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PRESENT STATUS OF HYBRID RICE GRAIN QUALITY IN SRI LANKA

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ABSTRACT

A wide range of consumer preferences for grain is observed in Sri Lanka. The physico chemical characteristics of hybrids developed in the Rice Research and Development Institute (RRDI) with IRRI collaboration shows that the total milled rice percentage did not show any significant difference from inbred lines. Higher brown rice percentages were observed in all the hybrids. Higher head rice recovery was obtained mostly from crosses of parents with good head rice recovery. Head rice percentage depended on the length and width of the grain. All the promising hybrids so far developed belonged to the long slender group and all the crosses where local parent H4 was used were red pericarped Amylose contents of the hybrids depended on the amylose contents of the parents used and ranged from intermediate to high. However, heterogeneity of grains for amylose content does not seem to effect cooking and eating quality.

KEYWORDS: Hybrid rice, Grain quality, Amylose content

INTRODUCTION

The extent of hybrid vigour for yield increase was the major concern when hybrid rice was first developed. Traditionally, rice is the staple food of Sri Lanka and the most important food crop in the country. Sri Lanka has reached a stage where further increase in rice area is not possible. The per capita consumption of rice is about 100kg/yr. Rice contributes to nearly 50% of the energy and 40% of protein in our daily diet. However, as rice is consumed in the milled form, the physical attributes of the intact endosperm are of foremost importance in determining consumer preference. Therefore, the percentage of head grain, grain dimensions and weight, chalkiness and translucency of the grains and cooking and eating quality should be considered during the development of hybrid varieties.

Most of these characteristics are genetically controlled. Grain size, shape and weight are determined by maternal genotype. However, the ultimate economic product of hybrid rice is basically a bulk of segregating endosperms of the F2 generation. Unlike other cereals, rice is consumed whole after cooking. Therefore the endosperm appearance, dimensions, and cooking and eating characteristics are of great concern from the consumers' point of view. Cooking and eating quality is mainly influenced by amylose content, gelatinization temperature and gel consistency. Khush *et al.* (1988) studied grain quality of several rice hybrids compared with that of the respective parental lines possessing diverse grain quality characteristics and concluded that the genetic heterozygosity of hybrids did not impair grain quality in physical and chemical characteristics.

A wide range of preferences for different grain types is observed in Sri Lanka. There is an increasing demand for red pericarp rice in Sri Lanka and this has led to the development of red pericarp rice by conventional methods. Therefore the development of red pericarp hybrid rice is essential. However, hull and pericarp colour is important depending on the processing conditions prior to the product reaching the market. Where the consumer preference is for parboiled rice, dark pericarp (bran) is not desired since more pressure has to be applied during milling to obtain an acceptable product. Where aromatic rice is preferred, both parents should possess the desired characteristic since aroma was observed to be recessive.

This study was undertaken to determine whether presently developed experimental hybrid rice combinations are acceptable in terms of grain quality by producers and end users.

MATERIALS AND METHODS

Seven experimental hybrids were developed in the 2000 *yala* season at the RRDI, Batalagoda using11 parental varieties. The quality parameters for the parents and crosses were determined in the grain quality laboratory of the RRDI Batalagoda. The samples were harvested from the field at maturity, shade dried in the laboratory for a period of two weeks to bring down the moisture percentage to 14% and then subjected to milling quality analysis. The major determinants of grain quality is rice milling quality which determines the head rice recovery, appearance dealing with the length, width, shape, colour, translucency and chalkiness of the polished rice and cooking and eating quality which is governed by the amylose content of rice. Samples were dehulled using a Satake dehuller and milled in a Mc Gill Sample mill for one minute. The head grains were separated manually. The length and width of the grain were measured using a micrometer screw gauge.

Amylose content is the most important criterion of the cooking and eating quality and was indexed by colorimetric iodine assay using a spectro-photometer to measure the colour developed on reacting with a I/KI solution (Juliano, 1971). The amylose content was classified as low, <20%, intermediate, 20-25% and high, >25%. The gelatinization temperature, which is a physical property of starch, is the range of temperature within which the starch granules begin to swell irreversibly in hot water. It gives an estimate of the cooking time. The volume of water required for cooking was determined by the degree of spreading of milled rice in a 1.7% KOH solution for 23 hours. Gelatinization temperature is classified as low (55^0-69.5^0 C), intermediate (70^0–74^0 C) and high (74.5^0-79^0 C). A distinct preference for rices with intermediate

gelatinisation is seen. Gel consistency gives an indication of the difference of the texture of cooked rice in varieties with similar amylose content. This is measured by the length of the gel when a powdered sample is digested with .2N KOH, cooled and placed horizontally for 1 hour (Cagampang *et al.*, 1973). Gel consistency can be classified as; hard, 26-40 mm; medium, 41-60 mm; and soft 61-100mm.

