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Ex situ conservation and qualitative characterization of traditional cultivars of rice (*Oryza sativa* L.)

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Genetic diversity of rice cultivars offers adequate opportunity for added advantage for rice improvement. Current study with 132 traditional rice cultivars had been collected from West Bengal, Manipur and Assam. Those cultivars are being preserved at repository of Uttar Banga Krishi Viswavidyalaya since 2009. Few of them had used in breeding programme to develop new desirable variety with unique characteristics. Those traditional cultivars were phenotypically characterized using PPV&FRA descriptor. In this piece of work, 44 traits were considered to record the morphological differences among the traditional cultivars. All the traditional cultivars showed one or few distinctive features that made different from each other. Finally the traditional cultivars were classified based few anticipated distinctive characters. Amylose content in endosperm was very low in ten, low in twelve, medium in 61 and high in 49 traditional cultivars. Amylose content of milled rice is a significant parameter in respect of consumer preference. Under Indian context, consumers prefer rice with medium amylose content (20-25%) in the endosperm. Strong aroma was emitted by 25, mild aroma by 23 and no aroma in 84 cultivars.

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Germplasm constitutes the foundation of any genetic improvement program of crop. The basic requirements for crop improvement are the knowledge on the extent of variability. It is the basis of all plant improvement programs. A number of scented and non-scented traditional cultivars of rice are available in India in general and Northeastern India in particular[1-3] and they are presently under rice cultivation system whose identity and distinctiveness needs to be established by different approaches for conservation and documentation. Traditional cultivars and wild species possess immense potential of most valuable genes which can be efficiently utilized in the breeding programs to develop high yielding rice varieties with quality and resistance to biotic and abiotic stresses[4,5]. Most of the traditional cultivars are *photoperiod-sensitive*.

Sufficient genetic variability can be used for developing superior cultivar. There is strong need that the local germplasm of scented and non-scented rice to be collected, preserved and characterized in detail[6], subsequently development of suitable cultivar parallel to Basmati for international market-demand. West Bengal is known as 'Bowl of Rice' with more than 450 traditional cultivars of rice[7,8]. Rice is cultivated in West Bengal on over 65% area under agricultural crops[9] in three different rice seasons, such as *Aus* (autumn rice), *Aman* (winter rice) and *Boro* (summer rice). The ecotypes of rice, spontaneously evolved in the state, are so diverse and different that scientists at one time coined them as *Oryza sativa* var. *Benghalensis*[8]. The exceptional variability of traditional cultivars of rice in West Bengal have been well recognized for their unique characteristics, viz., aroma, grain quality, taste, insect pest resistance, disease tolerance, abiotic stress tolerance, floating rice etc. The present research work on traditional cultivars of rice collected from West Bengal, Assam and Manipur were characterized based on "Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on Rice" (*Oryza sativa* L.)'' of PPV & FRA[10].

Methodology

One hundred thirty two traditional cultivars of rice were used in this study. Those traditional cultivars were collected from Assam, Manipur and West

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Bengal. Details of the genotypes studied are being given in Table 1.

Thirty days old seedlings were transplanted (singles seedling per hill) in four lines of 6 m length. RBD was followed with two replications with 132 treatments (Farmers' Varieties), in a total of 264 experimental units. Line to line spacing was 30 cm and hill to hill spacing was 20 cm. Suitable standard

Table 1 — Name of the traditional cultivars of rice used in this study and their place of collection

