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An Evaluation of Biochemical Characteristics of Rice (*Oryza sativa* L.) Landraces from Central and Peninsular India

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Introduction

Rice (*Oryza sativa* L.) is a major staple for half of the population worldwide. Different morphological and agronomic traits enable an easy and quick discrimination between varietal phenotypes. These characteristics are generally highly heritable, can be easily seen by the eye and are equally expressed in all environments. Therefore, these traits are *assessed* to distinguish a landrace population, and the durability, uniformity and stability (DUS) of these traits ensures the genetic purity of the landrace. Evaluation of these characteristics can be carried out by any farmer or researcher without institutional training and technical support. A compilation of these characteristics would be of great use to the farmers and conservators to ascertain the genetic purity and uniformity of the cultivars. An example is Deb's (2005) pioneering compilation of 36 morphological and agronomic characteristics of 417 *indica* rice landraces.

In addition to the morphological descriptors, biochemical descriptors are also important for characterization of rice landraces. Although a few of this biochemical characterization can be carried out by ordinary farmers, they are ideally performed in a laboratory. These biochemical descriptors are useful to curators for the management and maintenance of germplasm collection and to all users of rice genetic resources. We present here the first compilation of 6 biochemical descriptors of 238 rice landraces from central and peninsular India.

Materials

We examined a total of 238 rice varieties from Basudha's accession from nine states of central and peninsular India, namely, Andhra Pradesh, Chhattisgarh, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu and Telangana (**Fig. 1 and Table 1**).

Table 1: The number of Rice Landraces from Central and Peninsular Indian States Selected for Chemical Tests.

States	Number of varieties
Andhra Pradesh	1
Chhattisgarh	45
Goa	4
Karnataka	84
Kerala	33
Madhya Pradesh	1
Maharashtra	33
Tamil Nadu	33
Telangana	4
Total	238

