COOKING AND EATING CHARACTERISTICS IN UPLAND AND IRRIGATED RICE VARIETIES[1]

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ABSTRACT - Twenty-eight Brazilian rice cultivars proceeding from the Germplasm Center of the International Rice Research Institute (IRRI), were tested as to the grain quality characteristics. Amylose contents gelatinization temperature and gel consistency were analyzed and discussed. The percentage of amylose content ranged from 15.0 to 27.0% by the simplified hand method and from 16.0 to 26.0% on the autoanalysis method. The alkali test values ranged from 2.0 to 7.0 for spreading. By the gel consistency method, the length ranged from 27.0 to 98.0 mm. The evaluated cultivars showed gel consistency which encompassed from hard, medium, mediumly soft and soft. The cultivars IAC 47, Lageado, EEA 201, Paga Dívida, EEPG 261, Vermelho Pernambuco, Dourado Agulha, IAC 416, Canela de Ferro and EEPG 269 were selected with excellent cooking and eating characteristics which will be able to serve as gene sources in the rice breeding program for grain quality.

Index terms: grain quality, amylose content, gel temperature, gel consistency, alkali test.

CARACTERÍSTICAS CULINÁRIAS EM CULTIVARES DE ARROZ DE SEQUEIRO E IRRIGADO

RESUMO - Vinte e oito cultivares brasileiras de arroz oriundas do banco de germoplasma do Instituto Internacional de Pesquisa de Arroz (IRRI), foram testadas quanto às características de qualidade de grãos. Teores de amilose, temperatura de gelatinização e consistência de gel foram analisados e discutidos. A percentagem do teor de amilose variou de 15,0 a 27,0% pelo método manual simplificado e de 16,0 a 26,0% com o método de auto-análise. Os valores do teste de expansão em alkali que indica a temperatura de gelatinização variaram de 2,0 a 7,0. Para o método de consistência de gel, o comprimento variou de 27,0 a 93,0mm. As cultivares avaliadas apresentaram forte, média, medianamente fraca e fraca consistência de gel. As cultivares IAC 47, Lageado, EEA 201, Paga Dívida, EEPG 261, Vermelho Pernambuco, Dourado Agulha, IAC 416, Canela de Ferro e EEPG 269 foram selecionadas com excelentes características culinárias que poderão servir como fontes de genes nos programas de melhoramento de arroz no Brazil para qualidade dos grãos.

Termos para indexação: qualidade dos grãos, teores de amilose, temperatura de gel, consistência de gel, teste de expansão em alkali.

INTRODUCTION

In Brazil's rice breeding programs, emphasis has been given on grain yield with little attention to grain quality. Recent changes in market acceptability together with increased yield resulted in the growing importance of breeding programs, and the development of high yielding varieties has been of major concern in such programs.

In Brazil the majority of the population prefers rice with long, slender, and translucent grain that produces a high grain expansion ratio and a non-sticky product after cooking (Usberti Filho et al., 1986).

Many papers have reported rice grain quality related to varictal differences in cooking and eating properties (Jones, 1938; Juliano et al., 1964a and 1965).

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Starch is a major constituent of milled rice which differs widely among varieties (Juliano, 1979). The amylose content of the rice starch is the principal factor in volume expansion, tenderness, and gloss scores of cooked rice regardless of the water/rice ratio used during cooking (Juliano, 1972). The gelatinization of rice starch is positively correlated with the time required to cook milled rice (Beachell & Halick, 1957 and Juliano et al., 1965). The amylose content of starch is negatively correlated with tenderness, cohesiveness and gloss scores of milled rice with a fixed ratio of rice water (Juliano et al., 1965) while having the same amylose content may be differentiated by the tenderness of cooked rice by the gel consistency test (Cagampang et al., 1973).

In the Genetic Evaluation and Utilization (GEU) program of the International Rice Research Institute (IRRI), materials with intermediate amylose content, intermediate gelatinization temperature and soft gel consistency are the most important objectives of the rice breeding program (Klush et al., 1979).

This paper describes the cooking and eating characteristics of Brazilian rice varieties that can be utilized in rice breeding programs for specific grain quality in Brazil.

MATERIALS AND METHODS

Twenty-eight Brazilian varieties of rice were obtained from the International Rice Germplasm Center (IRGC) of the International Rice Research Institute (IRRI) as rough rice of about 5 grams each. The rough rice samples were dehulled with a satake husker and milled in a test tube for milling rice for 30 minutes About 2/10 of the tube was filled with aluminum oxide (AlO_2).

