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REGULAR ARTICLE

TRADITIONALLY CULTIVATED SALT TOLERANT RICE VARIETIES GROWN IN KHAZAN LANDS OF GOA, INDIA AND THEIR GRAIN QUALITY CHARACTERISTICS

Shilpa J. Bhonsle and S. Krishnan*
Department of Botany, Goa University, Goa-403 206, India

SUMMARY

The khazan lands (saline lands) have the potential for growing traditional rice varieties which are salt tolerant during rainy season without supplemental irrigation. In khazan land the rice varieties grown are limited, but specific traditional rice varieties like Korgut, Khochro and Assgo are grown predominantly. During this study, we have collected 10 traditionally cultivated rice varieties which grown in saline areas. These varieties were with unique morphological characteristics of shape, size and color. The physicochemical characteristics such as physical, chemical and cooking characteristics were studied. Among the varieties, the highest hulling (80%) was noted in varieties Muno, Shiedi and lowest in varieties Bello and Kalo Damgo (73%). The Length/Breadth (L/B) ratio ranged from 2.02-2.86. The lowest chalkiness was recorded in variety Kalo Novan (33.30%) and highest in variety Korgut (87.86%). Among the varieties studied, the amylose content (AC) ranged from 14.6-23.7% in variety Khochro and Kalo Novan respectively. The gel consistency was highest in traditionally cultivated rice variety Damgo (75.3 mm) and lowest in Khochro (34.6 mm). Kernel length after cooking (KLAC) ranged from 2.38-4.78 mm. The highest KLAC was recorded in Bello and minimum in variety Korgut. Kernel elongation ratio (ER) ranged from 1.03-1.66. The present investigation revealed that the traditionally cultivated rice varieties viz. Bello, Korgut, Khochro and Kalo Novan were with good grain quality characteristics.

Key words: Grain quality, Khazan lands, Physico-chemical properties, Rice diversity

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*Corresponding Author, Email: skrish8@yahoo.com, Tel.: 91-832-6519348

1. Introduction

Rice (*Oryza sativa* L.) is the principal cereal crop and it is consumed as the whole grain therefore, determination of physical, cooking and nutritional qualities are very important in view point of consumers. Grain quality characters are interrelated among themselves which in turn decides the final cooking and eating characteristics. Rice is the predominant food crop of Goa occupying an area of 39% (52,442 ha) of the total cultivated land in the state and the khazan lands occupy an area of 17,200 ha. Popularly rice varieties grown in khazan lands of Goa are Korgut (with awn), Khochro and Assgo. High soil salinity is a major problem in several rice growing countries, both in the tropics and in temperate regions.

The physio-chemical characteristics of rice grain are important indicators of grain quality. It is mainly determined by combination of many physical as well as chemical characteristics. The physical quality includes kernel size, shape, hulling, milling and head rice recovery. The chemical characteristics are determination of amylose content, gelatinization temperature, gel consistency and cooking behavior [1]. In the context of changing agricultural scenario, there has been increase in demand for the quality rice throughout the world. Grain quality evaluation and organoleptic analysis always helps the consumers to select better rice varieties [2 and 3]. In this paper, we are presenting the finding of grain quality

characteristics (physical, chemical, cooking) of the salinity tolerant traditionally cultivated rice varieties of Goa.

2. Materials and Methods

The systematic field survey was carried out and diverse traditionally cultivated rice germplasm was collected from different parts of Goa.

Physical traits

Hulling percentage was calculated by taking the average whole-grain yield. 100 g of rice seeds were de-hulled using a standard de-husker. For Grain classification, ten de-husked entire brown rice grains were measured using dial micrometer. Based on the L/B ratio, grains were classified into long slender (LS), short slender (SS), medium slender (MS), long bold (LB) and short bold (SB). Chalkiness of endosperm was calculated by observing the milled rice caryopsis under a stereo-zoom microscope, based on the orientation of chalkiness, the rice grains were classified into white belly, white centre and white back. To study the Chalk index, ten de-husked rice grains were placed on light box. The visually identified caryopsis with more than 50% of chalkiness was weighed and percentage of chalkiness was calculated [4].