Sl. No.	Name of landrace	Place of collection/ source of the seed
1.	Ayangleima Phou	Central Agriculture University, Imphal, Manipur
2.	Badshabhog	Maldah district, West Bengal
3.	Baigonmacchua	Tarai Research Society, Alipurduar, West Bengal
4.	Baigonbuchi	Uttar Dinajpur district, West Bengal
5.	Betho	Alipurduar district, West Bengal
6.	Beto	Tarai Research Society, Alipurduar, West Bengal
7.	Binni	Tarai Research Society, Alipur Duar, West Bengal
8.	Birai	ICAR-CPRI- Kahikuchi, Kamrup, Assam
9.	Birali-Selection	UBKV, Pundibari, Cooch Behar, West Bengal
10.	Biroi	Tarai Research Society, Alipurduar West Bengal
11.	Bitti	PSBSG, Sitalkuchi, Cooch Behar district, West Bengal
12.	Boichi	Alipurduar district, West Bengal
13.	Bonnidhan	Tarai Research Society, Alipurduar, West Bengal
14.	Bora	ICAR-CPRI- Kahikuchi, Kamrup, Assam
15.	Chakhao Amubi	Central Agriculture University, Imphal, Manipur
16.	Chakhao Angangbi	Central Agriculture University, Imphal, Manipur
17.	Chakhao Poireiton	Central Agriculture University, Imphal, Manipur
18.	Chakhao-Selection-1	UBKV, Pundibari, Cooch Behar, West Bengal
19.	Chakhao-Selection-2	UBKV, Pundibari, Cooch Behar, West Bengal
20.	Chakhao-Selection-3	UBKV, Pundibari, Cooch Behar, West Bengal
21.	Chakhao Sempak	Central Agriculture University, Imphal, Manipur
22.	Chapka Chakhao	Central Agriculture University, Imphal, Manipur
23.	Chinakamani	BCKV, Mohanpur, West Bengal
24.	Dharam Phou	Central Agriculture University, Imphal, Manipur
25.	Dhyapa	Alipurduar district, West Bengal
26.	Dubari Komal	ICAR-CPRI- Kahikuchi, Kamrup, Assam
27.	Dudhekalam Motajosawa	Tarai Research Society, Alipurduar, West Bengal
28.	Dudhekalam-1	Tarai Research Society, Alipurduar, West Bengal
29.	Dudhekalam-9	Tarai Research Society, Alipurduar, West Bengal
30.	Dudheswar	Tarai Research Society, Alipurduar, West Bengal
31.	Dudheswar -AD	Tarai Research Society, Alipurduar, West Bengal
32.	Fudugey	Kalimpong, Darjeeling district, West Bengal
33.	Garu Chakhua	ICAR-CPRI- Kahikuchi, Kamrup, Assam
34.	Ghee Bora	ICAR-CPRI- Kahikuchi, Kamrup, Assam
35.	Gobindobhog	BCKV, Mohanpur, West Bengal
36.	Hatidat Komal	ICAR-CPRI- Kahikuchi, Kamrup, Assam
37.	Jailang Lal Komal	ICAR-CPRI- Kahikuchi, Kamrup, Assam
38.	Jaldhyapa-2	Sitalkuchi, Cooch Behar district, West Bengal
39.	Jaldhyapa-3	Cooch Behar district, West Bengal
40.	Jaldhyapa-AD	Tarai Research Society, Alipurduar, West Bengal
41.	Jasawa-AD	Alipurduar district, West Bengal
42.	Jashoya	Tarai Research Society, Alipurduar, West Bengal
43.	Jhagarikartik	Tarai Research Society, Alipur Duar, West Bengal
44.	Jhapaka	Kalimpong, Darjeeling district, West Bengal
45.	Jonroi Buna	Uttar Dinajpur district, West Bengal
46.	Kabra	ICAR-CPRI- Kahikuchi, Kamrup, Assam
47.	Kagey	Kalimpong, Darjeeling district, West Bengal
48.	Kaike	Tarai Research Society, Alipurduar, West Bengal
49.	Kalakali	Tarai Research Society, Alipur Duar, West Bengal
50.	Kalo Khasa	Uttar Dinajpur district, West Bengal

(Contd.)

Table 1 — Name of the traditional cultivars of rice used in this study and their place of collection — (Contd.)