Flours for the amylose analysis were obtained with the UDY Cyclone Mill. Samples were powdered using a 40 - mesh sieve. With flours of gel consistency, 10 grains were ground into a fine flour (about 100 - mesh) for 55 seconds in a Wig-L-Bug amalgamator.

For the amylose test, 100mg of each sample was placed in a 100ml volumetric flask and 1ml of 95% ethyl alcohol, plus 9ml 1N NaOH were added and the mixture was heated over a boiling water bath for 10 minutes, removed, and left the samples for 1 hour to cool at room temperature and diluted to 100 ml with distilled water. Three standard samples of known amylose content; IR 24, IR 64 and IR 8 with low, intermediate and high amylose content respectively were used as checks.

Amylose content in rice is determined by several methods most of which are based on the method of Williams et al. (1958). Juliano (1971) modified the basic method for more speedy analysis both manually and semi-automatically. It is called the Simplified Amylose Procedure and this method was used to evaluate the materials from this experiment.

For the gel consistency test, 100mg of powder in duplicate were placed into 13 x 100mm cultures tubes (Pyrex nº 9820) and wetted with 0,2ml of 95% ethanol containing 0,025% thymol blue. The tube was shaken to disperse the starch, 2.0ml of 0.1N KOH was immediately added and the mixture was dispersed using a Vortex Genie (Scientific Industries, Springfield, Mass., Setting of 6). The tubes were covered with glass marbles and placed for 8 minutes into vigorously boiling water bath to reflux. The samples were then removed from the water bath, set room temperature for 5 minutes, and then cooled in an iced water bath for 15 minutes. The tubes were laid horizontally over ruled paper graduated in millimeters and the length of the gel was measured from the botton of the test tube to the gel front, 60 minutes later. The classifications used were: hard (27mm - 35mm), medium/hard (36mm - 40mm), medium (41mm - 60mm) and low (61mm - 100mm). This test was based on the method described by Cagampang et al. (1973).

Alkali test as an index for gelatinization temperature (Little et al., 1958) was also performed. Six whole milled rice grains were placed in small transparent plastic boxes containing 10 ml of 1.70% potassium hydroxide (KOH) solution. The boxes were covered and left undisturbed for 23 hours in an incubator maintained at 30°C. Two replications were used for each rice sample. CP 231, IR 36 and IR 42 with high, intermediate and low gelatinization temperature respectively were used as checks.

RESULTS AND DISCUSSION

Commercial rice varieties may be grouped on the basis of their apparent amylose content into waxy (1 to 2% amylose), low amylose (12 to 20%), intermediate amylose (20 to 25%), moderately high amylose (25 to 27%), and high (> 27%) (International Rice Research Institute, 1972).

The results of tests to measure the amylose content is shown in Table 1. The percentage of amylose content ranged from 15 to 27% by simplified manual method and from 16 to 26% by autoanalyzer method.

TABLE 1. Amylose content by simplified manual and autoanalyzer method of 28 brazilian rice varieties. IRRI, 1988.

Variety	Acession number	Type of number	% Amylose content		
			Simplif. Man method[a]	Auto analyzer method[b]	Score[c]
EEEA 30	39020	Irrigated	15.0	16.0	Low
IR 24 (check)	-	Irrigated	17.0	17.0	Low
IRGA 407	26072	Irrigated	18.0	18.0	Low
EEA 402	39023	Irrigated	17.0	18.0	Low
Batatais	24479	Upland	19.0	18.0	Low
Pérola	39090	Upland	19.0	19.0	Low
Verm. Pernambuco	39105	Upland	21.0	20.0	Intermediate
Jaguari	39074	Upland	23.0	20.0	Intermediate
Lageado	50490	Irrigated	23.0	20.0	Intermediate
Chatão	39006	Upland	23.0	20.0	Intermediate
EEA 201	26021	Irrigated	20.0	20.0	Intermediate
EEPG 261	55859	Upland	21.0	21.0	Intermediate
Dourado Agulha	3302	Upland	23.0	21.0	Intermediate
Iguape agulha	6465	Upland	23.0	21.0	Intermediate
Dourado	39012	Upland	23.0	21.0	Intermediate
Dourado precoce	39019	Upland	22.0	21.0	Intermediate
IR 64 (check)	-	Irrigated	23.0	21.0	Intermediate
Paga dívida	39085	Upland	23.0	21.0	Intermediate
IAC 47	19649	Upland	22.0	22.0	Intermediate
IAC 25	19642	Upland	21.0	22.0	Intermediate
IAC 164	55860	Upland	22.0	22.0	Intermediate
EEPG 269	55858	Upland	22.0	22.0	Intermediate
Canela de ferro	50448	Upland	23.0	22.0	Intermediate
Agulha precoce	38982	Upland	23.0	22.0	Intermediate
Cana roxa	38998	Irrig./Upland	23.0	22.0	Intermediate
De abril	38986	Irrigated	23.0	22.0	Intermediate
IAC 416	39048	Irrigated	24.0	23.0	Intermediate
Agulha ESAV	39075	Irrigated	23.0	23.0	Intermediate
IAC 1246	19645	Upland	22.0	23.0	Intermediate
IAC 165	55861	Upland	24.0	24.0	Intermediate
IR 8 (check)	-	Irrigated	27.0	26.0	High