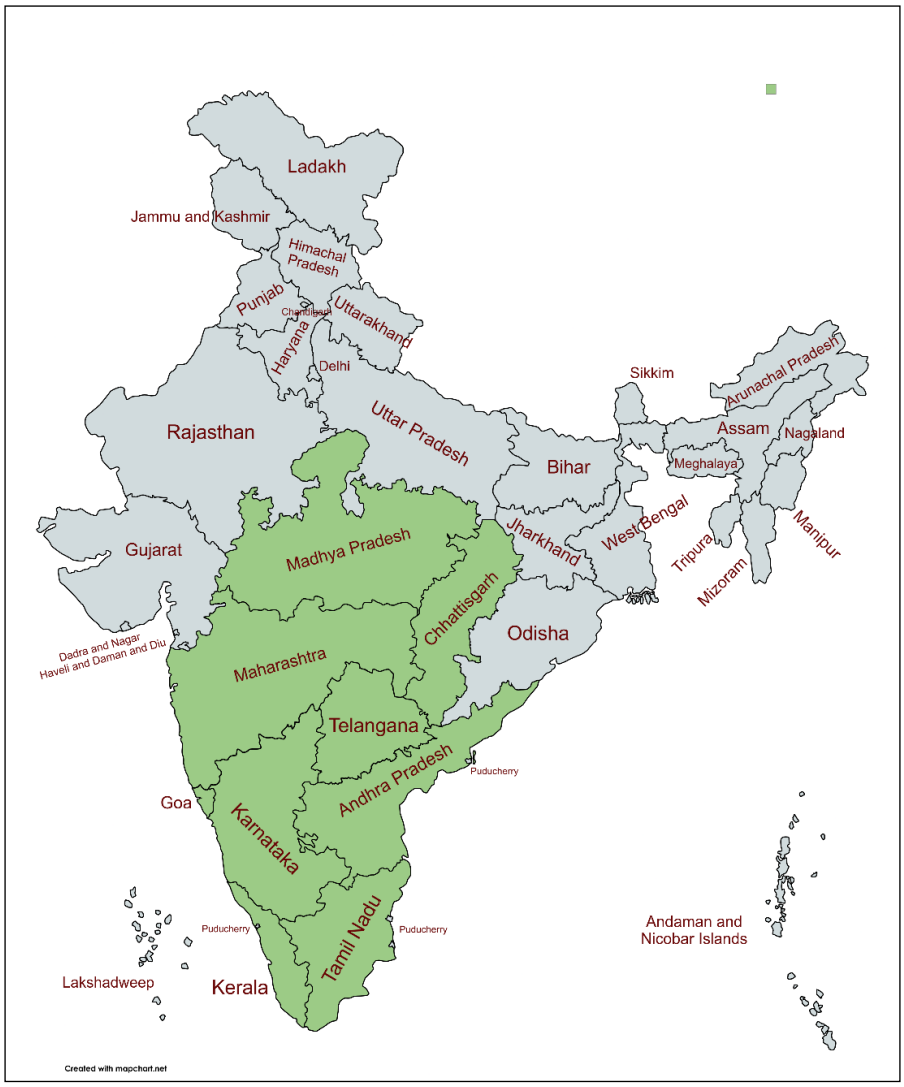

Fig. 1: Map Showing the States of Origin of the Rice Accessions from Central and Peninsular India (in green)

Methods

For biochemical characterization of the selected rice landraces, we evaluated the following descriptors: endosperm type based on amylose content; aroma, based on the presence of 2-acetyl 1-pyrroline (2AP); alkali digestion; gel consistency; and phenol reaction of the rice hull.

(a) *Endosperm Type*

By visual observation, two types of endosperms of polished rice kernels are distinguishable. In glutinous rice, which does not have amylose, the endosperm appears a waxy white. In non-glutinous rice, which contains

amylose, the endosperm appears cloudy and translucent (Bioversity International, IRRI & WARDA 2007). The standard classification is given in **Table 2**.

Table 2: Visual Classification of Endosperm Type

Visual Description	Endosperm type
Translucent	Non-glutinous
Cloudy	Intermediate
Waxy	Glutinous

(b) *Aroma*

Basmati-like aroma in fragrant rice landraces is detected when the rice kernel contains 2AP. As there is no transducer for chemical senses, the only reliable method of detection of aroma is by employing the human nose to smell the samples. For smelling, we relied on at least two trained persons to detect the aroma.
Alkali is known to enhance the release of 2AP, and acidification inhibits the release of 2AP. The characteristic smell of 2AP disappears after acid treatment and reappears upon re-alkalization. Accordingly, we used the method described by Brahmachary and Poddar-Sarkar (2015). We took 4 – 5 grains of unpolished rice kernels in a Petri dish, added 3 drops of 2% (w/v) KOH on the kernels, and left the sample under glass cover for 20 minutes. After 20 minutes the cover was removed for smelling the sample. Regardless of detection of any basmati-like aroma, we subsequently added 4 drops of 2% (w/v) HCl to acidify the sample, upon which the aroma disappeared. After this we added 5-6 drops of 2% (w/v) KOH to re-alkalize the kernels and cover the Petri dish. After 20 minutes we smelled the sample again, and the presence or absence of Basmati-like aroma was recorded. The strength of the aroma was recorded according to the standard code (Table 3):

Table 3: Standard Code for the Strength of Aroma due to Presence of 2AP

Strength of Aroma	Code
No aroma	0
Mild aroma	1
Strong aroma	2

(c) *Alkali Digestion*

Alkali digestion was measured by using methods of Little et al. (1958) and Chemutai et al. (2016), with slight modification. We placed 3 - 4 unpolished kernels of each rice landrace in a petri-dish. 3 to 4 drops of 2% (w/

v) KOH were added onto the kernels, submerging them in the solution. The petri dishes were then covered and placed at room temperature for 16 hours. After 16 hours the degree of disintegration of the kernels was rated visually according to standard evaluation system for rice by Bioversity International (**Table 4**).

Table 4: Standards of the Degree of Alkali Digestion.

Degree of Alkali Digestion	Classification
Grain not affected but chalky	Low
Grain swollen	Low
Grain swollen with collar incomplete	Intermediate
Grain collar complete and wide	Intermediate
Grain split with wide collar	Intermediate
Grain dispersed merging with collar	High
Grain fully dispersed	High

(d) *Gel Consistency*

Gel consistency in rice genotypes was determined by using the methods given in Cagampang et al. (1973), Chemutai et al. (2016) and Sattari et al. (2015) with slight modification. For each landrace, 100 mg ground kernels were weighed and placed in a 13 mm X 125 mm test tube, to which 0.2 ml of 95% ethanol containing 0.025% thymol blue was added. 2 ml of 0.2N KOH was added and stirred gently for 30 seconds on an electrical vortex. Subsequently, the test tubes with samples were placed in a boiling water bath at 102 °C for 10 minutes. The test tubes were then kept at room temperature for 5 minutes and then kept in ice bath for 30 minutes. Finally, the tubes were taken out and placed horizontally on a graph paper on a flat surface. After 1 hour, the distance travelled by the gel was measured. From the distance travelled by the gel, the consistency was inferred from the standard classification (**Table 5**).

