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PHYSICOCHEMICAL PROPERTIES OF SOME SELECTED RICE CULTIVARS OF SYLHET

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Abstract

Twenty one local rice cultivars of Sylhet, Eastern part of Bangladesh were evaluated for proximate physicochemical properties and cooking qualities. Rice cultivars were grown under field condition during the period from June to December, 2014 at the experimental field of the Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet while grain quality characteristics were studied in the laboratory of Bangladesh Rice Research Institute, Gazipur. Thousand paddy weights ranged between 10.4 to 26 g. Milling outturn of the tested cultivars varied from 37.5- 69.8%. The length and breadth of the milled rice ranged from 4.5 to 7.2 mm and 2.0 to 2.9 mm, respectively. Length-breadth (L-b) ratio ranges 1.8 and 3.1. In grain size and shape, three cultivars were long and slender type grain, four cultivars were short and bold, thirteen cultivars were medium and bold types and only one cultivar found short and round. All cultivars had good appearance, among the cultivars ten translucent type, three opaque type and eight white belly type grain chalkiness were found. All cultivars contained low to high amylose ranges from 8.2 to 26.5% which indicate both sticky and non-sticky cultivars were present. Protein percent of the varieties ranged from 7.4 to 11.1%. Alkali Spreading Value ranged from 4.9 to 7% which indicate intermediate to low gelatinized temperature. Cooking time of the local cultivars was more or less similar and ranged from 14 to 19.3 minutes. Elongation ratio and volume expansion of the cultivars ranged from 1.1 to 1.6 and 2.4 to 3.5, respectively.

***Keywords*:** Local rice cultivar, chalkiness, alkali spreading, elongation ratio

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Introduction

Rice (*Oryza sativa* L.) is an important cereal grain in the diet of nearly half of the world's population. It is the principal source of carbohydrate in Bangladesh, Myanmar, Srilanka and Vietnam (IRRI, 1981). Rice is usually consumed as a whole grain after cooking and in a regular Asian diet (Thomas *et al.,* 2013), can contribute for 40 to 80% of the total calorie intake (Singh *et al.,* 2005; Hossain *et al.,* 2009; Cai *et al.,* 2011). However, Bangladesh is very rich in local cultivars as because South and Southeast Asia is the center of origin of *Oryza sativa*. Additionally, some of the local rice cultivars have some important characteristics. Sylhet the eastern part of Bangladesh is especially very rich in rice germplasm. The agro-ecological conditions of Sylhet region are very diverse, providing suitable environment for growing rice varieties with wide genetic variations. Plenty of local rice cultivars are available and still cultivated by the rich farmers of Sylhet. These cultivars are low yielding but they have some special characteristics like fineness, aroma, acidity and drought tolerances, phosphorus uptake ability, higher Zinc and Selenium content. The grain quality information of these local rice cultivars are still lacking in Bangladesh and may have some special characteristics to be essential for future breeding program (Dipti *et al*., 2003). Providing adequate information on the quality of rice consumed by local population is important for nutrition issue as well as expected to be useful for minimizing fuel consumption while cooking (Thomas *et al.,* 2013). Many components contribute to rice quality; the most important are physical, cooking and eating qualities. One of the major concerns in local rice production is grain physical, nutritional and cooking qualities evaluation (FAO, 2004; Dong *et al.,* 2007). The constituents which highly influence cooking and eating qualities of rice are amylose content, gelatinization temperature and gelling consistency which can vary based on the varieties (Juliano, 1972; Bhattacharya *et al*., 2011). Consumers' preference varies based on the type of rice and their origin (Musa *et al.,* 2011). Based on these facts, the main objective of the present study was to provide details about physicochemical properties and cooking quality of different local rice cultivars of Sylhet, Bangladesh.

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Materials and Methods

Site description and Location

The experiment was carried out at the experimental field of the Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet. Geographically the experimental field situated at 24° 54′ 33.2″ N latitude and 91° 54′ 7.15″ E longitude at the elevation of 30 m above the sea level.

Laboratory location

The grain quality test was done at the laboratory of Grain Quality and Nutrition (GQN) Division, Bangladesh Rice Research Institute (BRRI), Gazipur 1701, Bangladesh.

Rice cultivar

Twenty one local rice cultivars i.e. Akhnisail, Bantos, Biruin, Biruy, Botabiruin, Chinigura, Chinirsail, Chorabiruin, Gandi, HanoiTV, Kakhibiruin, Kalijira, Khakibiruin, Maloti, Monasail (red), Monasail (white) Moinasailbiruin, Muktasail, Mikirsail (Red), Mikirsail (White) and Nagrasail were collected from different parts of Sylhet (the north-eastern region of Bangladesh).