a Based on simplified manual method (Juliano, 1971)
b Based on simplified autoanalyzer method (Juliano, 1971)
c Amylose of milled rice High (25%), Intermediate (20 - 25%) and Low (8 - 19%)

It was observed that there were no differences between the two methods, therefore, in the absence of autoanalyzer method, the simplified manual procedure can be adopted (Table 1). The results obtained are in accordance with the findings of Williams et al. (1958) who observed varietal difference in amylose content of 14.2 to 25.6 for Louisiana varieties and 13.6 to 23.1 for Texas varieties. However, the rice starch varies widely in amylose content from 0.8 to 1.3 for waxy and 3.1 to 37.2% for non waxy varieties (Reyes et al., 1965) but Juliano et al. (1964b) found the amylose content of milled rice samples ranged from 2.8 to 5.7 of dry weight for the four waxy rices. Juliano et al. (1964b) studying physicochemical properties of rice found in the amylose content of milled rice samples, which is within the range found in the samples shown in Table 1.

Comparing the type of culture, it was observed (Table 1) that 70% of the irrigated varieties had intermediate amylose content. With the exception of Perola and Batatais, all other Upland varieties had intermediate amylose content. The data indicates that most of varieties tested had acceptable amylose scores and can be utilized in the rice breeding program for specific grain quality.

The time required for cooking is determined by gelatinization temperature with a low of 55° to 69°C, intermediate (70° to 74°C) or high (75° to 79°C). The alkali digestion, as an indication of gelatinization temperature, is shown in Table 2. The alkali spreading among the materials tested ranged from 3.08 (EEA 402) to 6.75 (EEA 301) and 71% of varieties showed intermediate gelatinization temperature.

All improved varieties from the Agricultural Institute of Campinas - Brazil (IAC) had an intermediate gelatinization temperature (70°-74°C). However, Usberti Filho et al. (1968) had found low gelatinization in 84% of upland and irrigated advanced lines from IAC, which included the varieties IAC 25, IAC 165, IAC 47 and IAC 164 which were evaluated in this experiment (Table 2). The difference may have been influenced by environmental conditions

TABLE 2. Gelatinization temperature and gel consistency of 28 brazilian rice varieties. IRRI, 1988.

Variety	Alkali spreading[a] (values)	Gelatinization temperature	Gel (mm)	Consistency[b] score
IR 42 (check)	7.00	Low	29.0	Hard
EEA 301	6.75	Low	53.5	Medium
Batatais	6.58	Low	61.0	Medium-soft
IRGA 407	6.33	Low	70.5	Medium-soft
EEA 201	6.33	Intermediate	82.5	Soft
Canela de ferro	5.33	Intermediate	66.0	Medium-soft
IR 36 (check)	5.16	Intermediate	-	-
IAC 1246	5.00	Intermediate	59.5	Medium
De abril	5.00	Intermediate	51.5	Medium
Vermelho Pernambuco	5.00	Intermediate	61.0	Medium-soft
EEPG 269	5.08	Intermediate	67.0	Medium-soft
IAC 25	4.91	Intermediate	54.0	Medium
IAC 165	4.66	Intermediate	45.0	Medium
EEPG 261	4.74	Intermediate	70.0	Medium-soft
IAC 416	4.58	Intermediate	67.0	Medium-soft
Dourado agulha	4.91	Intermediate	59.5	Medium-soft
Iguape agulha	4.58	Intermediate	50.0	Medium
IAC 47	4.08	Intermediate	95.0	Soft
A. ESAV	4.08	Intermediate	27.0	Hard
IAC 164	4.41	Intermediate	34.0	Hard
Paga dívida	4.50	Intermediate	68.0	Medium-soft
Lageado	4.08	Intermediate	98.0	Soft
Dourado precoce	4.16	Intermediate	51.0	Medium
Cana roxa	4.16	Intermediate	38.5	Medium-hard
Dourado	4.41	Intermediate	55.5	Medium
Agulha precoce	4.58	Intermediate	54.0	Medium
Jaguari	3.99	High - intermediate	75.0	Medium-soft
Chatão	3.83	High - intermediate	49.0	Medium
EEA 402	3.08	High - intermediate	84.0	Soft
Pérola	3.49	High - intermediate	67.0	Medium-soft
CP 231 (check)	2.00	High	-	-
IR 32 (check)	-	-	70.0	Medium-soft
IR 48 (check)	-	-	57.0	Medium