Table 5: Gel Consistency Standards

Gel Distance (mm)	Gel
>60 mm	Soft
40 – 60 mm	Intermediate
< 40 mm	Hard

(e) Phenol Reaction

Phenol reaction was assessed by using the method described in Chang and Bardenas (1965), with slight modification. We took a clean Petri dish (90 mm diameter) and marked 4 zones for 4 samples in the Petri dish by writing the sample codes in their respective zones in the dish. We placed 3 rice grains (with husk) of each landrace on its demarcated position, onto which we added 3 drops of 2% phenol solution and kept each Petri dish for 48 hours in a dark place at room temperature. After 48 hours of soaking in phenol, each Petri dishes were taken out one by one and the colour change on the grains of each sample was recorded, following the standard classification (**Table 6**). Most of the indica varieties and wild Oryza species take on a dark brown or black coloration as a result of polyphenol oxidase activity whereas japonica varieties show no colour change.

Table 6: Standard Codes of Colour Change in Reaction to Phenol.

Reaction	Code
No color change	0
Mild color change	1
Purple or black color	2

Results

The results of our assessment are given in **Table 7**. Our data presented here are the first quantitative assessment of biochemical characteristics of 238 rice landraces from central and peninsular India and reveal that 42 landraces (17.64%) are aromatic. Gel consistency for 19 (7.98%) landraces was found to be considerably hard. A total of 18 landraces (7.56 %) are glutinous, and 45 landraces (18.90%) are non-reactive to phenol, plausibly indicating the introgression of these traits from *japonica* ancestral lines.

Table 7: Evaluation of Biochemical Characteristics of 238 Landraces from Central and Peninsular India.

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
STATE: ANDHRA PRADESH						
NELLUR PISTHAL	Non-glutinous	1	Intermediate	100	Soft	2
STATE: CHHATTISGARH						
ANANDA DHAN	Intermediate	0	Intermediate	112	Soft	2
ARDIGATI	Non-glutinous	0	Low	105	Soft	2
BANASPATTI	Intermediate	0	Intermediate	115	Soft	2
BAREGI	Intermediate	0	Intermediate	90	Soft	2
BASMATI ©	Non-glutinous	2	Intermediate	105	Soft	2
BIRI DHAN	Non-glutinous	0	Intermediate	108	Soft	1
CHITRI	Glutinous	0	Intermediate	112	Soft	1
DAVAR	Intermediate	0	Low	115	Soft	2
DOKRA DOKRI	Non-glutinous	0	Intermediate	110	Soft	2
DUBRAJ	Non-glutinous	0	Intermediate	115	Soft	0
DUDHIYA DANAR	Intermediate	0	Intermediate	70	Soft	1
HALDIGHATI	Non-glutinous	0	Intermediate	102	Soft	0
JAUPHUL	Non-glutinous	1	Intermediate	115	Soft	0
JEERAPHUL	Non-glutinous	1	Intermediate	84	Soft	1
KARRA PHUL	Intermediate	1	Low	48	Intermediate	1
KHURA BAHO	Non-glutinous	0	Intermediate	100	Soft	1
LAL CHURI	Non-glutinous	0	Low	87	Soft	0
LAL DHAN (C)	Intermediate	0	Intermediate	106	Soft	2
LAL DHAN PATLA	Non-glutinous	0	Intermediate	108	Soft	0
LOHONDI	Non-glutinous	2	Intermediate	92	Soft	1
LUSRI	Non-glutinous	1	Intermediate	115	Soft	2
MAKHAN	Non-glutinous	0	Intermediate	15	Hard	1
MALA GOURI	Intermediate	0	Intermediate	105	Soft	1
MASMUR LAILU	Intermediate	0	Intermediate	112	Soft	2
MUJARE	Non-glutinous	0	Low	70	Soft	2

