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Donors for quality characteristics in aromatic rice

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ABSTRACT

Germplasm collection of 782 accessions of aromatic rices were evaluated for three quality characteristics that determine cooking quality. The amylose content in these accessions ranged from 10.7% to 36.2%, gelatinization temperature or digestion value ranged from 1 to 7 and gel consistency ranged from 11 mm to 133 mm. Desirable amylose content, gelatinization temperature and gel consistency was observed in 259, 233 and 88 accessions, respectively. Accessions, Basmati 370-S1, Basmati 370-S18, Basmati 370-S19, Basmati 6311-(a) and Basmati 6311-(b) were good for all the three quality characteristics.

Key words: *Oryza sativa, amylose content, gelatinization temperature, gel consistency*

Grain quality of aromatic rice (*Oryza sativa* L.) is of prime importance in breeding programmes all over the world because it decides the consumer preference and thus acceptability of a variety (Khush, 2000). Several complex components like amylose content, gelatinization temperature and gel consistency collectively determine cooking as well as eating qualities of rice. Amylose content determines hardness of cooked rice. Waxy or glutinous rice lacks amylose and it does not expand in volume, it remains firm when cooked. Among non waxy and non-glutinous type of rices, varieties with intermediate amylose content are preferred because the grains of such varieties remain moist and tender after cooking. Indian Basmati types fall in this group. Gell temperature is the range within which the starch granules begin to swell irreversibly in hot water. Gel consistency is a reliable index for cooked rice texture. Cooked rice with hard gel consistency hardens faster than that with a soft one. Rices with soft gel consistency cook tender and also remain soft after cooking. In the past, inspite of consistent efforts to identify more and more varieties only limited number of rice varieties dominated the market. Improvement of rice crop with reference to quality traits has also been limited to only few accessions. Therefore, present study has been aimed at widening the genetic base by evaluating 782 aromatic rice accessions for above mentioned three important physio-chemical attributes determining quality of rice.

MATERIAL AND METHODS

The experimental material, consisting of 782 accessions belonging to different geographic areas *i.e.*, India, Pakistan, Indonesia, Philippines, China, Vietnam, Thailand and Iran, (provided by the Directorate of Rice Research, Indian Council of Agricultural Research, Hyderabad), was sown during kharif season of the year 1999, in two replications. Seeds from 5 randomly selected plants were collected for analyzing different physico-chemical characteristics. The panicles were threshed by using a hand thresher. Grain samples were dehulled (Satake Rice Machine, TOKYO) and passed through “Satake Rice White Machine” (TOKYO) for three minutes to obtain uniformly polished kernels.

Standard analytical methods were used for estimating amylose content (Juliano, 1971). Different accessions were classified according to the following standards:

Grain type	Range of amylose (%)	Type of cooked rice	Rice-water ratio
Waxy	0-8	Moist, sticky, glossy	1:1.3
Non-waxy			
Low amylose content	8-20	Sticky, soft	1:1.7
Intermediate amylose content	20-25	Dry, flaky, soft	1:1.9
High amylose content	25-32	Cook dry, flaky, hard	1:2.1

Table 1. List of the stocks with desirable amylose content (20-25%), gelatinization temperature (4-5) and gel consistency (40-60mm)