Sl. No.	Name of landrace	Place of collection/ source of the seed
51.	Kalo Nunia	Cooch Behar district, West Bengal
52.	Kalobhog-Selection	UBKV, Pundibari, Cooch Behar, West Bengal
53.	Kaloboichi	Tarai Research Society, Alipur Duar, West Bengal
54.	Kalodhyapa	Tarai Research Society, Alipurduar, West Bengal
55.	Kalojeera	BCKV, Mohanpur, West Bengal
56.	Kalshepa	Tarai Research Society, Alipurduar, West Bengal
57.	Kalturey	Kalimpong, Darjeeling district, West Bengal
58.	Kashiya Binni	Tarai Research Society, Alipurduar, West Bengal
59.	Kataribhog	Alipurduar, West Bengal
60.	Kauka	Alipurduar district, West Bengal
61.	Kauka-Selection	UBKV, Pundibari, Cooch Behar, West Bengal
62.	Khaiyamdhan	Tarai Research Society, Alipurduar, West Bengal
63.	Khama	Alipurduar district, West Bengal
64.	Kharadhan	PSBSG, Sitalkuchi, Cooch Behar district, West Bengal
65.	Khasa	Malda district, West Bengal
66.	Kola Joha-Big	ICAR-CPRI- Kahikuchi, Kamrup, Assam
67.	Kola Joha-Small	ICAR-CPRI- Kahikuchi, Kamrup, Assam
68.	Konkoni Joha	ICAR-CPRI- Kahikuchi, Kamrup, Assam
69.	Ladu	PSBSG, Sitalkuchi, Cooch Behar district, West Bengal
70.	Lagidhan	Tarai Research Society, Alipurduar, West Bengal
71.	Laldhyapa	Tarai Research Society, Alipurduar, West Bengal
72.	Maitee	Kalimpong, Darjeeling, West Bengal
73.	Malbati	Tarai Research Society, Alipurduar, West Bengal
74.	Malshira	Tarai Research Society, Alipurduar, West Bengal
75.	Mangamuthi	Tarai Research Society, Alipurduar, West Bengal
76.	Marichsal	Tarai Research Society, Alipur Duar, West Bengal
77.	Mohanbhog	BCKV, Mohanpur, West Bengal
78.	Munimahuari	Kalimpong, Darjeeling district, West Bengal
79.	Pahariboichi	Jalpaiguri district, West Bengal
80.	Pahariboichi-Selection	UBKV, Pundibari, Cooch Behar, West Bengal
81.	Panikuthi Shyamlal	Uttar Dinajpur district, West Bengal
82.	Phoolpakari-1	Tarai Research Society, Alipurduar, West Bengal
83.	Phoolpakari-2	Tarai Research Society, Alipurduar, West Bengal
84.	Phoren Mubi	Central Agriculture University, Imphal, Manipur
85.	Radhatilak	PSBSG, Sitalkuchi, Cooch Behar district, West Bengal
86.	Radhatilak-AD	Tarai Research Society, Alipurduar, West Bengal
87.	Radhunipagal	BCKV, Mohanpur, West Bengal
88.	Rampha	ICAR-CPRI- Kahikuchi, Kamrup, Assam
89.	Ronga Komal	ICAR-CPRI- Kahikuchi, Kamrup, Assam
90.	Sada Nunia	Cooch Behar district, West Bengal
91.	Sadabhatkalo	PSBSG, Sitalkuchi, Cooch Behar district, West Bengal
92.	Sadamala	Tarai Research Society, Alipurduar, West Bengal
93.	Satia	Tarai Research Society, Alipurduar, West Bengal
94.	Seshphal	Alipurduar district, West Bengal
95.	Sial Bhomra	Tarai Research Society, Alipurduar, West Bengal
96.	Silathia Bora	ICAR-CPRI- Kahikuchi, Kamrup, Assam
97.	Singara	Alipurduar district, West Bengal
98.	Sitalkuchi-1	UBKV, Pundibari, Coch Behar, West Bengal
99.	Sitalkuchi-2	UBKV, Pundibari, Coch Behar, West Bengal
100.	Sitalkuchi-3	UBKV, Pundibari, Coch Behar, West Bengal
101.	Sitalkuchi-4	UBKV, Pundibari, Coch Behar, West Bengal
102.	Sitalkuchi-5	UBKV, Pundibari, Coch Behar, West Bengal
103.	Sitalkuchi-6	UBKV, Pundibari, Coch Behar, West Bengal
104.	Tarapakari	Tarai Research Society, Alipurduar, West Bengal

(Contd.)

Table 1 — Name of the traditional cultivars of rice used in this study and their place of collection— (Contd.)

