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# COOKING QUALITY CHARACTERISTICS OF HYBRID RICE

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## ABSTRACT

**Grains produced on hybrids and parents were analysed for amylose content, gelatinization temperature, aroma and kernel elongation. To achieve uniformity in the texture of cooked rice and cooking time for hybrids, parents must have intermediate AC and GT with minimum intra-population variation. Both the parents must have optimum level of aroma and kernel elongation after cooking.**

**Key words:** Hybrid rice, cooking quality, kernel elongation.

Although hybrid rice technology has been highly successful in China, the spread of hybrids, particularly outside China, has still been facing several problems of which the poor grain quality of all existing hybrids is an important constraint. During the last decade, voluminous work has been undertaken for diversifying the cytoplasmic male sterile sources, enhancing the magnitude of heterosis for yield and improving genetic protection against insect-pests and diseases of the hybrids. However, limited efforts have been made on the grain quality of hybrid rice [1, 2]. Quality in rice is a complex phenomenon governed by physio-chemical properties of starch. In pure lines, all individual kernels are more or less uniform in respect to different grain quality characteristics. In hybrids, seeds borne on $F_1$ plants represent $F_2$ seed which are intermediate to the parents and uniform in shape, but differ in cooking quality characteristics. This affects the quality of cooked rice. The present study helps to understand the features of some important cooking quality characteristics, namely amylose content, gelatinization temperature, aroma and kernel elongation of hybrids.

## MATERIALS AND METHODS

Hybrids and parents were grown in R.B.D. with two replications. Grain samples were dehulled in a mini "Satake Rice Machine" and passed through "Satake rice whitening machine" for 3 minutes to obtain uniformly polished kernels.

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Amylose content was examined in three hybrids. From each hybrid and parent 150 and 25 kernels, respectively were used for single grain analyses [3]. Six hybrids representing intermediate x high, intermediate x intermediate, and intermediate x low combinations were studied for gelatinization temperature [4] using 200 individual kernels from each hybrid parent. Alkali spreading value was scored on a 7-point numerical scale [5] and classified as high (1-3), intermediate (4–5), and low (6–7).

Aroma was examined in two hybrids involving aromatic pollen parents. Two hundred single kernels from each hybrid were scored for aroma by using 1.7% KOH [6] supported by chewing individual kernels and using blind checks as control [7]. Kernel elongation was observed only in one hybrid. Length and breadth of 100 unbroken milled individual kernels were recorded before and after cooking. Individual kernels were cooked in a waterbath after soaking in water for 30 min before cooking. Elongation ratio was calculated by dividing the length of cooked rice by the original kernel length.

## RESULTS AND DISCUSSION

Properties of cooked rice (tenderness and cohesiveness) are controlled by amylose content and gelatinization temperature. Rice with intermediate values for both parameters remains nonsticky and tender after cooking, and low values for both makes the rice sticky on cooking. Rice with low gelatinization temperature cooks faster. Majority of the consumers worldover prefer nonsticky rice.

### AMYLOSE CONTENT

Parental means ranged from 18.1 to 30.5% (Table 1). Within the parents amylose content varied in the range of 4–6%, with 3.6 to 7.3 CV. The $F_2$ mean around midparent observed in this study supports the earlier studies [1], however, all the hybrids exceeded the parental limits [2]. Larger differences in parents resulted in larger range and greater variation in the hybrids. In high x high hybrid, amylose content varied from 20-34% with 10.9 CV. In case of high x intermediate hybrid, its