Amylose content (20-25%)
Ayepyaung-S2
Azucena-S1
Azucena-S2
Azucena-S3
Azucena-S4
Balugyun
Barah-S1
Bashmati
Basmati 1-S4
Basmati 1-S7
Basmati 1-S8
Basmati 1-S9
Basmati 1a-S2
Basmati 1a-S3
Basmati 1a-S5
Basmati 1a-S6
Basmati 1a-S7
Basmati 1a-S8
Basmati 1a-S11
Basmati 14-10-S1
Basmati 43a-S2
Basmati 43a-S3
Basmati 43a-S4
Basmati 43a-S5
Basmati 43a-S6
Basmati 93-S2
Basmati 93-S4
Basmati 93a-S2
Basmati 93a-S3
Basmati 93(b)-S2
Basmati 93(b)-S3
Basmati 93(b)-S4
Basmati 107-S2
Basmati 113-S10
Basmati 113-S2
Basmati 113-S5
Basmati 113-S8
Basmati 113-S9
Basmati 122-S2
Basmati 122-S3
Basmati 124-10-S1
Basmati 124-10-S2
Basmati 124-10-S3
Basmati 134a-S1
Basmati 134b-S5
Basmati 134b-S6
Basmati 134b-S8
Basmati 134b-S9
Basmati 138-S2
Basmati 140-S1
Basmati 140-S2
Basmati 140-S3
Basmati 213-S2
Basmati 213-S4
Basmati 242 S4
Basmati 334-S2
Basmati 334-S3
Basmati 370-S1
Basmati 370-S2
Basmati 370-S3
Basmati 370-S4
Basmati 370-S5
Basmati 370-S6
Basmati 370-S8
Basmati 370-S9
Basmati 370-S10
Basmati 370-S11
Basmati 370-S12
Basmati 370-S14
Basmati 370-S15
Basmati 370-S16
Basmati 370-S18
Basmati 370-S19
Basmati 370-S20
Basmati 370-S21
Basmati 370-S22
Basmati 370-S23
Basmati 370-S24
Basmati 370-S26
Basmati 372-S3
Basmati 372-S5
Basmati 372a-S2
Basmati 372a-S3
Basmati 372a-S4
Basmati 372a-S5
Basmati 372a-S6
Basmati 372a-S7
Basmati 372a-S9
Basmati 375-S1
Basmati 375-S2
Basmati 375-S3
Basmati 375-S5
Basmati 375-S6
Basmati 376-S3
Basmati 377-S1
Basmati 377-S2
Basmati 397-S6
Basmati 406-S1
Basmati 427-S3
Basmati 502-S3
Basmati 502-S4
Basmati c621-S3
Basmati c621-S4
Basmati c622-S11
Basmati 670-S2
Basmati 802-S1
Basmati 802-S4
Basmati 802-S5
Basmati 802-S6
Basmati 802-S7
Basmati 5836-S2
Basmati 5854
Basmati 5875-S3
Basmati 5875-S5
Basmati 6311a
Basmati 6311b
Basmati kamon
Basmati nahan 381-S4
Basmati nahan 381-S6
Basmati nahan 381-S7
Basmati norat 439-S2
Basmati surkh 112-S2
Basmati surkh 161-S1
Basmati surkh 161-S2
Basmati surkh 161-S3
Basmati surkh 161-S5
Basmati surkh 89-15-S8
Basmati surkh 89-15-S9
Basmati t-3-S2
Basmati t-3-S4
Basmati-S4
Basmati-S5
Begami t-1-S2
Bindli semi dwarf mutant-S2
BK-805-9-S1
Boga chakura-S1
Borhail-S1
Borhail-S2
Chok jye bi chal
Chinni sakkar
Chinnow
Dehradun basmati-S1
Dehradun basmati-S3
Dehradun local-S1
Dehradun local-S3
Dehradun local-S4
Della-S3
Dem sufaid
Dinarado-S1
Dm-24-(a)
Du thom thai binh hai phong-S1
Early basmati ranbir-S1
Early basmati ranbir-S2
Early basmati ranbir-S6
Early basmati ranbir-S9
FN-64
Ghanal-S1
Ghanal-S2
Gharis
Guinata-S1
Guinata-S2
Guinata-S3
Haryani t-27
Hasan serai
Hawm deng
HBC-45a
HBC-45b

Contd...

