmental influence is responsible for reflection of larger magnitude of coheritability estimates. High coheritability results in high response to selection of correlated variables. The highest positive coheritability of cooked kernel breadth was found with cooked kernel breadth wise elongation ratio (87.93%) followed by water absorption (60.25%) (Table-2). Cooked kernel length showed highest positive coheritability with cooked kernel lengthwise elongation ratio (80.14%) followed by water absorption (58.59%). Alkali digestion value showed highest positive coheritability with gel consistency (74.63%). Amylopectin content showed highest positive coheritability with alkali digestion value (75.82%) followed by gel consistency (66.49%). The character amylose content showed highest positive

Table 2. Estimation of correlation coefficients and coheritability (%) between various nutritional and cooking quality traits

Characters	Level	1	2	3	4	5	6	7	8	9	10	11	12
1. Starch content (g/100g of oven dry sample)	G	1.000	-0.422**	0.291*	0.448**	0.363**	0.404**	-0.134	-0.294*	-0.175	-0.288*	-0.151	0.257
	P	1.000	-0.421**	0.422**	0.446**	0.362**	0.403**	-0.132	-0.293*	-0.168	-0.286*	-0.150	0.250
	CoH(%)	1.000	-42.19	29.11	44.55	36.30	40.31	-13.22	-29.37	16.81	28.66	-15.06	25.12
2. Amylose content (g/100g of oven dry sample)	G	1.000	-0.999**	-0.391**	-0.759**	-0.667**	0.427**	0.504**	0.559**	0.618**	0.387**	-0.221	
	P		1.000	-0.998**	-0.388**	-0.758**	-0.665**	0.420**	0.503**	0.537**	0.615**	0.386**	-0.217
	CoH(%)		1.000	-99.95	-38.84	-75.83	-66.47	42.00	50.32	53.66	61.52	38.70	-21.63
3. Amylopectin content (g/100g of oven dry sample)	G			1.000	0.390**	0.759**	0.667**	-0.426**	-0.502**	-0.558**	-0.617**	-0.386**	0.221
	P			1.000	0.388**	0.758**	0.665**	-0.419**	-0.501**	-0.535**	-0.613**	-0.385**	0.217
	CoH(%)			1.000	38.78	75.82	66.49	-41.86	-50.15	-53.52	-61.29	-38.52	21.67
4. Total soluble sugar content (g/100g of oven dry sample)	G				1.000	0.376**	0.404**	-0.133	-0.233	-0.052	-0.212	-0.154	0.169
	P				1.000	0.377**	0.400**	-0.129	-0.231	-0.051	-0.210	-0.153	0.166
	CoH(%)				1.000	37.40	40.10	-12.98	-23.33	-4.96	-20.96	-15.34	16.46
5. Alkali digestion value	G					1.000	0.748**	-0.303*	-0.343**	-0.323*	-0.397**	-0.216	0.183
	P					1.000	0.746**	-0.297*	-0.342**	-0.310*	-0.396**	-0.215	0.180
CoH(%)					1.000	74.63	-29.76	-34.25	-31.02	-39.58	-21.59	17.92	
6. Gel consistency (mm)	G						1.000	-0.481**	-0.474**	-0.395**	-0.475**	-0.384**	0.091
	P						1.000	-0.472**	-0.472**	-0.379**	-0.471	-0.388**	0.090
CoH(%)						1.000	-47.18	-47.18	-37.80	-47.100	-38.31	8.79	
7. Cooked kernel length (mm)	G							1.000	0.816**	0.548**	0.552**	0.596**	0.051
	P							1.000	0.705**	0.522**	0.542**	0.586**	0.045
CoH(%)							1.000	80.14	51.76	54.03	58.59	4.94	
8. Cooked kernel lengthwise elongation ratio	G								1.000	0.608**	0.756**	0.860**	0.119
	P								1.000	0.581**	0.752**	0.859**	0.114
	CoH(%)								1.000	58.32	75.20	85.89	11.67
9. Cooked kernel breadth (mm)	G									1.000	0.920**	0.628**	0.063
	P									1.000	0.885**	0.602**	0.078
CoH(%)									1.000	87.93	60.25	5.92	
10. Cooked kernel breadth wise elongation ratio	G										1.000	0.785**	0.118
	P										1.000	0.782**	0.115
	CoH(%)										1.000	78.12	11.48
11. Water absorption (%)	G											1.000	0.253
	P											1.000	0.247
CoH(%)											1.000	24.72	
12. Total soluble protein content (g/100g of oven dry sample)	G												1.000
	P												1.000
	CoH(%)												1.000

*Significant at 5% probability level, **Significant at 1% probability level, G = genotypic correlation coefficient, P = Phenotypic correlation coefficient, CoH (%) = Coheritability.

coheritability with cooked kernel breadth wise elongation ratio (61.52%) followed by cooked kernel breadth (53.66%) and cooked kernel lengthwise elongation ratio (50.32%).

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