RESULTS AND DISCUSSION

The physical quality characteristics of the hybrids and parents are given in table 1. Brown rice percentages were high in all the hybrids compared to the parents. This indicates that the percentage hull is lower in hybrids than in inbred lines. The total milled rice however did not show any obvious difference although the highest TMR% was seen in the hybrid BgHR2.

Table 1. Physical grain quality characteristics of hybrids and their parents.

Variety/Hybrid	*BR*	*TMR*	*HG*	*BG*
IR62829 A/IR 65515-56-1-3-19R (BgHR11)	82.1	72.5	43.1	29.4
PMS 10 A/IR 29341-41-1R (BgHR12)	83.1	69.5	49.7	19.8
IR 69616 A/H 4 (BgHR1)	83.2	68.2	53.3	14.9
PMS 11A/H 4 (BgHR4)	82.3	68.6	55.6	13.0
PMS 8 A/At 95-6-8 (BgHR5)	83.2	69.0	52.6	16.4
PMS 11 A/ IR 49615-11-3-1-11R (BgHR3)	83.0	68.9	50.6	18.3
PMS 11A/IR 32809-26-3-3R (BgHR2)	85.0	73.2	55.4	19.8
IR 62829 A	80.9	72.1	50.2	21.9
PMS 10 A	81.6	72.6	45.3	27.3
IR 69616 A	80.2	70.2	49.6	20.6
PMS 11 A	80.7	68.8	58.9	9.9
PMS 8 A	79.9	68.5	55.2	13.3
IR 65515-56-1-3-19R	79.7	70.2	40.8	29.4
IR 29341-41-1R	80.4	70.9	48.7	22.2
H 4	80.4	72.4	57.7	14.4
At 95-6-8	80.7	71.9	52.7	19.2
IR 49615-11-3-1-11R	79.8	70.7	50.7	20.0
IR 32809-26-3-3R	80.2	71.5	52.3	19.2

BR = Brown Rice; HG = Head Grain; TMR = Total Milled Rice; BG = Broken Grain

The head grain percentage showed the greatest variation ranging from 43.1 to 58.9. It is observed that the parents possessing high head rice recovery gave hybrids with high head grain percentage, whereas the lowest head grain percentage was seen in IR 65515-56-1-3-19R (40.8%) which is one of the parents of the hybrid showing the lowest HG% (BgHR11). Thus selecting parents with high HG% is very important in hybrid rice breeding program.

Table 2 gives the grain dimensions. Length and width of 10 grains were measured using a micrometer screw gauge. Chalkiness and translucency was visually assessed and graded according to the degree of white belly or white centre the grade increasing with the degree of severity. Since all the varieties used as parents except At 95-6-8 had long grains, all the hybrids had long slender grain type. Endosperm appearance generally depended on that of the parents. All PMS11A crosses had white centre of WC2. Both the H4 crosses had red pericarp. The 1000-grain weights of the hybrids were generally intermediate to the parents as has been also reported by Kumar *et al.* (1994).

Table 2. Grain dimensions and endosperm characteristics of hybrids and parents.

Variety/Hybrid	*Length (mm)*	*Width (mm)*	*L/W*	*Appearance*		*Pericarp colour*	*1000 grain weight (g)*
				Chk	*Trs*		
IR62829 A/ IR 65515-56-1-3-19R (BgHR11)	6.87	1.72	L/S	WB-2	I	W	23.78
PMS 10 A/IR 29341-41-1R (BgHR12)	7.01	1.79	L/S	WB-1	I	W	24.39
IR 69616 A/H 4 (BgHR1)	6.70	1.76	L/S	WB-2	I	R	23.54
PMS 11A/H 4 (BgHR4)	6.17	1.98	L/S	WC-2	I	R	22.91
PMS 8 A/At 95-6-8 (BgHR5)	6.39	2.02	L/S	WB-2	I	W	23.11
PMS 11 A/IR49615-11-3-1-1-3R (BgHR3)	6.33	2.08	L/S	WC-2	I	W	22.72
PMS 11A/IR32809-26-3-3R (BgHR2)	7.00	1.90	L/S	WC-2	I	W	24.97
IR 62829 A	6.52	1.75	L/S	WB-1	I	W	22.96
PMS 10 A	6.29	1.82	L/S	WB-1	I	W	22.51
IR 69616 A	6.29	1.76	L/S	WB-1	I	W	22.37
PMS 11 A	6.20	1.87	L/S	WC-2	I	W	22.70
PMS 8 A	6.59	1.72	L/S	WC-1	I	W	23.01
IR 65515-56-1-3-19R	7.06	1.68	L/S	WB-2	I	W	24.21
IR 29341-41-1R	6.59	1.75	L/S	WB-1	I	W	23.24
H 4	6.19	2.16	L/M	WB-3	I	R	24.62
At 95-6-8	5.59	2.19	I/B	WB-3	I	W	22.95
IR 49615-11-3-1-1-3R	6.23	1.67	L/S	WB-2	I	W	22.58
IR 32809-26-3-3R	6.62	2.11	L/S	WB-2	I	W	23.42

Chk = Chalkiness; WB = White Belly; WC = White Centre; Trs = Translucency; I = intermediate
L/W = Length/Width ratio; L/S = long/slender; L/M = long/medium; I/B = intermediate/bold

Table 3 gives the characteristics that determine the cooking and eating quality of rice.