HBC-46
HBC-98
HBC-135
HKR-236
IET12017
Jai jai
Jeera sail-S2
Kalijira -8-1-S1
Kalijira 44-S1
Kalijira 286
Kali muk-(a)
Kamoh basmati 392
Karnal local-S1
Karnal local-S2
Karnal local-S4
Karnal local-S5
KCN80152
Khas khandari
Kinandangpula-S5
Kinandangpula-S7
Ku-79-1-S2
Lakho kuwar
Lal chaddu
Leung
Hawm
Major djamban-S3
Major djamban-S4
Major djamban-S5
Mikhudels-S2
Milagrasa-S2
Milfor-6
Milfor-6-2-S2
Milfor-6-2-S3
Milfor-c MTU6024-S1
MTU6024-S2
Mulai
Multani-S1
Multani-S2
Multani-S3
Muskh bodji
Muskhon 41-S4
N-10-S1 N-10-S2
N-12
N-501
N-541
N-566
N-640
N-701-S2
N-702
N-723
N-750
N-785
Nahang nuan
NK-4c-S1
Padan wangi-S1
Padi bewang-S1
Pakistan basmati-S2
Pakistan basmati-S4
Pak fine
Palawan-S4
Pedi empet bulan-2-S1
Penjula manis
Pusa 44-33-S2
Raj sail-S7
Ram jiwan-(b)
RPU-41-62
S-1732-S4
S-1733-S1
Sakoi bhanu bora
Sam chakura
Sams panoz
Seratus melam
Sifarasi
Si gupal-(a)
Sonsal-S2
T-3-S2
T-3-S3
T-3-S4
T-9 TCM-1
TD-52-S1
Tellahansa
Tilakchandan
Xiang geng deo-S1
Xiang geng deo-S3

Gelatinization temperature (4-5)
Basmati 93a-S2
Basmati 93a-S3
Basmati 107-S1
Basmati 113-S5
Basmati 122-S2
Basmati 122-S3
Basmati 140-S1
Basmati 140-S2
Basmati 140-S3
Basmati 213-S2
Basmati 213-S4
Basmati 213-S6
Basmati 242-S1
Basmati 334-S3
Basmati 370-S1
Basmati 370-S2
Basmati 370-S18
Basmati 370-S19
Basmati 370-S20
Basmati 370-S21
Basmati 370-S22
Basmati 372a-S5
Basmati 375-S2
Basmati 376-S3
Basmati 376-S4
Basmati 385-S3
Basmati 397-S5
Basmati 397-S6
Basmati 405-S1
Basmati 410-S2
Basmati 427-S2
Basmati 427-S3
Basmati 433-S1
Basmati 502-S2
Basmati c621-S2
Basmati c621-S4
Basmati c622-S3
Basmati c622-S4
Basmati c622-S5
Basmati c622-S6
Basmati c622-S7
Basmati c622-S8
Basmati c622-S12
Basmati c622-S13
Basmati c622-S14
Basmati 802-S2
Basmati 5836-S1
Basmati 5836-S5
Basmati 5836-S9
Basmati 5836-S10
Basmati 5853c
Basmati 5875-S1
Basmati 5875-S5
Basmati 5875-S7
Basmati 5888-S1
Basmati 6129-S3
Basmati 6131-S2
Basmati 6311a
Basmati 6311b
Basmati 6311-S2
Basmati 6313-S1
Basmati bahar-S2
Basmati kaman
Basmati kota-S1
Basmati mehtrah-S4
Basmati nahan 381-S1
Basmati nahan 381-S3
Basmati nahan 381-S5
Basmati nahan 381-S6
Basmati nahan 381-S7
Basmati norat
Basmati norat 439-S1
Basmati norat 439-S2
Basmati norat 439-S3
Basmati norat 439-S4
Basmati pardar S2
Basmati sathi-S1
Basmati sufaid 100-S4
Basmati sufaid 106-S1
Basmati surkh-S1
Basmati surkh 89-15-S6
Basmati surkh-89-15-S3
Basmati surkh-89-15-S5
Basmati surkh 161-S1
Basmati surkh 161-S7
Basmati t-3-576-S2
Basmati t-370
Basmati t-3-S1
Basmati t-3-S2

Contd...