**Table 1. Estimates of mean, range and coefficient of variation of rice hybrids and their parents for amylose content**

| Parent/hybrid | Mean (%) | Range (%) | CV |
|---|---|---|---|
| **Parents:** | | | |
| V20B[@] | 30.5 ± 0.22 | 28-34 | 5.7 |
| Improved Sabarmati | 18.1 ± 0.31 | 16-20 | 7.6 |
| IR 480-5-9 | 23.3 ± 0.41 | 20-25 | 7.9 |
| Pusa 205 | 30.0 ± 0.24 | 28-32 | 3.6 |
| **Hybrids:** | | | |
| V20A x Improved Sabarmati | 26.2 ± 0.51* | 14-36 | 23.7 |
| V20A x IR 480-5-9 | 27.0 ± 0.38* | 18-34 | 17.3 |
| V20A x Pusa 205 | 28.7 ± 0.26* | 20-34 | 10.9 |

*Differ significantly from the respective pollen parents at 5% level.
[@]Representative of its corresponding cms line V20A.

range was 18–34% and CV 17.3%. The high x low combination had the range of 14–36% and CV 23.7%.

Proportional distribution of high, intermediate and low amylose types in $F_2$ kernels of hybrids varied from hybrid to hybrid (Table 2). High amylose types were predominant in the high x high and high x intermediate hybrids. Even in a high x low combination, more than 50% kernels turned out to be high-amylose types. Such a high proportion of high-amylose types will lead to ununiform cooking. Therefore, depending on the regional preference, appropriate parents should be selected and high-amylose types avoided.

**Table 2. Segregation pattern for amylose content in $F_2$**

| Hybrid | Amylose content types (%) | | |
|---|---|---|---|
| | low | intermediate | high |
| **High x low** | | | |
| V20A x Improved Sabarmati | 11 | 35 | 54 |
| **High x intermediate** | | | |
| V20A x IR 480-9 | 6* | 24 | 70 |
| **High x High** | | | |
| V20A x Pusa 205 | 0 | 11* | 89 |

*Transgressive segregation.

GELATINIZATION TEMPERATURE (GT)

Significant differences between parents and hybrids in respect of mean, range and CV were observed for GT (Table 3). In five hybrids, the means were within the parental limits, only in V20A x Pusa 615, mean GT was higher than the high-value parent. Such intermediary nature and the tendency to exceed occasionally the high-value parents have been reported earlier [1, 2]. CV for alkali spreading value varied from 3.1 to 13.1% in parents and from 17.1 to 40.7% in hybrids. Unlike amylose content, the differences in parental means for alkali spreading values did not reflect the degree of variation in hybrids. For instance, V20A x Pusa 615 hybrid

**Table 3. Estimates of mean, range and coefficient of variation of rice hybrids and parents for gelatinization temperature (numerical score)**

| Parent/hybrid | Mean | Range | CV |
|---|---|---|---|
| **Parents:** | | | |
| V20B@ | 4.8 ± 0.04 | 4–6 | 4.4 |
| CP 231 | 2.0 ± 0.01 | 1–2 | 7.9 |
| Pusa 615-14-10-1 | 4.7 ± 0.04 | 3–6 | 13.1 |
| Improved Sabarmati | 5.8 ± 0.03 | 4–6 | 9.3 |
| Pusa 205 | 6.9 ± 0.02 | 6–7 | 4.4 |
| Pusa 743-1-1 | 6.9 ± 0.02 | 6–7 | 3.7 |
| IR 480-5-9 | 6.9 ± 0.01 | 6–7 | 3.1 |
| **Hybrids:** | | | |
| V20A x CP 231 | 2.9 ± 0.08* | 1–6 | 40.7 |
| V20A x Pusa 615-14-10-1 | 5.2 ± 0.08* | 3–7 | 22.3 |
| V20A x Improved Sabarmati | 4.7 ± 0.11* | 2–7 | 33.0 |
| V20A x Pusa 205 | 5.7 ± 0.07* | 4–7 | 17.1 |
| V20A x Pusa 743-1-1 | 5.7 ± 0.09* | 2–7 | 20.4 |
| V20A x IR 480-5-9 | 5.7 ± 0.09* | 3–7 | 23.0 |

@Representative of its corresponding cms line V20A.

*Differ significantly from the respective pollen parents at 5% level.

