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Genetic variability and genetic correlation among nutritional and cooking quality traits in bold grain rice

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ABSTRACT

Studies were conducted on 47 bold grain 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. 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 (%); in the nutritional character total soluble sugar content showed high heritability and genetic advance. These characters were predominantly governed by additive gene action. High heritability along with moderate genetic advance was observed in the cooking quality characters gel consistency, cooked rice kernel breadth and cooked rice kernel breadth wise elongation ratio and in the nutritional characters like total soluble protein content and amylose content. Lastly, 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 (dominance and epistasis). The genotypic correlation coefficient was found to be higher than the corresponding phenotypic correlation coefficient. This indicates a strong inherent association among total soluble protein content and other nutritional and cooking quality traits. 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%).

Key words: *Nutritional quality, cooking quality, genetic variability, bold grain rice*

Bold grain rice traditionally grown in Assam are low yielders and consumed by those doing hard physical work as these are thought to be retained in the stomach for a long time and give feeling of satiety. Good quality bold grain rice is, therefore, in great demand. Most of the cultivated modern high yielding varieties are medium and fine grained. Thus, characterization of traditional bold grain rice in terms of grain and nutritional qualities is essential for further genetic improvement. Genetic parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense and genetic advance are useful biometrical tools for determination of genetic variability. In the present investigation, forty seven local bold grain rice genotypes of Barak valley, Assam along with two check varieties namely Ranjit and Monohar Sali were studied to assess the magnitude of genetic variability and to estimate correlation amongst five nutritional and seven cooking quality characters.

METERIALS AND METHODS

The experimental material consisted of 47 bold grained rice genotypes (Table 1) 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. Grains were harvested in the first week of December 2006 and sun dried for three days. Immediately, the grains of each replicate were dehusked carefully before oven drying at 40°C to bring moisture content to 12%, powdered and stored in plastic bag sealed thoroughly before analysis of different nutritional characters. The nutritional characters were determined as follows: i) Total soluble protein content was determined following Lowry's method (Lowry *et al*. 1951) and ii) Total soluble sugar, starch, amylose and amylopectin content were determined by the method described by Sadasivam and Manickam (1996). The

Table. 1 List rice genotypes included in the experiment

Genotype	Name	Genotype	Name	Genotype	Name	Genotype	Name
G_1	Soulpona	G_{14}	Probat Jeera	G_{27}	Bata Sail	G_{40}	Agani Sali
G_2	Lati Sali	G_{15}	Kamal Bhog	G_{28}	Bar Madhava	G_{41}	Rashi
G_3	Chuto Mula	G_{16}	Betguti Dhan	G_{29}	Monohar Sali (Check)	G_{42}	Hathi Sali
G_4	Kartic Kalma	G_{17}	Heera Dhan	G_{30}	Ranjit (Check)	G_{43}	Shem Sail
G_5	Basanta Bahar	G_{18}	Baodun	G_{31}	Hacha Lath	G_{44}	Daura Sail
G_6	Karmi Sail	G_{19}	Kapilee Dhan	G_{32}	Samras	G_{45}	Chingra Sail
G_7	Soularpona	G_{20}	Chandmoni	G_{33}	Atha Sail	G_{46}	Khasi Dhan
G_8	Chaku Sail	G_{21}	Gouarchor	G_{34}	Latha Sail	G_{47}	Malati
G_9	Dhola Mula	G_{22}	George Sail	G_{35}	Haladhar Sali	G_{48}	Zoli
G_{10}	Kuiari Sali	G_{23}	Herapowa	G_{36}	Chatri Sail	G_{49}	Lalia Sail
G_{11}	Matonga	G_{24}	Dudh Mula	G_{37}	Maghi Sail		
G_{12}	Chafa Sail	G_{25}	Gajep Sail	G_{38}	Mala		
G_{13}	Methi Chikon	G_{26}	Kali Makuri	G_{39}	Dome Sail		

different cooking quality traits like alkali digestion value (Little *et al*. 1958), gel consistency (Cagampang *et al*. 1973), cooked kernel length, cooked kernel lengthwise elongation ratio, cooked kernel breadth, cooked kernel breadth wise elongation ratio and water absorption value were also determined (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 analyses of variance for all the twelve characters showed significant difference among the genotypes at P = 0.05. This indicated that the genotypes differed among themselves for these characters. The comparison of characters as regards to the extent of genetic variation could be better judged by the estimation of genotypic coefficient of variation (GCV) in relation to their respective phenotypic coefficient of variation (PCV). The difference between GCV and PCV was very small for all the biochemical characters (Table 2). This narrow difference between GCV and PCV implied very little environmental influence on the nutritional and cooking quality characters and the predominant role of

Table. 2 Estimates of genetic parameters for nutritional and cooking qualities in bold grain rice genotypes of Assam

Characters	Range Maxi mum	Mim mum	Mean	Standard error of mean $SE_{m\pm}$	PCV (%)	GCV (%)	Heritability in broad sense (%)	GA as % of mean
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 (% of starch)	25.62	15.17	21.50	0.03	14.86	14.85	99.97	31.61
Amylopectin content (% of starch)	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

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 (%). Das *et al*. (2007) also found high heritability coupled with high genetic advance for the characters like water uptake and alkali digestion value among 20 promising lowland rice genotypes. The nutritional character, 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, the same was true for the nutritional characters like total soluble protein content and amylose content. Nayak and Reddy (2005) observed high (broad sense) heritability associated with moderate genetic advance for the character 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 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 (dominance and epistasis) in bold grain rice.

The estimates of genotypic correlation coefficients are essential in evaluating the possibility of simultaneous improvement of many characters or improvement of a single complex trait on the assumption of correlated response to selection. 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 3). The genotypic correlation coefficient was found to be higher than the corresponding phenotypic correlation coefficient. This indicates a strong inherent association among total soluble protein content and other nutritional 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

Table 3. Estimation of correlation coefficients and coheritability (%) between various nutritional and cooking quality traits in bold grain rices of Assam

Characters	Level	1	2	3	4	5	6	7	8	9	10	11	12
Starch content	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
(g/100g of oven dry sample)	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
Amylose content	G		1.000	-0.999**	-0.391**	-0.759**	-0.667**	0.427**	0.504**	0.559**	0.618**	0.387**	-0.221
(g/100g of oven dry sample)	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
Amylopectin content	G			1.000	0.390**	0.759**	0.667**	-0.426**	-0.502**	-0.558**	-0.617**	-0.386**	0.221
(g/100g of oven dry sample)	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
Total soluble sugar content	G				1.000	0.376**	0.404**	-0.133	-0.233	-0.052	-0.212	-0.154	0.169
(g/100g of oven dry sample)	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
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
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
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
Cooked kernel lengthwise	G								1.000	0.608**	0.756**	0.860**	0.119
elongation ratio	P								1.000	0.581**	0.752**	0.859**	0.114
	CoH(%)								1.000	58.32	75.20	85.89	11.67
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
Cooked kernel breadth\ wise	G										1.000	0.785**	0.118
elongation ratio	P										1.000	0.782**	0.115
	CoH(%)										1.000	78.12	11.48
Water absorption (%)	G											1.000	0.253
	P											1.000	0.247
	CoH(%)											1.000	24.72
Total soluble protein content	G												1.000
(g/100g of oven dry sample)	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.

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 showed highly significant positive correlation with 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. High coheritability results in high response to selection of correlated variables. The highest positive coheritability of cooked kernel breadth was found with cooked kernel breadthwise elongation ratio (87.93%) followed by water absorption (60.25%) (Table-3). The character 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 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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