Basmati t-3-S3
Basmati t-3-S4
Basmati Tall-S2
Babelatic putech
Badshawbhog
Barah-S2
Begami-2-8-S2
Begami 40-S1
Begami 40-S2
Begami 40b-S1
Begami T-1-S2
Begami T-1-S3
Bhudawal Bindli-S1
Bindli semi dwarf mutant-S2
Boga chakura-S2
Bongcay
BPT-5204 285b
C4-63-S3
C4-63-S5
Chok jye bi chal
Chinnow
D-66-S1
Dawag basmati
Dehradun basmati-S2
Dehradun basmati-S3
Dehradun local-S1
Dehradun local-S2
Dehradun local-S3
Dem sufaid

Dinarado-S1
Dinarado-S2
Domsiah-S2
Domsiah-S4
Double dwarf
Double dwarf-1
Du thom thai binh hai phong-S1
Du thom thai binh hai phong-S2
Early basmati ranbir-S3
Ghanal-S1
Ghanal-S2
Ghanal-S3
Guinata-S1
Guinata-S2
Hansraj
Hansraj-b
HBC-135
HBC-34a
HBC-45a
HBC-45b
HBC-46
HBC-98
HKR-125
HKR-241
Hsiang nha-1
Hsiang nha-1a
Hsiang mi hsiang ma tsan-a
Hsiang mi hsiang ma tsan -b
IET 8585

Ilokhi bora I
R 841-85-S2
Jai jai
Karnal local-S2
Karnal local-S3
Karnal local-S4
Karnal local-S5
Khas khandari
Kinandangpula-S7
Kinandangpula-S8
Ku-79-1-S1
Kunsan-woo-shan-Gan
Lang kayam
Lcvhp
Leung hawm
Lua nhe-S1
Lua nhe-S2
Lua nhe da-b
Lua nhe Den-S1
Major djamban-S3
Major djamban-S4
Mikhudels-S1
Mikhudels-S2
Milagrasa-S4
Milfor-c
Milfor-6
Milfor-6-2-S3
Milpal-17
MTU-4407

MTU-6024-S1
MTU-6024-S2
Multani-S1
Multani-S2
Multani-S3
Muskh bodji
N-138-5
N-140-6
N-640
N-723
Nim ptb-21
Nk-4c-S1
Nk-4c-S2
Nk-4c-S3
Pak basmati-S2
Pak basmati-S3
Pak basmati-S5
Pak fine

Palawan-S1
Pusa 615 R 10
Raj sail-S3
Raj sail-S6
Raj sail-S7
Ram jiwan-(b)
Ram shri-S3
Ram tulsi
RPU-41-62
Sam chakura
Sathi basmati-S1
Sathi basmati-S2
Sathi-3436-S1
Sathi-3436-S2
Short straw-S1
Si gupal-(a)
Sita sail-S1
Sita sail-S2

T-3-S2
T-3-S3
T-3-S4
T-9
Taipei-309-S1
Taipei-309-S2
TCM-1
TCM-3
TD-52-S1
TD-52-S2
Tellahansa
Tilakchandan
UK-4c-a
UPRH-500
Zinya-31-S1
Zinya-31-S2
Zinya-31-S4.

Gel consistency (40-60mm)

1803-NR-541-16
Azucena-S3
Basmati-S3
Basmati 1-S8
Basmati 1-S11
Basmati 106-12-S2
Basmati 113-S9
Basmati 134b-S1
Basmati 134b-S11
Basmati 134b-S4

Basmati 134b-S5
Basmati 134b-S7
Basmati 134b-S9
Basmati 136-S2
Basmati 138-S4
Basmati 138-S5
Basmati 213-S3
Basmati 370-S1
Basmati 370-S3
Basmati 370-S5
Basmati 370-S8

Basmati 370-S9
Basmati 370-S11
Basmati 370-S18
Basmati 370-S19
Basmati 372a-S1
Basmati 372a-S2
Basmati 372a-S4
Basmati 406-S1
Basmati 406-S2
Basmati 410-S3
Basmati c621-S1

Contd...