Sl. No.	Name of landrace	Place of collection/ source of the seed
105.	Tarapakari-Selection	UBKV, Pundibari, Cooch Behar, West Bengal
106.	Thuri	PSBSG, Sitalkuchi, Cooch Behar district, West Bengal
107.	Tarai Research Society-1	Tarai Research Society, Alipurduar, West Bengal
108.	Tarai Research Society -2	Tarai Research Society, Alipurduar, West Bengal
109.	Tarai Research Society -3	Tarai Research Society, Alipurduar, West Bengal
110.	Tarai Research Society -4	Tarai Research Society, Alipurduar, West Bengal
111.	Tulaipanji	Uttar Dinajpur, West Bengal
112.	Tulaipanji-AD	Alipurduar, West Bengal
113.	Tulsibhog	Alipurduar, West Bengal
114.	Tulsimukul	Tarai Research Society, Alipurduar, West Bengal
115.	Uttar Banga Local -2	Tarai Research Society, Alipurduar, West Bengal
116.	Uttar Banga Local -3	Tarai Research Society, Alipurduar, West Bengal
117.	Uttar Banga Local -3-1	UBKV, Pundibari, Cooch Behar, West Bengal
118.	Uttar Banga Local -5	Tarai Research Society, Alipurduar, West Bengal
119.	Uttar Banga Local -6	Tarai Research Society, Alipurduar, West Bengal
120.	Uttar Banga Local -7	Tarai Research Society, Alipurduar, West Bengal
121.	Uttar Banga Local -8	Tarai Research Society, Alipurduar, West Bengal
122.	Uttar Banga Local -9	Tarai Research Society, Alipurduar, West Bengal
123.	Uttar Banga Local-10	Tarai Research Society, Alipurduar, West Bengal
124.	Uttar Banga Local -11	Tarai Research Society, Alipurduar, West Bengal
125.	Uttar Banga Local -12	Tarai Research Society, Alipurduar, West Bengal
126.	Uttar Banga Local -13	Tarai Research Society, Alipurduar, West Bengal
127.	Uttar Banga Local -14	Tarai Research Society, Alipurduar, West Bengal
128.	Uttar Banga Local -15	Tarai Research Society, Alipurduar West Bengal
129.	Uttar Banga Local -16	Tarai Research Society, Alipurduar, West Bengal
130.	Uttar Banga Local -17	Tarai Research Society, Alipurduar, West Bengal
131.	Uttar Banga Local -18	Tarai Research Society, Alipurduar, West Bengal
132.	Uttar Banga Local -19	Tarai Research Society, Alipurduar, West Bengal

cultural practices were followed[11] to obtain good crop stand. The crop was transplanted during 2nd week of July, during *Kharif* season of 2013 and 2014.

Data of various traits were as per the "Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on Rice (*Oryza sativa* L.)" of Protection of Plant Varieties and Farmers' Rights Authority (2007), New Delhi, Government of India[10]. Ten plants from each replication were considered for recording data. To study the stability, traditional cultivars were grown for two consecutive seasons (*Kharif* 2013 and *Kharif* 2014). Data and/or observations were recorded on 44 qualitative and quantitative characters.

Results and Discussion

Ex situ conservation

Collected traditional cultivars are being conserved by cultivating every year during *Kharif* season. Seedlings are raised in the puddle condition during second week of June. Thirty days old seedlings are transplanted (singles seedling per hill) in four lines of 6 m length for each traditional cultivars. Line to line spacing was 30 cm and hill to hill distance was 20 cm. Appropriate cultural practices compatible to humid tropic Tarai Zone were followed to obtain good crop stand[11].

Vigorous roguing was implemented done during all the critical stages of the crop, such as, active tillering, before flowering, during flowering and before harvesting. Roguing is done based on morphological characteristics of the plant to confirm varietal uniformity. Those 132 traditional cultivars are being conserved *ex situ* since 2009 at Rice Research Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India (Fig. 1).

Qualitative and quantitative characterization

In the guideline of DUS characterization of rice (PPV&FRA, 2007), there are 62 distinct characters. In this endeavor, 44 characters have been used for characterization of 132 traditional cultivars (Supplementary Table 1). All this 44 distinctive characters have been used for characterization under different state of the each character.

Fig. 1 — Some distinctive characters of traditional cultivars. a) Tulsibhog; b) Sadamala; c) Radhatilak; d) Pahariboichi; e) Kauka; f) Thuri; g) Ramigelee; h) Jasoya; i) Kaloboichi j) Kartick Sal; k) Dudhkalam; l) Tulaipaniji; m) Kalo Nunia; n) Radhatilak; o) Bora; p) Kalo Joha; q) Konkoni Joha.

Coleoptiles of all the traditional cultivars showed no color, thus, all the traditional cultivars under our study were classified as 'colorless' (Table 2). Out of 132 traditional cultivars, 110 traditional cultivars showed green colored basal leaf sheath (Hatidat Komal, Tulsibhog, Kauka, Mohanbhog, etc.).