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
PITTI HIDSK	Non-glutinous	2	Intermediate	112	Soft	1
PORTI	Non-glutinous	0	Low	95	Soft	2
RAJ BAKO	Intermediate	0	Intermediate	117	Soft	1
RAM KELA	Non-glutinous	0	Intermediate	115	Soft	2
RAMBHOG	Intermediate	2	Intermediate	105	Soft	2
RAMIGALI	Non-glutinous	0	Intermediate	90	Soft	2
RAMKALI	Non-glutinous	0	Intermediate	85	Soft	2
RAM-LAKSHMAN	Non-glutinous	0	Intermediate	95	Soft	1
RUPOILI	Non-glutinous	0	Intermediate	95	Soft	1
SAFRI	Non-glutinous	0	Intermediate	85	Soft	2
SIKI	Non-glutinous	0	Intermediate	100	Soft	0
SINDUR SINGHA	Non-glutinous	0	Low	72	Soft	1
SONA PAN	Intermediate	0	Intermediate	90	Soft	2
SRIKOMAL	Non-glutinous	0	Intermediate	115	Soft	1
TIL KASTURI	Non-glutinous	0	Low	70	Soft	2
TULSI MALA	Intermediate	0	Intermediate	98	Soft	1
VISHNUBHOG (C)	Non-glutinous	0	Intermediate	70	Soft	0
VISHNUBHOG-1 (C)	Non-glutinous	2	Low	115	Soft	2
WARANGAL	Intermediate	0	Intermediate	90	Soft	2
WEDO	Non-glutinous	0	Intermediate	82	Soft	1
STATE: GOA						
KONCHRI	Intermediate	0	Intermediate	120	Soft	1
KORGUT	Intermediate	0	Intermediate	102	Soft	2
KORGUT KHARI	Non-glutinous	0	Low	65	Soft	1
SAHABHAGI	Non-glutinous	0	Intermediate	75	Soft	1
STATE: KARNATAKA						
AJIPA	Non-glutinous	2	Intermediate	85	Soft	0
ALLURU SUNNA	Non-glutinous	0	Intermediate	107	Soft	2
AMBEMOHAR	Glutinous	0	Low	32	Hard	1
ANANDI	Glutinous	0	Low	5	Hard	2

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
ANANDUR SANNA	Intermediate	2	Intermediate	105	Soft	0
ARUNURVADLLU	Intermediate	0	Low	106	Soft	2
ATHI KARAYA	Non-glutinous	1	Low	68	Soft	0
BANGAR SANNA	Non-glutinous	0	Intermediate	110	Soft	1
BELGAM SANNA	Glutinous	0	Intermediate	107	Soft	2
BHOLA SALE	Intermediate	0	Intermediate	113	Soft	1
BILI MUNDUGA	Intermediate	0	Intermediate	80	Soft	2
BITI DHADI BUDDA	Intermediate	0	Intermediate	35	Hard	1
BLACK STICK	Glutinous	0	Low	65	Soft	2
BUDDA BHATTA	Intermediate	0	Intermediate	90	Soft	2
CHINNA PONNI	Non-glutinous	0	Intermediate	106	Soft	2
CHITTIGA	Intermediate	0	Intermediate	77	Soft	1
COIMBATORE SANNA	Intermediate	0	Intermediate	102	Soft	0
DAMBAR SALEH	Intermediate	0	Intermediate	110	Soft	1
DODDA BAIR NELLU	Intermediate	0	Intermediate	103	Soft	2
DODDA VALLYA	Non-glutinous	0	Intermediate	115	Soft	1
DOPPA BHATTA	Intermediate	0	Intermediate	91	Soft	2
ELCHIR	Non-glutinous	0	Intermediate	55	Intermediate	2
GAJABUNDA	Glutinous	0	Intermediate	97	Soft	1
GAMA GADALE	Intermediate	0	Intermediate	108	Soft	2
GIDDA BATHA	Non-glutinous	0	Intermediate	112	Soft	2
GIDDA GOWRI	Non-glutinous	0	Intermediate	115	Soft	2
GIDDA MULARI	Glutinous	0	Intermediate	108	Soft	1
GULVADY SANNA	Intermediate	0	Intermediate	80	Soft	2
HALLINGA	Intermediate	0	Low	95	Soft	2
HEMAVATHI	Non-glutinous	0	Intermediate	115	Soft	2
JAVA GOURI	Intermediate	0	Intermediate	116	Soft	2
KAGGI SALLA	Non-glutinous	2	Intermediate	100	Soft	2
KAJE JAYA	Intermediate	0	Intermediate	95	Soft	2
KALAMEH	Non-glutinous	0	Intermediate	70	Soft	1