Agronomic practices

Seedlings were raised in well prepared seed bed at 21 July 2014 and twenty-six days old seedlings were transplanted in the field at 16 August following Randomized complete block design (RCBD) with three replications with the spacing of 20 cm × 15 cm in 10 m^2 plots. Fertilizers were applied at the rate of 80, 40, 40 kg ha^{-1} as N, P and K in the form of urea, TSP and MoP, respectively. The whole amount of TSP (Triple super phosphate), MoP (Muriate of potash) were applied as basal at the time of final land preparation and thoroughly incorporated into the soil. Urea was top dressed in three equal splits at 10, 25 and 45 DAT. Fertilizer dose was 180-40-40, N-P-K respectively. Harvesting was done within the first two weeks of December. After harvesting rice grain quality such as physical, chemical and cooking qualities were analyzed in the Grain Quality and Nutrition Division of Bangladesh Rice Research Institute (BRRI), Gazipur.

Processing of rice cultivars

Only whole rice grains without any physical damage or insect infestation was selected for analysis. The 200 g rough rice was dehulled by Satake rice mill to see chalkiness. The resulting brown rice was polished for 75 second in Satake grain-testing mill TM05. This polished rice was ground by a Cyclone sample mill.

Physical properties

One thousand whole rice grains without any physical damage or insect infestation were randomly selected and weighed separately. Milled rice outturn was expressed as percent of milled rice. Head rice outturn was determined by separating broken rice by hand and expressed as percent of head rice. Milled rice length and breadth (mm) were measured by slide calipers. The length of milled rice was divided by its breadth to determine the length to breadth ratio. In determining the size, milled rice was classified into three classes i.e. long (>6 mm in length), medium (5-6 mm in length) and short (<5 mm in length) (Dipti *et al.,* 2003). For shape, the length:breadth ratio of milled rice was grouped into three: slender (ratio>3.0), bold (ratio 2-3) and round (ratio>2.0) (Dipti *et al.,* 2003).

Chalkiness of kernel is visually scored for the presence of white belly (dorsal side of the grain), white center (dorsal side in the center) and degree of translucency. Chalkiness were classified into four classes depending on presence of white belly, none, less than 10%, 10% to 20%, more than 20%.

Grain appearance is largely determined by endosperm opacity, the amount of chalkiness either on the side of the grain or in the center and the condition of the eye or pit left after germ.

Chemical properties

Chemical properties like as amylose content was determined based on the Iodine-binding procedure as described by Juliano (1971). In brief, for 100 mg of rice flour, 1 ml of ethanol (95%) and 9 ml of 1 N NaOH were added in a volumetric flask (100 ml) followed by thorough mixing. Further, samples were heated on a boiling water bath for 10 minute to gelatinize the starch and later on cooled to room temperature. Five milliliter of gelatinized starch solution was then transferred to a 100 ml volumetric flask followed by addition of 1 ml of 1N acetic acid and 2 ml of iodine solution, with the volume adjusted to 100 ml with distilled water. All the contents were thoroughly vortex mixed and allowed to stand for 20 minute. The absorbance was measured at a spectrophotometer. The amylose contents in samples was determined based on the standard curve prepared using potato amylose. Based on amylose content, milled rice was classified as Waxy (0-2%), Very low (3-9%), Low (>10-19%), Intermediate (>20-25%) and High (≥25%), (Juliano, 1972).

Protein content was determined by Micro Kjeldahl method (AOAC, 1970). Nitrogen multiplied by a factor of 5.95, based on 16.8% nitrogen contained in the major rice protein fraction gluten (Juliano, 1966).

Alkali Spreading Value was estimated by dispersing triplicate six whole milled rice grains in 10 ml 1.7% potassium hydroxide (KOH) for 23 h at room temperature and scored according to Little *et al.* (1958). The alkali spreading value classified into three classes corresponds to the gelatinization temperature, High (1.0-3.0%), Intermediate (4.0-5.0%) and Low (6.0-7.0%).

Cooking properties

Cooking time was measured when 90% of cooked rice was totally gelatinized. Imbibition ratio is the increase in volume of cooked rice over uncooked rice. Volume of cooked and uncooked milled rice was measured by water displacement method. Five gram of milled rice was placed in a graduated cylinder containing 50 ml of water and the change in volume was noted. For cooked rice volume 5 gm of milled rice was cooked and the cooked rice was placed in the same cylinder and the change in volume was measured. Elongation ratio was determined by the randomly selected of cooked rice length over the length of uncooked raw samples.

Statistical analysis

Chemical properties data are the mean of three replications were presented in the Tables and standard deviation was done whenever necessary.

Results and Discussion

Grain brightness or cleanness, grain length to breadth ratio and degree of milling also influence the grain appearance. Milling outturn of tested rice varieties varied from 70.0 to 72.4% (Table 1). Milling quality is the measure of rough rice performance during milling process. More than 70.0% milling outturn is acceptable to millers and farmers. Head rice outturn of rice varieties varied from 37.5-69.8% (Table 1). It is the proportion of whole grain in milled rice and it depends on varietal characteristics and drying condition (Wasserman and Calderwood, 1972; Witte, 1972 and Adair *et al*., 1973).

