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Grain quality characteristics of two-line rice hybrids in Kerala

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Abstract

A study was conducted to analyse the quality characteristics of promising two line rice hybrids at College of Horticulture Vellanikkara, Kerala Agricultural University, Thrissur. The Hulling percentage ranged from 55.56 (TGMS 74S x Aiswarya) to 83.33 (TGMS 82S x Prathyasa). The milling percentage exhibited a range of 48.00(TGMS 74S x Aiswarya) to 68.96(TGMS 81S x Makom) for hybrids with a mean value of 62.16. Cooking quality analysis revealed intermediate amylose and alkali spreading value for the hybrids TGMS 91S x Makom, TGMS 91S x Kanchana , TGMS 81S x Makom and TGMS 81S x Aiswarya. Sensory quality characters of all two line rice hybrids exhibited red streaks (pericarp) after cooking and well separated moderately soft and desirable taste.

Key words: Rice quality, Physical properties, cooking quality, milling quality

Introduction

Rice (*Oryza sativa* L.) is the most important staple food for about 50 per cent of the world's population. Ninety per cent of the world's rice is grown and consumed in Asia. Rice provides about 29.4 per cent of total calories/capita/day in Asian countries (FAO 2006). However, increase in rice production is not commensurate with population growth. The total global rice production is declining gradually even with the extensive use of the high yielding modern varieties and hybrids. In India rice is grown in area of 45.54 million ha with a production of 99.18 million tonnes and a productivity of 2178 kg ha^{-1}. In Kerala, rice is cultivated in an area of 0.21 million ha with a production of 0.47 million tonnes and a productivity of 2238 kg ha^{-1}.

In countries where rice is consumed, traits of grain quality dictate market value and have a pivotal role in the adoption of new varieties (Juliano, 2003 and Fitzgerald *et al.*, 2008). Quality traits encompass physical appearance, cooking and sensory properties and more recently, nutritional value. The value of each trait, for example the length of the grain, varies according to local cuisine and culture. Physical properties include yield of edible and marketable polished grain, uniform shape, whiteness and, in most countries, translucence. These traits are immediately obvious to consumers and so are major factors defining market value. Cooking and sensory qualities typically include: cooking time (Juliano *et al*., 2003) textural properties of cooked rice aroma and its retention after cooking and the ability to remain soft for several hours after cooking (Philpot *et al.*, 2006).

Yield of rice hybrids by itself would not make hybrid rice technology acceptable. They must also have acceptable grain quality. Only limited efforts have been made to improve the grain quality of hybrid rice (Khush *et al.,* 1986). Since rice hybrids have entered the country recently there is a need to look into the quality aspects so that hybrid rice can be developed coupled with improved quality characteristics. Rice grain quality is mainly determined by the combination of many physical as well as chemical characters. Physical quality characters include kernel size, shape, hulling, milling percentage and head rice recovery. Chemical quality is mainly determined by amylose content, gelatinization temperature, gel consistency. High volume expansion and greater length wise expansion of kernel during cooking decide the consumer preference. (Mahalingam *et al*., 2012). Rice with soft to medium gel consistency, intermediate amylose content and gelatinization temperature is a preferred level for the consumer which determines the eating and cooking quality of rice grains (Bao et al., 2002). So far 102 rice hybrids were released for cultivation in India are based on three line (CGMS) systems, however

no hybrids released based on two line system. The present study was, therefore, aimed to identify high yielding two line cross combinations with acceptable grain yield and cooking quality parameters. The best performing two line hybrids based on mean performance for grain yield, along with its parents were analyzed for physical and cooking quality characters.

Materials and methods

The materials used in the study comprised of 10 promising two line rice hybrids produced in the Department of Plant Breeding and Genetics, College of Horticulture Vellanikkara, Kerala Agricultural University Thrissur. The grain quality parameters were carried out

Table 1: List of hybrids selected for analysis of quality parameters

S. No.	Details of the hybrids
1	TGMS 91S x Samyuktha
2	TGMS 81S x Matta Triveni
3	TGMS 74S x Kanchana
4	TGMS 74S x Kairali
5	TGMS 91S x Makom
6	TGMS 82S x Prathyasa
7	TGMS 81S x Makom
8	TGMS 81S x Kanchana
9	TGMS 81S x Aiswarya
10	TGMS 74S x Aiswarya

Grain and milling quality characters:

Kernel colour: Kernel colour was identified as red or white.