Chemical traits

Alkali spreading value (ASV) was calculated using six milled rice grains in Petri plates. 10 ml of 1.7% of KOH was added and kept in incubator at 27-30°C for 23 hours. Then the alkali spreading value was calculated as low, low-intermediate, intermediate or high [5]. The Amylose content (AC**)** of different varieties was calculated in comparison with standard graph [6 and 7]. To 100 mg of rice flour 1 ml of 95% ethanol and 9 ml of 1.0 N NaOH was added. This was mixed well and heated in a boiling water-bath for 10 min. Samples were diluted to 100 ml with distilled water. From this suspension, 5 ml of sample was taken and 1 ml of acetic acid (57.75 ml in one liter water) was added to acidify the sample along with 1.5 ml of iodine solution (0.2% iodine + 2% potassium iodide) and the volume was made to 100 ml with distilled water. The samples were incubated at room temperature for 20 min. The absorbance was measured at 620 nm using spectrophotometer. As a control, NaOH solution was used. For Gel consistency (GC), 100 mg of rice flour was taken in test tube (2×19.5 cm), 0.2 ml of ethanol containing 0.25% thymol blue and 2.0 ml of 0.2 N of KOH were added and kept in boiling water-bath for 8 min, cooled, mixed well and kept in ice bath for 20 min. Later the test tubes were laid horizontally for one hour and measurements were made using graph paper. The degree of disintegration of kernel was evaluated using a 7 point scale [8 and 9].

Cooking characteristics

Volume expansion ratio (VER) and elongation ratio (ER): 15 ml of water was taken in 50 ml graduated centrifuge tubes and 5 g of rice sample was added. Initial volume increase was measured (Y) and soaked for 10 min. Then increase in volume before cooking was noted (Y-15). Rice samples were cooked for 20 min in a water bath. Cooked rice was placed on bloating paper. Ten cooked rice kernels were selected (intact at both ends) and length of the kernels measured using graph paper for computing the kernel length after cooking (KLAC). Then the cooked rice was placed in 50 ml water taken in 100 ml measuring cylinder and increase in volume of cooked rice in 50 ml of water was measured (X). Then the volume raise was recorded (X-50). VER and ER were calculated [10].

3. Results and Discussion

During this study we had collected 10 traditional salt tolerant rice varieties which are unique in their morphological characters viz. shape, size and color (Figure 1). All the traditionally cultivated rice varieties are specific to Goa region and cultivated in small patches. Out of 10 rice varieties collected, cultivation of some of the varieties such as Kalo Novan, kalo damgo, and Bello are becoming rare, due to the introduction of high yielding rice varieties, hence local germplasm and their genetic diversity are being eroded. The rice varieties like Korgut,

Muno and Assgo are still popularly cultivated in khazan lands of Goa due to its high salinity tolerance. Grain quality is a very wide area which encompasses the diverse characters that are directly or indirectly related to exhibit one quality type [11].

Fig. 1. Salt tolerant rice varieties of Goa

1. Assgo, 2. Bello, 3. Damgo, 4. Kalo Damgo, 5. Kalo Korgut, 6. Kalo Novan, 7. Khochro, 8. Korgut, 9. Muno, 10. Shiedi

Physical characteristics

The hulling percentage for traditionally cultivated salt tolerant rice varieties ranged from 73-80% (Table 1). The highest hulling (80.1%) was noted in varieties Muno, Shiedi and lowest in Kalo Damgo and Bello (73.4 and 73.2%). Milling recovery depends on grain shape and appearance, which has direct effect on the percentage of hulling, milling and head rice recovery [12].