Physical properties

The thousand grain weight particularly useful as a comparative indication of coarseness of the grain and total rice yield. The 1000-grain weight varied from the ranges 14.0-25.0 g depending on the variety at different (12.0-13.5%) moisture levels (Table 2). Among the cultivars Chora biruin had highest 1000-grain weight (25.0 g) followed by Khaki biruin and the lowest by Chinigura (14.0 g) which was at par with Kalizira. Gozubenli (1992) reported that the grain weight panicle^{-1} was affected by the rate of fertilizer and plant density. According to Manzoor *et al*. (2006), 1000-grain weight was affected by cultivation methods. However, Aide and Beighly (2006) reported that cultivation methods didn't have much effect on 1000-grain weight.

The grain lengths varied from 4.2 to 6.7 mm. Lengths to breadth ratio of the samples determine the fineness of the grain. In most of the cultivars length to breadth ratio was in between 2.0 to 3.0. Only three cultivars named Khaki biruin, Kakhi buruin and Bota biruin had length to breadth ratio above 3 and 2 cultivars named Mikirsail were less than 2. Grain size and shape are important for consumer acceptance.

Table 1. Milling properties of local rice cultivars

Name of the cultivars	Milling Outturn (%)	Head rice Outturn (%)	Moisture (%)
Khakibiruin	71.5	68.2	13.1
Kakhibiruin	71.8	68.9	12.5
Botabiruin	72.4	67.9	12.8
Kalizira	70.8	67.2	13.5
Gandi	72.1	37.5	13.0
Chorabiruin	70.0	62.3	13.1
Biruin	70.9	62.1	13.2
Biruy	71.1	69.8	12.3
Mikirsail(white)	71.3	67.5	13.0
Mikirsail (red)	71.5	67.5	12.8
Monasail (white)	72.0	68.5	12.4
Monasail (red)	72.0	68.5	12.0
Akhnisail	70.0	68.9	12.5
Chinirsail	70.3	67.9	13.1
Bantos	70.0	67.9	12.3
Maloti	70.1	68.2	12.5
Muktasail	70.5	68.9	12.1
Moinasailbiruin	70.4	68.2	12.2
Hanoi TV	70.0	68.2	12.3
Nagrasail	70.1	68.5	12.1
Chinigura	70.0	68.6	12.2
Mean±SDV	70.9±0.8	66.3±6.8	12.6±0.4

Uniformity of milled rice was in shape and size is considered as the first quality characteristics of rice. The grain samples size and shape were mostly medium bold. Most of the varieties had good appearance. Among the twenty one cultivars ten had translucent grain. The others were either Opaque, white belly or white center (Table 2).

Table 2. Physical properties of local rice cultivars

Name of the cultivars	1000 paddy wt. (gm)	Length (mm)	Breadth (mm)	Length and Breadth ratio (L/B)	Size and Shape	Appearance	Chalkiness
Khakibiruin	24.0	6.7	2.2	3.1	LS	Good	Opaque
Kakhibiruin	22.0	6.6	2.1	3.1	LS	Good	Tr
Botabiruin	21.5	6.7	2.0	3.3	LS	Good	Tr
Kalizira	14.8	4.2	2.0	2.1	SB	Good	Tr
Gandi	18.3	5.0	2.2	2.3	MB	Good	Tr
Chorabiruin	25.0	5.6	2.3	2.4	MB	Good	Opaque
Biruin	23.0	5.4	2.3	2.3	MB	Good	Opaque
Biruy	19.8	5.2	2.3	2.3	MB	Good	Tr
Mikirsail (red)	19.3	4.7	2.5	1.9	SR	Good	Wb
Mikirsail (white)	18.9	4.8	2.7	1.8	SB	Good	Wb
Monasail (red)	19.5	6.0	2.2	2.4	MB	Good	Wb
Monasail (white)	19.2	5.8	2.3	2.5	MB	Good	Wb
Akhnisail	20.5	5.2	2.2	2.4	MB	Good	Wb
Chinirsail	16.5	5.0	2.2	2.3	MB	Good	Tr
Bantos	19.4	5.0	2.2	2.3	MB	Good	Tr
Maloti	20.0	5.1	2.2	2.4	MB	Good	Tr
Muktasail	21.0	5.1	2.4	2.1	MB	Good	Wb
Moinasailbiruin	21.5	5.3	2.2	2.4	MB	Good	Tr
Hanoi TV	22.5	4.9	2.4	2.1	SB	Good	Wb
Nagrasail	19.5	5.3	2.1	2.5	MB	Good	Wb
Chinigura	14.0	4.2	1.8	2.3	SB	Good	Tr
Mean±SDV	19.9±2.7	5.3±0.7	2.2±0.2	2.4±0.4	-	-	-