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
KANNUR RATNACHURI	Non-glutinous	0	Intermediate	110	Soft	1
KARAVALI	Intermediate	0	Intermediate	115	Soft	1
KAREYA JEBI	Non-glutinous	0	Intermediate	100	Soft	2
KAVALA KANNU	Glutinous	0	Intermediate	85	Soft	1
KAYAMEH	Non-glutinous	0	Intermediate	105	Soft	1
KEMPU JADDU	Non-glutinous	0	Intermediate	94	Soft	1
KEMPU PURIGO NELLU	Non-glutinous	0	Low	103	Soft	2
KEYASAKKI	Non-glutinous	0	Low	55	Intermediate	2
KOLKE DODRA	Intermediate	0	Intermediate	95	Soft	2
KULTHI KAYAME	Non-glutinous	0	Intermediate	115	Soft	2
KUMKUM KESHARI	Intermediate	2	Low	35	Hard	2
KUNDAPULLAN	Non-glutinous	2	Intermediate	114	Soft	0
KUNJI KUNJI	Intermediate	0	Intermediate	65	Soft	2
KURUVA	Intermediate	0	Intermediate	75	Soft	2
MALGUDI SANNA	Non-glutinous	0	Intermediate	103	Soft	1
MARA BATHA	Intermediate	0	Intermediate	92	Soft	2
MASKATI	Non-glutinous	0	Intermediate	108	Soft	2
MATHALLAGA	Glutinous	0	Intermediate	85	Soft	2
MEESE BATHA	Non-glutinous	0	Low	7	Hard	0
MISE BATTA	Intermediate	0	Intermediate	30	Hard	1
MORADDA	Non-glutinous	0	Low	40	Hard	2
MUKKAN RATNACHURI	Intermediate	0	Intermediate	43	Intermediate	1
MUTTU GULLA	Intermediate	0	Low	20	Hard	2
MYSORE SANNA	Non-glutinous	0	Low	70	Soft	2
MYSURU SUNNA	Intermediate	0	Intermediate	115	Soft	2
NEERU MULLUGA	Intermediate	0	Intermediate	107	Soft	2
ONDHU KADDI	Non-glutinous	0	Intermediate	65	Soft	0
PADMAREKHA	Intermediate	0	Intermediate	45	Intermediate	0

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
PAKISTAN BATTA	Non-glutinous	2	Intermediate	75	Soft	0
PARIMALA SANNA	Non-glutinous	2	Intermediate	113	Soft	0
PITTASALEH	Non-glutinous	0	Intermediate	103	Soft	2
RAICHUR SANNA	Intermediate	0	Intermediate	95	Soft	0
RAJ KAMAL	Non-glutinous	0	Low	112	Soft	1
RAJA KAYAME	Non-glutinous	2	Low	116	Soft	1
RAJA MUDI	Non-glutinous	0	Intermediate	60	Intermediate	2
RAKTHA SALE	Non-glutinous	0	Intermediate	98	Soft	2
RASA KADAMBA	Non-glutinous	0	Intermediate	97	Soft	0
RATNACHURI	Intermediate	0	Intermediate	108	Soft	0
SANNA BATTA	Intermediate	0	Intermediate	87	Soft	2
SANNA VALLYA	Non-glutinous	0	Intermediate	102	Soft	1
SANNAKKI BATTA	Non-glutinous	1	Intermediate	103	Soft	0
SANRAJ KAYAME	Intermediate	0	Intermediate	112	Soft	2
SELAM SANNA	Non-glutinous	0	Intermediate	110	Soft	0
SELAM SANNA	Non-glutinous	0	Intermediate	105	Soft	0
SHARBATI	Non-glutinous	2	Intermediate	111	Soft	1
SIDDHA SANNA	Non-glutinous	0	Intermediate	100	Soft	2
SINDHURA MADHU SALE	Non-glutinous	0	Low	116	Soft	1
TALA BATHA	Non-glutinous	0	Intermediate	90	Soft	2
VELLA PONNI	Non-glutinous	0	Intermediate	70	Soft	2
YELLA SALLI	Intermediate	2	Intermediate	40	Hard	2
STATE: KERALA						
ADUKAN	Intermediate	0	Intermediate	96	Soft	2
ARTHARAYI	Intermediate	0	Intermediate	98	Soft	1
ARYAN	Non-glutinous	0	Intermediate	106	Soft	1
CHENGEERAN	Intermediate	0	Intermediate	108	Soft	2
CHENNELLU	Non-glutinous	0	Low	110	Soft	2
CHETTU VELIYAN	Intermediate	0	Low	92	Soft	0