Kernel length (mm): Length of 10 unbroken brown rice, in three sets was measured and the mean was expressed in mm and the grains were categorized as follows:

Size category	Length (mm)
Extra long	>7.50
Long	6.61-7.50
Medium	5.51-6.60
Short	< 5.50

Kernel width (SES-IRRI, 1996): Breadth of 10 unbroken brown rice was measured using vernier caliper in three sets and the mean was expressed in mm

Milling traits: Milling recovery of rough rice is an estimation of the quantity of head rice and total milled rice that can be produced from a unit of rough rice. It is generally expressed as percentage (Khush *et al.*, 1979) as given below:

$$\text{Hulling percentage} = \frac{\text{Total hulled rice}}{\text{Total rough rice}} \times 100$$

$$\text{Milling percentage} = \frac{\text{Total milled rice}}{\text{Total rough rice}} \times 100$$

$$\text{Head rice recovery} \quad \frac{\text{Total head rice}}{\text{Total rough rice}} \times 100$$

Amylose content: Samples were weighed about 100 mg ± 0.5 mg three times for each sample and these samples were placed into 100 ml volumetric flasks. To this, 1 ml of ethanol was added by using pipette to wash down any of the flour adhering to the side of the flask. These contents were shaked well in order to wet the entire sample. To this, 9.0 ml of NaOH solution (1M) was added and mixed it well until the starch was completely dissolved by standing overnight. The test solutions were allowed to cool at room temperature and made up the volume with the distilled water. The blank solution was prepared without the sample in the 1000 ml volumetric flask, from the prepared test solutions, 0.5 ml aliquot was pipetted out into two test tubes. To this, 5.0ml of water, 0.1 ml of acetic acid and 0.20 ml of iodine were added, to make up the volume to 10.0 ml. These contents were mixed well by using vortex mixer. The test chemicals were measured the absorbance at 720 nm against the blank solution using the spectrophotometer. Based on the amylose content the rice was categorized as waxy (< 2%), very low (2 – 8%), low (8- 19%), intermediate (20 - 25%), and high (>25%) suggested (IRRI, 1972)

Alkali spreading value: Ten milled rice kernels were placed in 10.0 ml of 1.7 per cent KOH in shallow container (petriplate) .The kernels were so arranged that they did not touch each other. They were allowed to stand for 23 hours at 30^0 C. The appearance and disintegration of the kernels were usually after incubation based on the following numerical scale. A rating of 1 to 2 was classified as high final gelatinization temperature, 3 as high intermediate, 4 to 5 as intermediate(70-74^{0}C) and 6 to 7 as low final gelatinization temperature (<70^{0}C)

Numerical scale for rating kernels for alkali spreading value:

Description	Score
Grain not affected	1
Grain swollen	2
Grain swollen, collar incomplete or narrow	3
Grain swollen, collar complete and wide	4
Grain split or segmented, collar complete and wide	5
Grain dispersed, merging with collar	6
Grain completely dispersed and intermingled	7

Cooking quality characters:

Volume expansion ratio: The volume of raw rice as well as cooked rice was determined by water displacement using a measuring cylinder (Onate and Del Mundo, 1966):

$$\text{Volume expansion ratio} = \frac{\text{Volume of cooked rice}}{\text{Volume of raw rice}}$$

Kernel elongation ratio:Kernel elongation was determined as described by Azeez and Shafi (1966). Ten raw and ten cooked kernels were taken at random and their length was measured as given below:

$$\text{Kernel elongation ratio} = \frac{\text{Mean length of cooked kernel}}{\text{Mean length of raw kernel}}$$

Sensory characters:

Appearance after cooking: 5g rice samples were taken in a test tube.15 ml of water added and soaked for 10 min. Rice samples were cooked in a water bath for 15 min and transferred in to a petridish and scored as per panel test performance like white, creamish white, red streaks, white with brown streaks and white with black streaks

Cohesiveness: 5g rice samples were taken in a test tube.15 ml of water added and soaked for 10 min. Rice samples were cooked in a water bath for 15 min and transferred in to a petridish and scored as per panel test performance like well separated, partially separated, slightly separated, moderately separated and very sticky.

Tenderness to touch: 5g rice samples were taken in a test tube.15 ml of water added and soaked for 10 min. Rice samples were cooked in a water bath for 15 min and transferred in to a petridish and scored as per panel test performance like soft, moderately soft, moderately hard, hard and very soft.

Tenderness on chewing: 5g rice samples were taken in a test tube.15 ml of water was added and soaked for 10 min. Rice samples were cooked in a water bath for 15 minutes and transferred in to a petridish and scored as per panel test performance like soft, moderately soft, moderately hard, hard and very soft.

Taste: 5g rice samples were taken in a test tube.15 ml of water added and soaked for 10 min. Rice samples were cooked in a water bath for 15 min and transferred in to a petridish and scored as per panel test performance like good, desirable, tasteless and undesirable.