Basmati c622-S2	Basmati surkh 112-S1	N-791
Basmati c622-S13	Basmati surkh 112-S2	Nk-4c-S3
Basmati 670-S2	Basmati surkh 161-S2	Penjula manis
Basmati 5875-S4	Basmati surkh 161-S4	PGB
Basmati 6113-S4	Basmati surkh 161-S7	Raj sail-S1
Basmati 6113-S7	Basmati t-3-S3	Ram tulsi
Basmati 6129-S2	Early basmati ranbir-S4	Rani kajal
Basmati 6129-S3	Early basmati ranbir-S7	Rikuta norin 20-(a)
Basmati 6129-S4	IR 841-85-S1	Rodljolele-S1
Basmati 6129-S6	Jeera sail-S2	Sathi 3436-S1
Basmati 6129-S7	MTU11	Short straw-S1
Basmati 6129-S8	Muskhon 41-S1	Short straw-S2
Basmati 6131-S1	Muskhon 41-S4	Sifarasi
Basmati 6131-S2	N-10-S3	Sitabo tabo
Basmati 6311a	N-508	TCM-2
Basmati 6311b	N-509	Tom duang hai duang
Basmati 6311-S2	N-533-S1	UPRH-500
Basmati mehtrah-S1	N-533-S2	Xiang geng deo-S1

Gelling temperature is the measure of cooking ease and is indexed by alkali digestibility test (Little *et al.*1958). According to this method gelatinization temperature is determined by the extent of alkali spreading score of the individual milled seed soaked in 1.7% KOH solution for 23 hours at 30° C using a 1-7 scale. A high rating (6-7) indicates more disintegration and this is classified under low gelatinization temperature, intermediate rating (3-5) indicates medium disintegration and classified as intermediate gelatinization temperature while grains with high gelatinization temperature remain unaffected.

Gel consistency was determined by the method given by Cagampang *et al* (1973). However, in the present study test tubes of 15 mm x 150 mm (diameter x length) were used, rather than 10 mm x 110 mm used for this method. Varieties with gel consistency >60 mm, between 40-60 mm, and <40 mm were considered soft, medium and hard gel accessions, respectively.

RESULTS AND DISCUSSION

For amylose content, 768 accessions were tested. Overall range of amylose content for different accessions ranged from 10.7% to 36.2% which indicate large variation in germplasm for amylose content (CD=1.21). Basmati 5836 had maximum amylose content of 36.2%, while Khao Dongai had minimum amylose content ie.10.7%. Twenty-four accessions showed amylose content between 10.0% to 20.0%, two hundered fifty two had intermediate amylose contents (20.1% to 25.0%) listed in Table 1 and the remaining had high amylose content (above 25.0%). Most of the high amylose content accessions were of Basmati type and fell in the range of 30.0% to 36.2%.

Gelatinization temperature or digestion value ranged from 1 to 7. Out of the 782 accessions, 300 accessions were having high gelatinization temperature, 232 had intermediate gelatinization temperature (Table 1) and the remaining were having low gelatinization temperature.

Gel consistency values ranged from 11 mm to 133 mm for different accessions indicating significant variation for this trait among the germplasm evaluated. Total 769 accessions were evaluated for gel consistency, out of which 642, 86 and 39 showed soft, medium and hard consistency, respectively. The accessions having desirable gel consistency are listed in Table 1. Rice with soft to medium gel consistency is preferred by most of the rice consumers (Tang *et al.*, 1989, Siddiq 1992). Two accessions namely Azucena E and Dehradun Basmati showed hard gel consistency (11.0 mm) where as Sonsal exhibited soft gel consistency with value of 133 mm.

Five donors namely Basmati 370-S1, Basmati 370-S18, Basmati 370-S19, Basmati 6311-(a) and Basmati 6311-(b) possessed the desirable range of all the three quality characteristics. Out of these five, three were selections from Basmati 370 and two were selections from Basmati 6311. Present study indicated that large variability in germplasm collection for the traits such as amylose content, gelatinization temperature and gel consistency trait. This variability can be used for the improvement of rice crop in India for quality characteristics.

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