Among the varieties studied, the L/B ratio ranged from 2.02-2.86. The variety Bello recorded the highest L/B ratio and least was found in Muno. Based on the L/B ratio, the collected rice varieties were classified into five different categories: Damgo, Shiedi (long bold); Kalo korgut (long slender); Assgo, Kalo Damgo, Kalo Novan, Khochro, Korgut, Muno (short bold); Bello (medium slender). The grain size and shape are the first criteria for rice quality that breeders consider in developing new varieties for release and commercial production [13]. The hulling percentage, L/B ratio and grain classification of traditionally cultivated rice varieties are summarized in Table-1.

Table 1. Percentage of hulling, L/B ratio and grain classification of salt tolerant rice varieties

Sl. No.	Traditionally cultivated Varieties	Mean Hulling %	Mean L/B ratio	Grain Classification
1	Assgo	74.7±0.43	2.19±0.02	SB
2	Bello	73.26±0.96	2.86±0.05	MS
3	Damgo	77.43±1.36	2.26±0.20	LB

4	Kalo Damgo	73.4±2.25	2.41±0.01	SB
5	Kalo Korgut	75.1±1.80	2.59±0.26	LS
6	Kalo Novan	78.13±0.90	2.51±0.17	SB
7	Khochro	77.40±1.01	2.56±0.29	SB
8	Korgut	77.86±0.58	2.40±0.10	SB
9	Muno	80.16±0.37	2.02±0.015	SB
10	Shiedi	80.1±0.7	2.34±0.03	LB

SB, short bold; LB, long bold; LS, long slender; MS, medium slender

Chalkiness in the rice grain was classified into white belly, white back and white centre. Assgo, Bello, Damgo, Kalo Damgo, Khochro and Korgut belong to white belly type. Varieties Kalo Korgut, Muno, Shiedi recorded white back type of chalkiness and white centre in variety Kalo Novan. The frequency of chalkiness was calculated and the chalky area more than 20% was observed in all the rice varieties studied. The highest chalkiness was recorded in varieties Korgut (87.86) and lowest in Kalo Novan (33.30). Maximum percentage (100%) of chalkiness was recorded in varieties Damgo, Kalo Korgut, Khochro, Muno and Shiedi (Table 2).Chalkiness indicates the loose packing of starch granules, as the width of the rice grain increases chalkiness appears in the grain [14].

Table 2. Chalkiness of endosperm in salt tolerant rice varieties

Sl. No.	Varieties	Type	Frequency	Kernel area (Extent)	Percentage of chalkiness
1	Assgo	White belly	P	Long (more than 20 %)	75.8±2.51
2	Bello	White belly	P	Long (more than 20 %)	76.60±1.21
3	Damgo	White belly	P	Long (more than 20 %)	100±0.00
4	Kalo Damgo	White belly	P	Long (more than 20 %)	58.2±3.35
5	Kalo Korgut	White back	P	Long (more than 20 %)	100±0.00
6	Kalo Novan	White centre	P	Long (more than 20 %)	33.30±0.90
7	Khochro	White belly	P	Long (more than 20 %)	100±0.00
8	Korgut	White belly	P	Long (more than 20 %)	87.86±0.65
9	Muno	White back	P	Long (more than 20 %)	100±0.00
10	Shiedi	White back	P	Long (more than 20 %)	100±0.00

P, present

Chemical characters

The low alkali spreading value (ASV) and high gelatinization temperature (GT) were detected in Assgo, Damgo, Kalo Korgut, Khochro, Muno and Shiedi. The intermediate ASV and GT were noted in varieties such as Bello, Kalo Damgo, Kalo Novan and Khochro. The low-intermediate ASV and high-intermediate GT was observed in variety Korgut (Table 3). The GT, gel consistency (GC) and amylose content (AC) are major rice traits, which are directly related to cooking and eating quality [8]. Based on the amylose content (AC) the rice grains were classified as waxy, very low, low, intermediate and high AC. The lowest AC was recorded in variety Khochro, whereas highest in Kalo Novan (Table 3). The main factor that determines the texture of cooked rice is amylose content. However, the cohesiveness, tenderness, colour and gloss differ greatly based on gel consistency [12].

