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Morphological and Physico-Chemical Characterization of Scented Radhunipagol and Danaguri Rice Landraces Grown in the Gangetic Alluvial Soil of West Bengal

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Abstract

A field experiment was conducted during Kharif season 2018 at the Experimental farm of University of Calcutta in Baruipur, South 24 parganas, West Bengal. Two popular scented landraces of West Bengal-Radhunipagol and Danaguri were sown in randomized block design. The 12 agro-morphological characters followed by DUS test according to the guidelines of PPV & FRA was conducted for both the rice germplasms. Later, the grain quality parameters, cooking and nutritional quality were also recorded. There is a high demand of scented rice both in national and international market but the major attention has been given to the long grained Basmati types only whereas some medium and short grained local landraces have better quality and aroma and compete well with the Basmati types. Being able to make these kind of rice genotypes available in the market shall help many marginal farmers of our country and also grow the demand of non basmati type rice varieties among the consumers. Therefore, collection, characterization and conservation of such germplasms is necessary. In the present investigation, Radhunipagol and Danaguri are noted to be long statured, late maturing with grain yield per plant 27.28 and 28.54 respectively. The physical grain quality and cooking parameters were recorded which revealed low amylose content, medium to hard gel consistency and intermediate GT score. Here, Danaguri was strongly aromatic and Radhunipagol was moderately aromatic. The nutritional quality- zinc, iron and protein content showed better result than many Basmati types. High yield with high micronutrient content and aroma is generally preferred therefore the rice varieties Radhunipagol and Danguri can be recommended and utilized in the hybridization programme.

Introduction

Rice is staple food and consumed by majority of the population of the world and the demand shall increase in future. The cultivation and use of small and medium-grained non-Basmati type scented rices in Bengal region of eastern India have been documented in punthi (manuscript), district gazetteers, books, folk literatures, etc. for a long period. Radhunipagol and Danaguri are traditionally cultivated in the lower gangetic alluvial soil of West Bengal. These kind of rice are very popular in Bengali society and culture for preparation of bhog (rice intermixed with pulses), payash (dessert), pistak or pitha (home-made cake), etc. during social functions and religious festivals for a long period, but its cultivation has been marginalized to small pockets of a few districts during last four decades due to large-scale adoption of high-yielding varieties in the region. In the recent times, farmers in native areas cultivate Radhunipagal and Danaguri rice following traditional practices intermixed with a few modern technologies during kharif (wet) season. In the present-day agricultural system, it has become a necessity to register important landraces as farmers' varieties under PPV&FRA, 2001 to strengthen the right of the farming community to conserve, cultivate and protect the same against unauthorized utilization by multi-national seed companies at national and global level. Hence, agro-morphological and physico-chemical characterization of both the rice needs to be done as legal evidence to find out phenotypic and genetic distances from other closely related genotypes as well as to avoid duplication in rice germplasm conservation

system. Grain quality parameters like size and shape of grain and kernel, amylose content (Juliano, 1971), gelatinization temperature (Little *et al*., 1958) and aroma (Nagaraju *et al.*, 1991) were determined at Molecular Laboratory, Department of Genetics and Plant Breeding, University of Calcutta, West Bengal, India.

Materials and Methods

For the present study, two local small-grained non basmati aromatic rice landraces, Radhunipagol and Danaguri were taken. Twenty-five days old seedlings were transplanted in the field during Kharif season 2018. Row and plant spacing of 15 x 20 cm in three replications. In this study, the fertilizer dose of N: P: K used was 60:30:30 Kg ha^{-1}. Agro-morphological characters for randomly selected five plants in each replication were recorded at different crop growth stages. The quantitative characters like days to 50% flowering, days to maturity, plant height (in cm), tillers per plant, panicles per plant, panicle length (in cm), number of filled grains per panicle, 1000 grain weight (g) and total grain yield per plant (g) etc. were recorded.

The DUS descriptors following 'DUS Test Guidelines for Rice' of PPV&FRA, Government of India (www.plantauthority. gov.in) were used to define the morphological and related characteristics of both the rices.

The grain quality parameters recorded were hulling percentage, milling percentage, head rice recovery percentage, elongation ratio. The cooking qualities are amylose content, gel consistency, alkali spreading value, aroma and GT score. The other parameters include micronutrient contents i.e. zinc and iron using Atomic Absorption Spectrophotometric method and protein content by Kjeldahl method.