Local rice cultivar, Chalkiness, Alkali spreading, elongation ratio

Chemical properties

Starch has two fractions, amylose and amylopectin. Amylose content of the tested varieties varied from 8.2 to 26.5%. Result indicated that five cultivars were sticky, seven cultivars were intermediate type amylose content and eight cultivars showed high amylose content. Higher the amylose contents of rice higher the volume of expansion and high degree of flakiness. Amylose contents of rice can play a significant role in determining many of the cooking and eating qualities of milled rice (Asghar *et al*., 2012). Amylose content higher than 25% gives non-sticky soft or hard cooked rice. High amylose rice is known to cook dry and fluffy, but can become hard on cooling (Thomas *et al.*, 2013). Rice having ≥20-25% gives soft and relatively moist cooked rice and these intermediate amylose rice are preferred in most rice growing areas of the world (Annonymous, 1997).

In contrast, low amylose content (<9-20%) is considered as moist and sticky rice which is very much popular in Japan, China, Thailand, Malaysia and Northeast region of Bangladesh. Protein contents of rice are important from nutritional point of view. The nutritional value depends on the total quantity and quality of protein. Rice is an important source of protein and supplies more than 60% of the total protein consumed in Bangladesh (Dipti *et al.*, 2003). Average rice protein content is 7.0-7.4% whereas, in this experiment protein content of studied rice varied between 7.0 to 11.1%. The highest protein content found in Monasail (white) which is 11.1% followed by Muktasail, Moinasail biruin and Biruy. Protein content also depends on soil fertility and cultural management practices. Alkali spreading value of the grain in 1.7% KOH is inversely related to gelatinization temperature of the grain. Alkali spreading value ranges from 5.1 to 7.0% which correspond to low gelatinization temperature. Only one of the tested varieties had alkali spreading value 4.9% which corresponds to intermediate gelatinization temperature (Table 3).

Table 3. Chemical properties of local rice cultivars

Name of the cultivars	Amylose (%)	Protein (%)	Alkali spreading Value
Khakibiruin	9.0	7.9	7.0
Kakhibiruin	12.7	9.0	7.0
Botabiruin	10.6	9.1	6.8
Kalizira	21.1	8.6	5.5
Gandi	24.6	9.1	6.3
Chorabiruin	8.2	8.7	7.0
Biruin	8.2	7.4	7.0
Biruy	20.3	9.4	6.4
Mikirsail (white)	22.7	8.8	6.6
Mikirsail (red)	25.4	9.3	6.8
Monasail (red)	23.5	9.4	4.9
Monasail (white)	22.5	11.1	5.1
Akhnisail	26.4	7.0	6.3
Chinirsail	25.3	9.2	6.3
Bantos	25.7	9.3	6.5
Maloti	26.4	9.0	6.5
Muktasail	25.8	9.6	5.7
Moinasailbiruin	24.6	9.4	6.4
Hanoi TV	26.5	8.7	6.8
Nagrasail	25.2	8.7	5.6
Chinigura	20.2	9.1	5.3
Mean±SDV (n=21)	20.7±6.5	8.9±0.8	6.3±0.7

Cooking properties

The choice of rice variety for consumption greatly depends on cooking properties as rice is consumed almost immediately after cooking. Rice is a staple food in most of the developing countries; reduced cooking time can be beneficial especially when fuel consumption is of concern (Thomas *et al.*, 2013). Cooking time varied from 13.0 to 19.3 minutes among the tested varieties. The highest cooking time (19.3 min) was observed in Mikirsail and lowest in Chinigura (13 min). Elongation ratio of the tested rice varieties ranges from 1.1 to 1.6.

The highest elongation ratio was found in Mikirsail and the lowest was found in Khakibiruin and Kakhibiruin. It is an important parameter for cooked rice. If rice elongates more in lengthwise it gives a finer appearance and if expands girthwise, it gives a coarse look (Annonymous, 1997). Imbibition ratio of the tested varieties varied from 2.4 to 3.3. Imbibition ratio of the volume of cooked rice over the volume of uncooked rice and high volume expansion is associated with high amylose (Dipti *et al.*, 2003). The highest imbibition ratio was found in Muktasail (3.3) which was at par with Gandi and Chinirsail (Table 4). The lowest imbibition ratio was found in Moinasail biruin (2.4) followed by Khakibiruin, Monasail and Biruin (Table 4).

Conclusion

It can be concluded from the study that Khakisail, Chinirsail, Botabiruin, Maloti and Nagrasail could be used for plain rice. On the other hand Chinigura and Kalizira could be used as aromatic rice for polao rice.

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