Leaf colour of 11 cultivars were light green, 42 were medium green and 78 were dark green indicating that most of the cultivars were having dark green leaves. Only five had anthocyanin colouration on leaves and remaining 127 cultivars no anthocyanin colouration (Table 2). Out of those five with anthocyanin colouration in leaf, Chakhao-Selection-1 showed anthocyanin colouration at leaf tip only, further two cultivars, namely Kataribhog and Chakhao-Selection-2 showed anthocyanin colouration only as blotches on leaves. Kharadhan exhibited uniform anthocyanin colouration throughout the leaf.

Leaf sheath anthocyanin colour also varied among the cultivars. Twenty seven cultivars showed anthocyanin colouration. Remaining 105 cultivars had no leaf sheath anthocyanin colouration. Out of those 27 cultivars with anthocyanin colouration, six cultivars (Silathia Bora, Uttar Banga Local-6, Kagey, Sitalkuchi-

Table 2 — Variability in qualitative characters of traditional cultivars

Sl. No.	Characters	Classification	No of traditional cultivars
1.	Coleoptiles: Color	Colorless	132
		Green	0
		Purple	0
2.	Basal leaf: sheath color	Green	110
		Light Purple	17
		Purple lines	4
		Uniform purple	1
3.	Leaf: Intensity of green color	Light	11
		Medium	43
		Dark	78
4.	Leaf: Anthocyanin coloration	Absent	127
		Present	5
5.	Leaf: Distribution of anthocyanin coloration	On tips only	1
		In blotches only	2
		On margins only	1
		Uniform	1
6.	Leaf sheath: anthocyanin coloration	Absent	105
		Present	27
7.	Leaf sheath: Intensity of anthocyanin coloration	Very Weak	6
		Weak	12
		Medium	6
		Strong	2
		Very Strong	1
8.	Leaf: Pubescence of blade surface	Absent	0
		Weak	5
		medium	31
		strong	78
		Very strong	18
9.	Leaf: Auricle	Absent	0
		Present	132
10.	Leaf: Anthocynin coloration of auricle	Colorless	119
		Light purple	8
		Purple	5
11.	Leaf: Anthocynin coloration of collar	Absent	118
		Present	14
12.	Leaf: Ligule	Absent	0
		Present	132
13.	Leaf: Shape of ligule	Truncate	0
		Acute	0
		Split	132
14.	Leaf: Color of ligule	White	119
		Light purple	8
		Purple	5
15.	Culm: attitude	Erect	53
		Semi-erect	51
		Open	21
		Spreading	7
16.	Flag Leaf: attitude of blade (early obs.)	Erect	109
		Semi-erect	23
		Horizontal	0
		Drooping	0
17.	Spikelet: Density of pubescence of lemma	Absent	0
		Weak	30
		Medium	42
		Strong	40
		Very strong	20

(Contd.)

Table 2 — Variability in qualitative characters of traditional cultivars — (Contd.)

Sl. No.	Characters	Classification	No of traditional cultivars
18.	Male sterility	Absent	132
		Present	0
19.	Lemma: Anthocyanin coloration of keel	Absent/Very weak	57
		Weak	18
		Medium	13
		Strong	24
		Very Strong	20
20.	Leaf: Collar	Absent	0
		Present	132

1, Chapka Chakhao, Hatidat Komal, Sada Nunia and Kataribhog) were with very weak anthocyanin colouration, 12 cultivars (Ronga Komal, Bonnidhan, Garu Chakua, Jonroi Buna, Kalokhasa, Singara etc.) were classified as weak anthocyanin colouration, six (Dubari Komal, Chakhao Poireiton, Chakhao Sempak, Dharam Phou, Sitalkuchi-2 and Ghee Bora) were medium anthocyanin colouration, two cultivars (Chakhao Amubi and Chakhao-Selection-2) showed strong anthocyanin colouration and Kharadhan exhibited very strong colouration.

Leaf pubescence was present in all the traditional cultivars. Five of those showed weak pubescence (Phoolpakari, Jashoya, Kalakali, Radhunipagal and Kalodhyapa), 31 were found to have medium pubescence (Chakhao Poireiton, Uttar Banga Local-10, Munimahuauri, Malshira, Kalojeera, Tulaipanji etc.), 78 were strong (Khaiyamdhan, Tarai Research Society-3, Tulsimukul, Radhatilak-2, Baigonmacchua, Laldhyapa etc.) and 18 (Uttar Banga Local-9, Kashiya Binni, Beto, Panikuthi Shyamlal, Binni, Chakhao Angangbi etc.) were very strong leaf pubescence (Table 2). None of the cultivars showed absence of pubescence of blade surface of leaf (Table 2). Five of the cultivars showed weak leaf pubescence, 31 were medium, 78 were strong and 18 showed very strong leaf pubescence.