Results and Discussions

Agromorphological characteristics and DUS Testing

Days to 50% Flowering and Days to maturity reveal that both the genotypes belong to long duration type with late heading and late maturity (Table 1). The plants were long statured. The number of filled grains

Table 1. Mean of the 9 agro-morphological traits of Radhunipagol and Danaguri

ENTRY NAME	DAYS TO 50% FLOWERING	DAYS TO MATURITY	PLANT HEIGHT (IN CMS)	TILLERS PER PLANT	PANICLE PER PLANT	PANICLE LENGTH (IN CMS)	NO. OF FILLED GRAINS PER PANICLE	1000 GRAIN WEIGHT (IN GMS)	TOTAL YIELD PER PLANT (IN GMS)
DANAGURI	123	147	137.66	13	13	23.13	210	27.9	28.54
RADHUNIPAGOL	120	145	126.66	13.33	14.33	28.166	225.66	11.66	27.48

per panicle and the grain yield per plant was average for Radhunipagol and Danaguri. Grain yield values are 27.48 and 28.54 for Radhunipagol and Danaguri respectively. The characteristics and the scale for each characters of the two rice germplasms following DUS Test Guidelines for Rice of Protection of Plant Varieties and Farmers' Rights Authority (PPV & FRA) are described in Table 2. In order to implement the system for plant variety protection and for granting Plant Breeder's Rights to a breeder or farmer or institution, DUS testing is compulsory.

Physical Grain Quality and Cooking Quality Parameters

The grain shape and size of both the rice germplasms is noted to be short and bold. Hulling percentage, milling percentage and head rice recovery percentages for each of the landraces is provided in Table 3. The Elongation ratio for Danguri and Radhunipagol is 2.42 and 2.64 respectively. The amylose content of the rice grains were recorded to be low. Gel consistency is recorded to be medium to hard (Cagampang, G.B., Prez, C.M. and Juliano, B.O. 1973). Generally, soft and tender cooked rice is a preferred characteristics. An intermediate result is noted for alkali spreading value showing that the kernel was segmented and collar was complete and wide. Therefore, the gelatinization temperature (GT) score is intermediate (70°C-74°C). Furthermore, Radhunipagol is moderately aromatic whereas Danaguri is strongly aromatic (Table 4).

TABLE 2. Plant characteristics of Radhunipagol and Danaguri following DUS Test guidelines

Characteristics	Radhunipagol		Danaguri	
	Scale	Remarks	Scale	Remarks
Basal Leaf: Sheath Colour	3	Purple lines	1	Green
Leaf: Distribution of Anthocyanin Colouration	1	On tips only	1	On tips only
Leaf: Pubescence Blade Surface	5	Medium	5	Medium
Leaf: Auricles	9	Present	9	Present
Leaf: Length of Blade	7	Long	7	Long
Leaf: Width of Blade	3	Narrow	3	Narrow
Flag Leaf: Attitude of Blade	3	Semi-erect	3	Semi-erect
Spikelet: Colour of lemma	5		2	
Panicle:Awns	1	Absent	1	Absent
Stem:Thickness	5	Medium	5	Medium
Stem:Length	5	Medium	3	Short
Stem:Anthocyanin colouration of nodes	1	Absent	1	Absent
Stem:Anthocyanin colouration of internodes	9	Present	1	Absent
Stem:Intensity of anthocyanin colouration of nodes	3	Weak	3	Weak
Panicle:Exertion	7	Well-exerted	7	Well-exerted
Grain:Length	1	Very short	1	Very Short
Grain:Width	3	Narrow	3	Narrow
Decorticated grain:Colour	1	White	1	White
Decorticated grain:Aroma	9	Present	9	Present

Table 3. Mean of physical grain quality parameters.

Entry Name	Hulling %	Milling%	Head Rice Recovery %	Elongation Ratio
Danaguri	76.5	66.71	60.69	2.42
Radhuniapgol	78.75	68.78	64.8	2.64

Table 4. Mean of cooking quality parameters.

Entry Name	Amylose content %	Gel consistencymm	Alkali Spreading Value	Aroma	GT Score
Danaguri	14.13	41	5.33	1	Intermediate
Radhunipagol	16.39	32	4.67	2	Intermediate

Table 5. Micronutrient content and Protein Content in Radhuniapagol and Danaguri.

Entry Name	Zinc Content ppm	Iron Contentppm ppm	Protein Content %
Danaguri	38.7	2.88	7.97
Radhunipagol	23.74	2.91	6.57

ppm-parts per million.

Micronutrient and Protein content

Other than grain yield, nutritional quality is equally important to choose the best rice variety for consumption. Also, deficiency of micronutrients lead to malnutrition and various health hazards. The zinc and iron content for both the varities is reported in Table 5. The zinc content in Danaguri is 38.7ppm. Therefore, the nutritional quality for the varieties is found to be more than some the long grained Basmati types. Identification of suitable parents enriched with high micronutrient content along with yield and other quality parameters for future breeding programme is much need in the present days.

Conclusion

Radhunipagol and Danaguri are small grained aromatic rice landraces of West Bengal with late maturity and the plants were long statured having no panicle awns and leaf anthocyanin colour distribution on tips of leaf only. on lower nodes and internodes. The kernels were short-bold in shape and white in colour which had low amylose content, intermediate gelatinization temperature and medium-strong aroma. Though a high similarity is found between Radhunipagal and Danguri yet could be distinguished from each and from other scented rice by the characteristics of anthocyanin colouration on internodes, basal leaf sheath colour and stem length following the DUS test guidelines. These rice genotypes performed better in terms of grain yield and had higher nutritional quality than many Basmati types. Hence, selection of such varieties can be useful in breeding programmes.

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