It is seen that when one of the parents has high amylose the hybrids also has high amylose. However in the hybrids with low amylose content all the parents had intermediate amylose content. In the case of the hybrids with intermediate amylose content at least one of the parents had intermediate amylose content thus showing the complexity of inheritance of amylose content. High amylose content was always associated with intermediate gelatinization temperatures. Although most of the parents used had soft gel consistencies none of the hybrids possessed this character. However, the most desired gel consistency is the intermediate type in terms of cooked rice quality.

Table 3. Amylose content, gelatinization temperature and gel consistency of hybrids and parents.

Variety/Hybrid	*Amylose content*	*Gelatinization Temperature*	*Gel Consistency*
IR62829A/IR65515-56-1-3-19R (BgHR11)	Low	High	Intermediate
PMS 10 A/IR 29341-41-1R (BgHR12)	Low	Intermediate	Intermediate
IR 69616 A/H 4 (BgHR1)	High	Intermediate	Intermediate
PMS 11A/H 4 (BgHR4)	High	Intermediate	Hard
PMS 8 A/At 95-6-8 (BgHR5)	High	Intermediate	Hard
PMS 11A/IR 49615-11-3-1-1-3R (BgHR3)	Intermediate	Intermediate	Intermediate
PMS 11A/IR 32809-26-3-3R (BgHR2)	Intermediate	High/Int	Intermediate
IR 62829 A	Intermediate	High	Intermediate
PMS 10 A	Intermediate	Low	Soft
IR 69616 A	Low	Low	Soft
PMS 11 A	Low	Low	Intermediate
PMS 8 A	Intermediate	Low	Soft
IR 65515-56-1-3-19R	Intermediate	Intermediate	Intermediate
IR 29341-41-1R	Intermediate	Low	Soft
H 4	High	High	Intermediate
At 95-6-8	High	High	High
IR 49615-11-3-1-1-3R	Intermediate	Intermediate	Intermediate
IR 32809-26-3-3R	Low	High	Intermediate

Grain dimensions, especially grain length is of prime importance in marketing. The size and shape of the grain is primarily determined by the size of lemma and palea. The grain size of any hybrid is highly uniform and no genetic segregation is expected or observed within the panicle. Seed borne on hybrid plants is normally expected to be between the two parents. However, it has been suggested that as far as possible, both parents should have the desirable grain type. Where grain size differs, at least the female parent should have the desirable grain type. There is a general feeling among breeders that out pollination potential is higher in CMS lines with short grains. However, out-crossing seems to depend more on stigma exertion and angle and time of opening of lemma and palea rather than on grain size. It is

suggested that if the objective is to produce hybrids with long/slender grains, CMS lines with long grained genetic backgrounds should be developed.

Grain weight is highly correlated to grain size. Grain size is a product of grain length and grain width, which are independently inherited. Therefore, heterosis in grain weight differs according to the cross combinations.

Consumer acceptance of a variety is dependent not only on the appearance of the grain but also on the cooking and eating quality. Of the endosperm characteristics, amylose content is the primary factor affecting eating quality. Rices with high amylose contents are not sticky, cook fluffy but become dry on cooling. Intermediate amylose rices cook fluffy, but remain moist and soft on cooling. The low amylose rices cook sticky and soft. This character has been reported to show both dosage and maternal effects and has been reported to be monogenic in inheritance (Kumar and Khush1986; Kumar *et al.*, 1987).

Of the hybrids developed it is seen that BgHR1 shows great promise as it gives high yields (6.37 t/ha), a 46% yield increase over the inbred high yielding variety Bg357 (Abeysekera *et al.*, 2000), and also has red pericarp colour which is in demand among the local consumers.

CONCLUSION

The major challenge in indica hybrid rice breeding is to ensure that heterotic rice hybrids possess grain quality that is at least comparable if not superior to inbred check varieties grown by farmers. They should also be acceptable to consumers in terms of cooking and eating quality, which is primarily influenced by the amylose content. Hybrids with superior head rice recovery can be produced if parents with high head grain percentage are selected. Grain size and shape does not pose a problem if hybrids of medium grain size are to be produced. However, if long grained hybrids are required both parents should have long grains. Parents with widely different endosperm appearance should not be crossed if good market acceptability is desired. By choosing the appropriate parental lines, hybrids with desired cooking and eating quality characteristics can be developed.

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