The gel consistency (GC) was measured into soft, medium and hard. The GC of the rice samples ranged from 34.6-75.3 mm. The length of the blue gel was highest in rice varieties Damgo, Shiedi and lowest in Kalo Korgut (Table 3). Rice with soft to medium gel consistency, intermediate amylase content and intermediate gelatinization temperature is a preferred level for the consumers[15].

Table 3. Alkali spreading value, gelatinization temperature, amylose content and gel consistency in salt tolerant rice varieties

Sl. No.	Varieties	Alkali spreading value	Gelatinization temperature	Amylose in %	Length of blue gel in mm	Gel consistency
1	Assgo	L	H>74 °C	19.57±0.51	48±1	Medium
2	Bello	I	I (70-74 °C)	16.0±1.28	55.3±1.52	Medium
3	Damgo	L	H >74°C	17.2±0.69	75.3±3.51	Soft
4	Kalo Damgo	I	I (70-74 °C)	20.34±0.83	74±2	Soft
5	Kalo Korgut	L	H >74°C	21.78±0.92	44.3±2.51	Medium
6	Kalo Novan	I	I (70-74 °C)	23.7±0.76	60.3±0.57	Medium
7	Khochro	L	H >74 °C	14.6±0.37	34.6±0.57	Hard
8	Korgut	LI	HI	17.5±1.40	64.6±2.51	Soft
9	Muno	L	H >74°C	17.4±1.35	60.0±1	Medium
10	Shiedi	L	H >74°C	21.6±0.762	75.3±3.51	Medium

L, Low; I, Intermediate; LI, Low-intermediate; H, High; HI, High-intermediate; OTB, other than Basmati

Cooking characteristics

The volume expansion ratio (VER) in traditionally cultivated rice varieties ranged from 1.6-4.01. The highest VER was reported in variety Khochro and lowest in variety Kalo Korgut. High amylose rice show high volume expansion and a high degree of flakiness [12]. Kernel length after cooking (KLAC) ranged from 2.50-4.78 mm in rice varieties. The highest KLAC was observed in varieties Bello and Korgut and minimum in variety Kalo Damgo. Kernel elongation ratio (ER) in rice varieties examined ranged from 1.03-1.66, highest in variety Bello and lowest in Kalo Damgo (Table 4). Consumers base their concept of quality on the grain appearance, size and shape of the grain, behavior upon cooking, taste, tenderness and flavor of cooked rice. The cooking quality preferences vary within the country, within ethnic groups and from one country to another or within different geographical regions[16].

Table 4. Volume expansion ratio, kernel length after cooking and elongation ratio in salt tolerant rice varieties

Sl. No.	Varieties	Volume Expansion ratio	Kernel length after cooking (mm)	Elongation ratio
1	Assgo	2.63±0.05	2.85±0.01	1.31±0.005
2	Bello	3.10±0.1	4.78±0.16	1.66±0.07
3	Damgo	2.20±0.1	2.76±0.05	1.22±0.13
4	Kalo Damgo	3.2±0.1	2.50±0.05	1.03±0.01
5	Kalo Korgut	1.6±0.1	2.873±0.04	1.08±0.16
6	Kalo Novan	3.43±0.28	3.81±0.11	1.51±0.06
7	Khochro	4.06±0.05	2.56±0.11	1.10±0.04
6	Korgut	3.10±0.1	4.78±0.16	1.66±0.07
9	Muno	2.16±0.05	2.52±0.005	1.24±0.01
10	Shiedi	3.03±0.05	2.93±0.05	1.24±0.03

4. Conclusions

The paper has concentrated on the physical, chemical and cooking characteristics of salt tolerant rice varieties of Goa. The present investigation revealed that the traditionally cultivated rice varieties viz. Korgut, Khochro, Muno and Shiedi showed good grain quality characteristics. The results imply that three major characteristics such as amylose content, gelatinization temperature and grain shape are involved in grain quality especially these characteristics which influence the physicochemical properties like texture. The present study revealed that some of the indigenous traditionally cultivated salt tolerant rice varieties have potential for consumer's preferences and it could be used for breeding programme for the improvement of valuable grain quality traits.

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