Results and Discussion

Quality analysis

The physical and cooking quality characters of superior two line rice hybrids produced in the study and their parents are presented in Table 2, 3 and Table 4. The female parents having white kernels and the male parents had red kernels. But all the promising hybrids exhibited red kernels. The length of kernels ranged from 4.34 (TGMS 81S x Aiswarya) to 6.51 (TGMS 91Sx Kanchana) for hybrids and 3.41 (Prathyasa) to 4.94 (Matta Triveni) for parental average being 5.36 and 4.49 for hybrids and parents. Kernel width ranged from (TGMS 81S x Kanchana) to 2.43 (TGMS 91S x Samyuktha) for hybrids and 1.08 (Kairali) to 1.86 (Prathyasa) for parents average being 1.04 and 1.22 for hybrids and concerned parents taken for the study. The hulling percentage ranged from 55.56 (TGMS 74S x Aiswarya) to 83.33(TGMS 82S x Prathyasa) for hybrids and 70.5 (Aiswarya) to 80 (Prathyasa) for parents average being 72.83 and 75.21 for hybrids and parents.

The milling percentage exhibited a range of 48.00 (TGMS 74S x Aiswarya) to 68.96 (TGMS 81S x Makom) for hybrids with a mean value of 62.16. maximum milling percentage was recorded by the parent TGMS 81S (68.88) and Kairali (50.1) showed the minimum value average being 62.82. Amylose content of promising two line hybrids ranged from 21.2 per cent (TGMS 74S x Kairali) to 26.2 per cent (TGMS 74S x Aiswarya) and the mean amylase content was 24.04 per cent. Highest amylose content was observed in the pollinator parent Aiswarya (27.5 per cent) and the TGMS 91S recorded the minimum value of 21.5 per cent average being 24.56. The two line hybrid TGMS 74S x Kairali was found to be have a mean alkali spreading value of 5.0 where as the lowest value of 1.9 was recorded by the hybrid TGMS 81S x Matta Triveni. The average alkali spreading value for hybrids was 3.51. Among the parents TGMS 74S and Kanchana (4.3) recorded a maximum alkali spreading value and Matta Triveni (1.0) recorded the minimum alkali spreading value with a mean value of 3.17. The two line rice hybrid TGMS 82S x Prathyasa reported the highest volume expansion ratio (2.50) and the lowest by 2.00 (TGMS 81S x Aiswarya) with a mean value of 2.20. Volume expansion ratio of the parents ranged from 2.11 (Makom) to 2.50 (Prathyasa) and mean was 2.19.

The mean kernel elongation ratio exhibited a range of 1.13 (TGMS 91S x Makom) to 1.32 (TGMS 74S x Kairali) with a mean value of 1.25. Maximum kernel elongation ratio was recorded by Matta Triveni (1.32) and Samyuktha (1.15) showed the minimum value average being 1.24. Abdominal white is absent in all two line rice hybrids and endosperm type showed intermediate type. Sensory quality characters all two line rice hybrids exhibited red streaks after cooking and well separated, moderately soft and desirable taste.

Better understanding of the factors that contribute to the overall grain quality of rice will lay the foundation for developing new breeding and selection strategies for combining high quality,with high yield. It is necessary to meet the growing global demand for high quality rice while offering producing countries additional opportunities for generating higher export revenues.

Keralities have a dietary preference towards red kernelled rice. All the promising two line hybrids have red kernels. Milling recovery defined the recovery of milled rice from the paddy, Milling recovery of two line rice hybrids reflected less loss of paddy on milling (Fig. 1). The cooking quality of rice depends mainly on amylose content and gelatinization temperature. Amylose content determines the stickiness of cooked rice. Intermediate amylase content is preferred by Keralities. Low amylose content show low water absorption ,expansion on cooking and the grains become sticky. The variety with high amylase amylose content cooks dry and fluffy but becomes hard on cooking and hence, intermediate amylose content is preferred is preferred in Kerala. Intermediate amylose content was noted for the hybrids, TGMS 91S x Samyuktha, TGMS 81S x Matta Triveni, TGMS 91S x Kanchana, TGMS 91S x Makom, TGMS 81S x Makom , TGMS 81S x Kairali and TGMS 81S x Aiswarya.