Only 27 cultivars showed leaf sheath anthocyanin coloration (Table 2) and remaining 105 showed no leaf sheath anthocyanin coloration. Six cultivars had very weak anthocyanin coloration (Table 2), 12 weak, 06 medium, 02 strong and 01 (Kharadhan) showed very strong anthocyanin color. Most of the traditional cultivars of rice illustrated very weak and weak anthocyanin color on leaf sheath.

All the cultivars exhibited presence of leaf auricle (Table 2). Among the cultivars studied here, 119 were colorless auricle, 08 were light purple and 05 were purple color auricles. All cultivars had well defined collar of which, 118 had no anthocyanin coloration of leaf collar. All 132 traditional cultivars showed presence of ligule at leaf collar region. All had split shape of ligule (Table 2) of which, 119 were white 08 were light purple and 05 were purple colored.

Fifty three cultivars had erect culm, 51 were semi-erect, 21 were open and only 07 were spreading type of culm. The number of cultivars with erect type of flag leaf blade were 109 (Table 2) and 23 were semi-erect. All cultivars showed the presence of pubescence of lemma in varying densities (Table 2). Thirty cultivars had weak pubescence, 42 had medium, 40 had strong and 20 showed very strong pubescence of lemma.

Fifty seven cultivars were found absent or very weak anthocyanin coloration of keel (Table 3), 18 had weak anthocyanin, 13 were medium, 24 were strong and 20 were found to have very strong anthocyanin coloration of keel. Fifty eight cultivars had no anthocyanin coloration of area below apex, 13 were weak, 14 were medium, 37 were strong and 20 were found to have very strong anthocyanin coloration of area below apex. Fifty five cultivars had no anthocyanin coloration of apex (Table 3), 15 were weak, 11 were medium, 26 were strong and 25 were found very strong anthocyanin coloration of apex.

Most of the cultivars (118) showed white colored stigma (Table 3), only two (Chakhao Poireiton, Konkoni Johaand) had light purple colored stigma and 12 were found to have purple colored stigma. Ten cultivars showed anthocyanin coloration of nodes (Table 3) of which, 03 were weak 02 were medium and five were found to have strong intensity of coloration of. Only 11 cultivars had anthocyanin coloration of internodes. Thirty three cultivars showed erect type of attitude of blade (Table 3), 87 were semi-erect, 08 were horizontal and only 04 showed drooping type of attitude of blade.

Table 3 — Variability in qualitative characters of traditional cultivars

Sl. No.	Characters	Classification	No of traditional cultivars
1.	Lemma: Anthocyanin coloration of area below apex	Absent	58
		Week	13
		Medium	14
		Strong	27
		Very Strong	20
2.	Lemma: Anthocyanin coloration of apex	Absent	55
		Week	15
		Medium	11
		Strong	26
		Very Strong	25
3.	Spikelet: Color of stigma	White	118
		Light green	
		Yellow	
		Light purple	2
		Purple	12
4.	Stem: Anthocyanin coloration of nodes	Absent	122
		Present	10
5.	Stem: Intensity of anthocyanin coloration of nodes	Week	3
		Medium	2
		Strong	5
6.	Stem: Anthocyanin coloration of inter-nodes	Absent	121
		Present	11
7.	Flag leaf: attitude of blade (late observation)	Erect	33
		Semi-erect	87
		Horizontal	8
		Drooping	4
8.	Panicle: Curvature of main axis	Straight	3
		Semi Straight	30
		Deflexed	40
		Drooping	59
9.	Spikelet: Color of tip of lemma	White	0
		Yellow	35
		Brown	27
		Red	24
		Purple	22
		Black	24
10.	Lemma and Palea: Color	Straw	21
		Gold & gold furrows on straw background	35
		Brown spots on straw	8
		Brown furrow on straw	3
		brown (tawny)	
		Redish to light purple	26
		Purple spots/ furrow on straw	23
		Purple	6
		Black	10
11.	Panicle: awns	Absent	100
		Present	32
12.	Panicle: color of awn (late observation)	Yellowish white	5
		Yellowish brown	9
		Brown	3
		Redish brown	4
		Light red	
		Red	3
		Light purple	5
		Purple	3
		Black	0

(Contd.)