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
CHITANI	Non-glutinous	0	Intermediate	118	Soft	2
CHOMAN	Non-glutinous	0	Intermediate	110	Soft	2
GANDHASALEH	Non-glutinous	1	Intermediate	50	Intermediate	0
HAPPY HILL	Non-glutinous	0	Intermediate	92	Soft	1
JEERAGA SALEH	Non-glutinous	1	Intermediate	98	Soft	2
KANNI CHENNELLU	Non-glutinous	0	Intermediate	45	Intermediate	1
KARUTHA NYAVARA	Intermediate	0	Intermediate	112	Soft	2
KAVUNGIN POOTHALA	Non-glutinous	0	Intermediate	110	Soft	1
KOLARYAN	Intermediate	0	Intermediate	55	Intermediate	2
KUNJI PONNARIYAN	Non-glutinous	2	Intermediate	95	Soft	2
MALAYODUMBAN	Non-glutinous	0	Intermediate	60	Intermediate	0
MAVILON	Non-glutinous	0	Intermediate	29	Hard	1
NJAVARA BLACK	Intermediate	0	Intermediate	80	Soft	2
NYAVARA	Non-glutinous	0	Intermediate	118	Soft	2
NYAVARA KAJE	Intermediate	0	Intermediate	115	Soft	2
ONAMOTTAN	Intermediate	0	Low	85	Soft	1
PALLIYARAL	Non-glutinous	0	Intermediate	88	Soft	2
POKKALI	Non-glutinous	0	Intermediate	95	Soft	1
RAKTA SHALI	Non-glutinous	0	Intermediate	103	Soft	0
RAKTHASALI	Non-glutinous	0	Low	50	Intermediate	0
THAVALA KANNAN	Intermediate	0	Intermediate	75	Soft	2
THONNURAN	Intermediate	0	Intermediate	120	Soft	2
THONNURAN THONDI	Intermediate	0	Intermediate	90	Soft	2
THOWWAN	Intermediate	0	Intermediate	60	Intermediate	1
VACHAN	Intermediate	0	Intermediate	85	Soft	1
VELIYAN	Intermediate	0	Intermediate	60	Intermediate	2
VELLA THONDI	Glutinous	0	Intermediate	5	Hard	2
STATE: MADHYA PRADESH						
JEERA SHANKAR	Non-glutinous	0	Intermediate	106	Soft	0

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
STATE: MAHARASHTRA						
AJARA GHAN-SAL	Non-glutinous	0	Intermediate	50	Intermediate	0
AKOLE KAAL BHAT	Non-glutinous	0	Intermediate	110	Soft	2
AMBEMOHAR-2	Glutinous	0	Intermediate	90	Soft	2
CHIMAN-SAL	Non-glutinous	2	Intermediate	30	Hard	0
DEEPIKA RANI	Non-glutinous	2	Intermediate	95	Soft	2
DHABUL RED	Intermediate	0	Intermediate	75	Soft	2
DHAVUL	Non-glutinous	0	Intermediate	80	Soft	2
DONGARI	Intermediate	0	Intermediate	78	Soft	2
GARAM MASALA	Non-glutinous	1	Intermediate	40	Hard	0
JIRKUDI	Non-glutinous	0	Intermediate	100	Soft	2
JONDHAJI JIRGA	Intermediate	0	Intermediate	70	Soft	1
JUNA KOLAM	Non-glutinous	0	Intermediate	95	Soft	1
KAAL BHAT	Glutinous	1	Intermediate	25	Hard	1
KAKERI	Intermediate	0	Intermediate	80	Soft	2
KALA BHAT	Glutinous	2	Intermediate	110	Soft	2
KALI-SAL	Non-glutinous	1	Intermediate	55	Intermediate	2
KALI-SAL-SATARA	Intermediate	0	Intermediate	110	Soft	2
KARIGA JAVELI	Non-glutinous	2	Intermediate	70	Soft	2
KASBAI	Non-glutinous	2	Intermediate	78	Soft	2
KOTHIMBIR-SAL	Non-glutinous	2	Intermediate	95	Soft	0
KOTPE	Non-glutinous	0	Intermediate	115	Soft	2
MAHADI	Intermediate	0	Intermediate	40	Hard	2
MALGUDIA KALAM	Intermediate	0	Intermediate	110	Soft	2
MASAD KAMOD	Intermediate	0	Intermediate	60	Intermediate	2
MUNGAL=DODAKI	Intermediate	0	Intermediate	75	Soft	1
RAIBHOG	Non-glutinous	1	Intermediate	45	Intermediate	0
SOORTI	Glutinous	1	Intermediate	87	Soft	2
TAMBKUDIYA	Intermediate	0	Intermediate	112	Soft	2
TELOSHING	Intermediate	0	Intermediate	110	Soft	2