Gelatinization temperature is the temperature at which starch grains swell irreversibly when boiled in water. It ranges from 56-79^{0}C, depending on the hardness of starch granules. The higher the gelatinization temperature of rice, the more water and time are needed to cook. Gelatinization temperature is assayed as alkali digestion value. Intermediate gelatinization temperature is preferred (70-74^{0}C). The two line hybrids TGMS 91S x Kanchana, TGMS 74S x Kairali, TGMS 91S x Makom, TGMS 82S x Prathyasa, TGMS 81S x Makom, TGMS 81S x Kanchana, TGMS 81S x Aiswarya and TGMS 74S x Aiswarya exhibited intermediate gelatinization temperature.

Table 2: Grain and Milling quality characteristics of Two line hybrids and parents

Sl. No	Two line rice hybrids	Kernel colour	Kernel length (mm)	Kernel width (mm)	Hulling %	Milling %	Head rice Recovery	Abdominal white	Amylose content	Alkali spreading value
1	TGMS 91S x Samyuktha	Red	5.70	2.43	76.74	68.60	58.17	Absent	24.5	2.6
2	TGMS 81S x Matta triveni	Red	5.99	1.14	72.32	58.82	31.13	Absent	23.0	1.9
3	TGMS 91S x Kanchana	Red	6.51	0.51	75.43	61.40	45.33	Absent	25.0	3.1
4	TGMS 74S x Kairali	Red	4.35	1.07	71.76	64.71	59.71	Absent	21.2	5.0
5	TGMS91S x Makom	Red	5.64	1.03	79.17	66.67	45.33	Absent	23.6	3.9
6	TGMS 82S x Prathyasa	Red	5.19	0.22	83.33	53.66	46.15	Absent	25.8	4.3
7	TGMS 81S x Makom	Red	4.93	1.09	72.41	68.96	56.00	Absent	24.6	3.7
8	TGMS 81Sx Kanchana	Red	6.34	0.48	66.67	63.32	47.17	Absent	22.0	3.1
9	TGMS 81S x Aiswarya	Red	4.34	1.26	75.00	67.50	51.92	Absent	24.5	3.6
10	TGMS 74S x Aiswarya	Red	4.62	1.17	55.56	48.00	37.49	Absent	26.2	3.9
11	Aisawarya	Red	4.85	1.10	70.5	62.3	52.34	Absent	27.5	3.8
12	Kanchana	Red	4.71	1.12	71.5	64.9	56.00	Absent	26.5	4.3
13	Kairali	Red	3.73	1.08	77.8	50.1	37.49	Absent	24.5	2.7
14	Matta triveni	Red	4.94	1.15	71.7	63.1	52.01	Absent	23.6	1.0
15	Makom	Red	4.65	1.25	77.2	57.1	36.43	Absent	27.4	3.3
16	Prathyasa	Red	3.41	1.86	80.00	65.65	46.16	Absent	24.5	3.4
17	Samyuktha	Red	4.43	1.52	78.56	67.65	52.34	Absent	25.6	3.2
18	TGMS 74S	White	4.61	1.16	73.42	67.62	42.50	Slightly present	22.3	4.3
19	TGMS 81S	White	5.35	1.19	75.52	68.68	47.17	Slightly present	21.6	3.9
20	TGMS 82S	White	4.92	1.08	74.38	61.35	52.19	Slightly present	23.3	2.1
21	TGMS 91S	White	5.02	1.15	76.45	63.10	59.61	Slightly present	21.5	2.5

Table 3: Cooking quality characterstics of two line rice hybrids and parents

Sl. No	Two line rice hybrids	Volume expansion	Elongation ratio	Endosperm type
1	TGMS 91S x Samyuktha	2.13	1.25	Intermediate
2	TGMS 81S x Matta triveni	2.30	1.28	Intermediate
3	TGMS 91S x Kanchana	2.11	1.32	Intermediate
4	TGMS 74S x Kairali	2.16	1.32	Intermediate
5	TGMS91S x Makom	2.23	1.13	Intermediate
6	TGMS 82S x Prathyasa	2.50	1.23	Intermediate
7	TGMS 81S x Makom	2.29	1.27	Intermediate
8	TGMS 81Sx Kanchana	2.14	1.31	Intermediate
9	TGMS 81S x Aiswarya	2.00	1.28	Intermediate
10	TGMS 74S x Aiswarya	2.32	1.15	Intermediate
11	Aisawarya	2.13	1.20	Non waxy
12	Kanchana	2.35	1.30	Non waxy
13	Kairali	2.21	1.13	Non waxy
14	Matta triveni	2.15	1.32	Non waxy
15	Makom	2.00	1.27	Non waxy
16	Prathyasa	2.50	1.22	Non waxy
17	Samyuktha	2.20	1.15	Non waxy
18	TGMS 74S	2.26	1.25	Waxy
19	TGMS 81S	2.31	1.27	Waxy
20	TGMS 82S	2.09	1.29	Waxy
21	TGMS 91S	2.10	1.28	Waxy