Table 3 — Variability in qualitative characters of traditional cultivars — (Contd.)

Sl. No.	Characters	Classification	No of traditional cultivars
13.	Panicle: distribution of awn	Tip only	17
		Upper half only	7
		Whole length	8
14.	Panicle: Presence of Secondary Branch	Absent	0
		Present	132
15.	Panicle: Secondary Branching	Weak	32
		Strong	99
		Clustered	1
16.	Panicle: Attitude of branching	Erect	3
		Erect to semi-erect	20
		Semi-erect	20
		Semi-erect to spreading	80
		Spreading	9
17.	Panicle: Exertion	Partially exerted	0
		Mostly exerted	22
		Well exerted	110

Three showed straight panicle curvature of main axis (Table 3), 30 were semi-straight, 40 were deflexed and 59 were drooping type of panicle curvature of main axis. Thirty five cultivars showed yellow spikelet color of tip of lemma (Table 3), 27 were brown, 24 were red, 22 were purple and 24 showed black spikelet color of tip of lemma. Twenty one cultivars were found have straw coloured lemma and palea (Table 3), 35 were gold and gold furrows on straw background, 08 were brown spot on straw, 03 were brown furrows on straw colour, 26 were reddish to purple, 23 were purple spots/furrows on straw, 06 were purple coloured and 10 were black colour lemma and palea.

Only 32 cultivars were found to have awn (Table 3) of which, 05 cultivars showed yellowish white coloured awn, 09 were yellowish brown, 03 were brown, 04 were redish brown, 03 were red, 05 were light purple and 03 showed purple color awn. Seventeen cultivars showed their distribution of awn on tips only (Table 3), 07 were found their distribution at upper half only and 08 were found their distribution on whole length of the panicle.

In present study, all the cultivars were found with presence of secondary branching of panicle (Table 3). Thirty two cultivars had weak secondary branching, 99 had medium secondary branching and only 01 had cluster secondary branching of panicle (Thuri). Clustered habit appears to result mainly from reduction in pedicel length. This feature resulted high grain density in a panicle[12]. This result also corroborated with the findings of Chakrabarty *et al*. for the cultivar Khejurchari. Findings of Sahu *et al*.[14] for the cultivars Amajhopa, Kaudidhul, Chhindguchhi, Nariyal Phool and Amaruthi also established the availability of clustered panicles in the traditional cultivars of rice. Three cultivars had erect type of panicle attitude of branches, 20 were erect to semi-erect type, 20 were semi-erect type, 80 were semi-erect to spreading type and only 09 had spreading type of panicle attitude of branches. Twenty two cultivars had mostly exerted panicle. Rremaining 110 had well exerted panicle.

Fifteen cultivars showed early leaf senescence (Table 4), 95 were under medium category and 22 were late. In present study out of 132 cultivars, 13 showed white color of sterile lemma (Table 4), 68 were straw coloured, 09 were gold coloration, 07 were red and 35 were purple.

Shape of decorticated grain of 46 cultivars were short, 18 were medium slender, 54 were long bold and 14 were long slender. Colour of decorticated grain of 07 cultivars were green (Table 4), 47 were white, 34 were light brown, 07 were variegated brown, 13 were

Table 4 — Variability in qualitative characters of traditional cultivars

Sl. No.	Characters	Classification	No of traditional cultivars
1	Leaf senescence	Early	15
		Medium	95
		Late	22
2.	Sterile lemma: color	White	13
		Straw	68
		Gold	9
		Red	7
		Purple	35
3.	Grain: Phenol reaction of lemma	Absent	
		Present	
4.	Decorticated grain: Shape (in lateral view)	Short slender	0
		Short bold	46
		Medium slender	18
		Long bold	54
		Long slender	14
		Extra- long slender	0
5.	Decorticated grain: Color	Light Green	7
		White	40
		Light brown	34
		Variegated brown	7
		Dark brown	13
		Light red	17
		Red	8
		Variegated purple	
		Purple	1
		Dark purple	5
6.	Endosperm: Presence of amylose	Absent	0
		Present	132
7.	Decorticated grain: Aroma	Absent	84
		Present	38

dark brown, 17 were light red, 08 were red and 05 were dark purple. The extent of amylose content in endosperm was classified into five categories, like very low (<10%), low (10-19%), medium (20-25%) and high (26-30%) and very high (>30%). Ten cultivars showed very low content of amylose in endosperm (Table 4), 12 had low amylose, 61 had medium amylose and 49 had high amylose in the endosperm. Amylose content is very important in respect of consumer preference under Indian circumstances. The medium amylose content (20-25%) is preferred by Indian consumers as it remains non-sticky.