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
TULSA	Non-glutinous	1	Intermediate	30	Hard	1
VELCHI	Intermediate	2	Low	58	Intermediate	2
VELCHURI	Non-glutinous	0	Intermediate	60	Intermediate	1
ZEENI	Non-glutinous	1	Intermediate	112	Soft	2
STATE: TAMIL NADU						
ARUPATHAM KURUVAI	Intermediate	0	Intermediate	65	Soft	2
ATHUR KITCHALI SAMBA	Non-glutinous	0	Intermediate	85	Soft	0
BALICHA	Non-glutinous	0	Intermediate	5	Hard	2
CHENNA KICHIDI	Intermediate	0	Intermediate	95	Soft	0
GARUDAN SAMBA	Intermediate	0	Intermediate	70	Soft	2
JEERAGA SAMBA	Non-glutinous	1	Intermediate	100	Soft	0
KAIVARA SAMBA	Glutinous	0	Intermediate	80	Soft	2
KALLURUNDAI	Glutinous	0	Intermediate	90	Soft	2
KARUN KURUVAI	Non-glutinous	0	Intermediate	72	Soft	2
KARUPPU GOWNI	Intermediate	0	Intermediate	103	Soft	2
KAWUNI	Glutinous	0	Intermediate	63	Soft	2
KICHALI SAMBA	Non-glutinous	0	Intermediate	112	Soft	2
KULLA KER	Non-glutinous	0	Intermediate	102	Soft	2
KURUVA	Intermediate	0	Intermediate	115	Soft	2
KURUVAI	Non-glutinous	0	Intermediate	60	Intermediate	2
MADAI MALAI	Intermediate	0	Intermediate	36	Hard	0
MAPPILLAI SAMBA	Intermediate	0	Intermediate	99	Soft	0
MUTRINA SANNAM	Non-glutinous	0	Intermediate	110	Soft	0
NATTU PONNI	Non-glutinous	0	Intermediate	90	Soft	0
NATU	Intermediate	0	Low	110	Soft	2
NEL KICHIDI	Non-glutinous	0	Intermediate	65	Soft	0
NJAVARA GOLDEN	Intermediate	0	Intermediate	107	Soft	1
POONGAR	Intermediate	0	Intermediate	98	Soft	2
RAJAPPU SAMBA	Non-glutinous	0	Intermediate	95	Soft	0

LANDRACE	Endosperm Type	Aroma	Alkali Digestion	Gel: Mean Distance (mm)	Gel Consistency	Phenol Reaction
SALEM SANNA	Non-glutinous	0	Intermediate	90	Soft	2
SHIVAPPU GOWNI	Glutinous	0	Intermediate	85	Soft	2
SHIVAPPU KAWNI	Non-glutinous	0	Intermediate	55	Intermediate	2
SHIVAPPU KUZHADICHAN	Non-glutinous	0	Intermediate	103	Soft	1
SOORAKURUVAI	Non-glutinous	0	Intermediate	105	Soft	2
THENKAPPU SAMBA	Non-glutinous	1	Intermediate	86	Soft	2
THUYA MALLI	Non-glutinous	0	Intermediate	115	Soft	2
TIRUNEL VELI SAMBA	Non-glutinous	0	Intermediate	115	Soft	0
VADAN SAMBA	Non-glutinous	0	Low	105	Soft	0
STATE: TELENGANA						
BASKAMALA	Non-glutinous	0	Intermediate	90	Soft	2
BURMA WHITE	Non-glutinous	0	Intermediate	80	Soft	1
CHITTI MUTYALU	Non-glutinous	0	Intermediate	104	Soft	1
MUGAJAI	Non-glutinous	1	Low	85	Soft	2

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Conflict of Interest

Authors declare no conflict of interest.