Table 4: Sensory quality characteristics of selected materials

Sl. No	Two line rice hybrids	Appearance after cooking	Cohesiveness	Tenderness in touching	Tenderness on chewing	Taste
1	TGMS91S x Samyuktha	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
2	TGMS 81S x Matta triveni	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
3	TGMS 91S x Kanchana	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
4	TGMS 74S x Kairali	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
5	TGMS91S x Makom	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
6	TGMS 82S x Prathyasa	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
7	TGMS 81S x Makom	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
8	TGMS 81Sx Kanchana	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
9	TGMS 81S x Aiswarya	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
10	TGMS 74S x Aiswarya	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
11	Aisawarya	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable

Sl. No	Two line rice hybrids	Appearance after cooking	Cohesiveness	Tenderness in touching	Tenderness on chewing	Taste
12	Kanchana	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
13	Kairali	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
14	Matta triveni	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
15	Makom	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
16	Prathyasa	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
17	Samyuktha	Red streaks	Well separated	Moderately soft	Moderately soft	Desirable
18	TGMS 74S	White	Partially separated	soft	soft	Desirable
19	TGMS 81S	White	Partially separated	soft	soft	Desirable
20	TGMS 82S	White	Partially separated	soft	soft	Desirable
21	TGMS 91S	White	Partially separated	soft	soft	Desirable

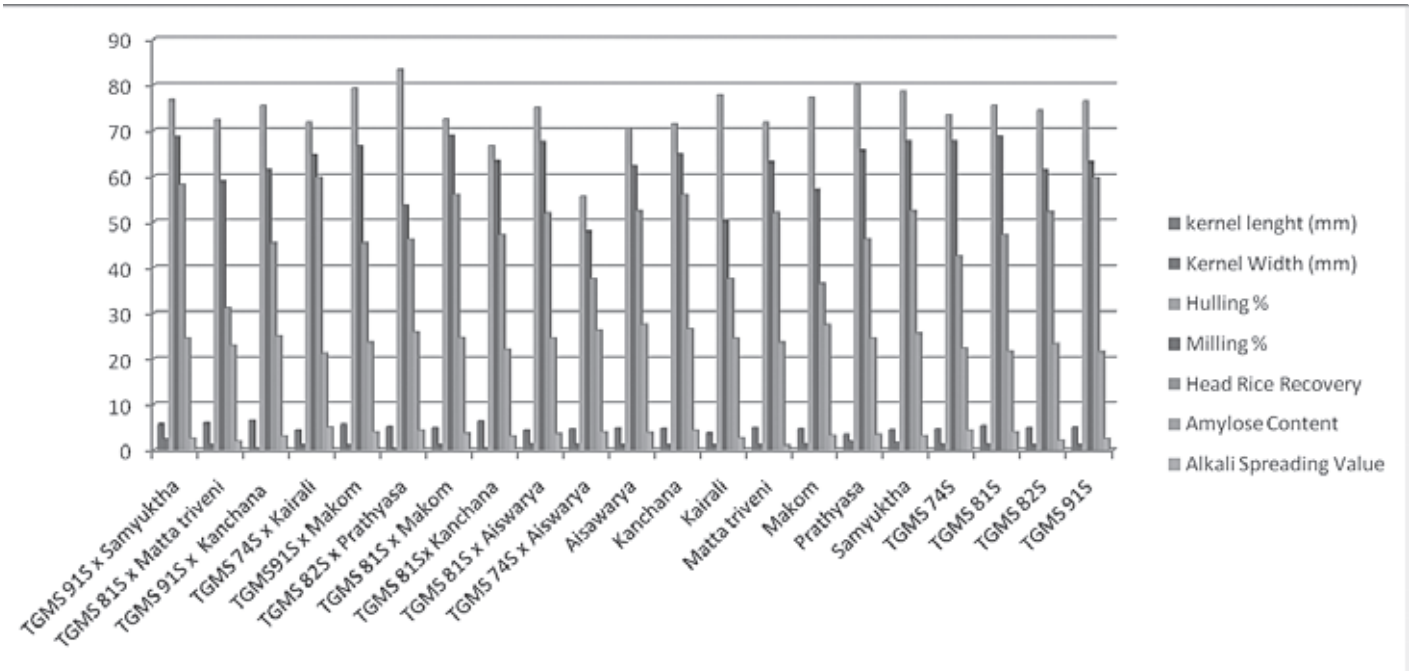

Figure 1: Grain and milling quality characters of promising two line hybrids and parents

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