(intermediate x intermediate) did not have lower CV than the intermediate x low hybrids. This trend may be attributed to the intrapopulation variation within a parent.

The segregation for GT did not follow a definite pattern. The intermediate x high hybrid had high GT types in high proportion (77%), while the intermediate x low GT hybrids had predominance of low-GT types (30-68%). The intermediate x intermediate hybrid had all three GT types, showing a tendency more towards low-GT types and 16% transgressive segregates (Table 4). In intermediate x low hybrids, transgressive segregates were observed towards high GT with 6–35% frequency. The occurrence of high-GT grains due to transgressive segregation is not desirable as high-GT types remain hard after cooking and hence, not preferred. The intermediate x intermediate and intermediate x low hybrids should be evaluated carefully to avoid those producing high proportion of high-GT grains.

**Table 4. Segregation for gelatinization temperature in $F_2$**

| Hybrid | GT types (%) | | |
|---|---|---|---|
| | low | intermediate | high |
| **Intermediate x high** | | | |
| V20A x CP 231 | 6* | 17 | 77 |
| **Intermediate x intermediate** | | | |
| V20A x Pusa 615-14-10-1 | 38 (16)* | 55 | 7 |
| **Intermediate x low** | | | |
| V20A x Improved Sabarmati | 30 | 35 | 35* |
| V20A x Pusa 205 | 61 | 39 | 0 |
| V20A x Pusa 743-1-1 | 68 | 25 | 7* |
| V20A x 480-5-9 | 62 | 31 | 6* |

*Transgressive segregation.

AROMA

Segregation for aroma gave 3 nonaromatic : 1 aromatic ratio (Table 5). Evaluation of the bulk grain samples in two hybrids gave a feeling of mild aroma during and after cooking.

**Table 5. Segregation for aroma among $F_2$ kernels in rice hybrids**

| Hybrid | Segregation | | $\chi^2$ (3:1) | P |
|---|---|---|---|---|
| | nonaromatic | aromatic | | |
| V20A x Dinorado | 154 | 46 | 0.42 | 0.50–0.70 |
| V20A x Improved Sabarmati | 157 | 43 | 1.21 | 0.20–0.30 |

Hybrids involving only one aromatic parent may not produce desirable level of aroma as only one-fourth of their bulk grains will be aromatic. Therefore, both the parents should have optimum level of aroma.

KERNEL ELONGATION

Linear kernel elongation during cooking to around twice the original kernel length with minimum breadthwise expansion is one of the important characteristics of the basmati rice and also a desirable character for long nonbasmati varieties, to get a premium price in the market. In this study, mean kernel elongation ratio was equal to the midparent value. The CV was 6.1 and 6.7% in the parents and 8.8% in the hybrid (Table 6). After cooking, only 5% of the kernels showed desirable level of kernel elongation. Therefore, both parents must have desirable degree of kernel elongation.

**Table 6. Mean, range, CV and segregation pattern for kernel elongation ratio**

| Parents/hybrid | Mean | Range | CV | Elongation ratio in different groups (%) | | |
|---|---|---|---|---|---|---|
| | | | | 1.2-1.5 | 1.5-1.80 | 1.80-2.00 |
| V20* | 1.5 ± 0.02 | 1.2 - 1.6 | 6.1 | 61 | 39 | 0 |
| Pusa 615-14-10-1 | 1.8 ± 0.02 | 1.6 - 2.0 | 6.7 | 0 | 32 | 68 |
| V20A x Pusa 615-14-10-1 | 1.6 ± 0.01 | 1.3 - 2.0 | 8.8 | 39 | 56 | 5 |

*Representative of its corresponding cms line V20A.

Heterosis is considered to be related with genetic diversity of parents. In rice germplasm, geographically and morphologically diverse accessions are known to have identical physico-chemical kernel properties. Since cooking quality characteristics of the hybrids are intermediate between those of parents, for the development of acceptable quality hybrids, parents must have similar amylose content, gelatinization temperature, kernel elongation, and aroma.

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