[a] Based on alkali spreading value (Little et al., 1958); Low (6-7); Interm. (4-5); High-interm. (3) and High (2).
[b] Based on Standard Evaluation System for Rice (IRRI, 1983); Hard (35 mm); Medium-hard (36 - 40 mm); Medium (41 - 60 mm); Medium-soft (61 - 80 mm).

such temperature during ripening which affects the gelatinization temperature (Klush et al., 1979). A high ambient temperature during grain development results in a starch with higher gelatinization temperature (Klush et al., 1979). Beachell & Stansel (1963) have shown that low temperature results in higher amylose content and lower gelatinization temperature of the starch.

The gel consistency test, which complemented the test for amylose, was also used to evaluate the rice lines. Among the varieties tested the gel (mm) ranged from 27 to 98, and 36% of varieties did not have gel consistency values predicted from amylose content (Tables 1 and 2). The data are in accord with Cagampang et al. (1973) who reported that the varieties having the same amylose content may be differentiated in the eating quality of cooked rice by the gel consistency test, and that factors other than amylose, Amylopectin ratio, influence gel consistency.

In Table 3, the selected cultivars with suitable cooking and eating characteristics are found. It was observed that all selected materials showed intermediate amylose content. Whereas for the trait - gelatinization temperature, except for the cultivar Paga Dívida, all the others presented intermediate gelatinization temperature. With relation to gel consistency, 70% of the selected materials, showed mediumly weak gel consistency (Table 3). These selected materials presented suitable cooking and eating characteristics which will be able to serve as excellent sources of genes in rice breeding programs aiming at good characteristics of grain quality.

CONCLUSIONS

1. No difference was found between the two methods utilized to determine amylose content. Therefore, in the absence of the autoanalyzer method, the simplified manual procedure can be adopted.

2. Eighty-two percent of varieties tested were of intermediate amylose content and can be utilized in the rice breeding program for cooking eating characteristics.

3. Among the varieties evaluated, IAC 47, Lageado, EEA 201, Paga Dívida, EEPG 261, Vermelho Pernambuco, Dourado Agulha, IAC 416, Canela de Ferro, and EEPG 269, were found to have desirable cooking and eating characteristics and may be utilized in rice breeding for specific grain quality.

TABLE 3. Donor parents selected with desirable grain quality characteristics for rice breeding program in Brazil. IRRI, 1988.

Variety	Amylose content[a]	Gelatinization temperature[b]	Gel consistency[c]
IAC 47	Intermediate	Intermediate	Soft
Lageado	Intermediate	Intermediate	Soft
EEA 201	Intermediate	Intermediate-low	Soft
Paga dívida	Intermediate	Intermediate	Medium-soft
EEPG 261	Intermediate	Intermediate	Medium-soft
Vermelho pernambuco	Intermediate	Intermediate	Medium-soft
Dourado agulha	Intermediate	Intermediate	Medium-soft
IAC 416	Intermediate	Intermediate	Medium-soft
Canela de ferro	Intermediate	Intermediate	Medium-soft
EEPG 269	Intermediate	Intermediate	Medium-soft

[a] Amylose of milled rice: Intermediate (20 - 25%)

[b] Based on alkali spreading value (Little et al., 1958): Low (6 - 7) and Intermediate (4 - 5)

[c] Based on standard Evaluation System for Rice (IRRI, 1983): Medium-soft (61 - 80 mm) and Soft (80 mm).

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