Twenty five cultivars were found strong aromatic (Kalo Nunia, Kalobhog-selection, Badshabhog, Chinakamani, Mohanbhog, Tulaipanji, Kalojeera, Gobindobhog, Tulsibhog, Konkoni Joha, Kola Joha-Small, Kola Joha-Big, Rampha, Kabra, Birai, Ghee Bora, Jailang Lal Komal, Silathia Bora, Garu Chakhua, Bora, Munimahuauri, Kalturey, Khasa, Chakhao Poireiton, Radhunipagal), 23 were found medium aromatic (Sial Bhomra, Jhagarikartik, Bitti, Sada Nunia, Kataribhog, Khama, Baigonmacchua, Tulaipanji-AD, Uttar Banga Local-19, Laldhyapa, Singara, Kalakali, Marichsal, Kauka, Lagidhan, Dubari Komal, Hatidat Komal, Ronga Komal, Uttar Banga Local-7, Uttar Banga Local-8, Uttar Banga Local-12, Uttar Banga Local-16, Tarai Research Society-4) and remaining 84 were found non-aromatic. As a natural gift, the 'Basmati' is known for its aroma and grain characteristics, such as long slender grains. It occupied a considerable international and national markets for it aroma and long slender grains and it gets high price. Many local traditional cultivars are grown traditionally which excel in aroma, grain quality and cooking quality. A large number of aromatic traditional cultivars are available in our country, particularly in eastern and north-states.

Crop genetic resources are of utmost important requirement of crop improvement. The modern high yielding rice varieties gradually replaced the traditional varieties and land races of rice resulting in reduction in varietal diversity across the country[15-17]. In the last 100 years as many as 100000 varieties of rice have simply vanished from the farmers' field. At present there are fewer than a dozen of varieties are being cultivated in 70% of the land under rice[18]. Conservation of rice biodiversity is a vital approach to addressing sustainability in a rapidly changing world. Biodiversity is intrinsically essential for conservation of valuable traits[19,20]. Considering the importance of conservation of rice genetic resources, 132 local traditional cultivars have been characterized and are being conserved *ex situ* at Rice Research Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India.

Every landrace had shown one or few distinctive characters confirming them different from other existing traditional cultivars and modern varieties in respect qualitative and quantitative characters[3,5,6,1,21-24]. Very high variability was observed among the land races for days to heading, plant height, number of effective tillers per hill, pubescence of blade surface of leaf[21,23], attitude of blade (late observation) of flag leaf[24], number of grains per panicle[25,26], grain dimensions, awn[6,21], culm attitude[22], 1000-grains

weight[26], colour of lemma and pelea, decorticated grain color[12], grain aroma[26,27], amylose content of endosperm, and grain yield[27].

Those distinct rice land races are being conserved *ex situ* at Rice Research Farm of Uttar Banga Krishi Viswavidyalaya. Cultivar diversity reflects the 'Use Value' of rice. Thus the maintenance of cultivar diversity has a positive option value, since it possesses options open, as farmers do not know the future benefit and use of presence of variability of traditional cultivars[28].

Conclusions

Diversity of rice land races provides ample opportunity for further improvement of the crop. Some of the traditional cultivars have been used in breeding programme to introduce unique desirable character(s) to already in cultivated variety. Every landrace possessed one or few distinctive features which made them different from other existing traditional cultivars. Finally the traditional cultivars were classified based on few anticipated distinctive characters. The desirable traits of those traditional cultivars may be introgressed in the cultivated genotypes for their further improvement. Out of 132 traditional cultivars, 25 traditional cultivars were found strong aromatic, 23 were mild aromatic and remaining 84 were non-aromatic.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at http://nopr.niscair.res.in/jinfo/ijtk/IJTK_21(01)(2022)168-179_Suppl Data.xlsx

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Conflicts of Interest

The authors have no conflict of interest to disclose.

Authors' Contributions

DTS and BR designed the study; DTS conducted the field experiment and collected data; DTS, MR, BR, SKR analyzed the data, DTS, SM, NS, GKP did the biochemical analysis, DTS, BR, SKR, MR took part in writing the manuscript.

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