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Evaluation of Grain Quality and Cooking Property of Selected Local Rice Cultivars in Bangladesh

M. A. Sobur[1], S. R. Ray[1], S. Sharmin[1], M. A. Haque[2] and M. J. H. Bhuiyan[1*]

[1]Department of Biochemistry and Molecular Biology
Bangladesh Agricultural University, Mymensingh - 2202
[2]Division of Grain Quality and Nutrition,
Bangladesh Rice Research Institute, Gazipur
[*]Corresponding author: abir062003@gmail.com

Abstract

To assess the grain qualities of local rice cultivars, an experiment was carried out on seven varieties i.e., Pajam, Kataribhog, Rata boro, Ganjia, Binnaful, Nizersail, and Jirasail. Several physicochemical traits (length, breadth, moisture content and chalkiness), milling quality (head rice yield and milling outturn), nutritional aspect (protein content) and cooking properties (amylose content, cooking time, grain elongation, water uptake ratio, gel consistency, and gelatinization temperature) were measured. The moisture content (11.10% to 12.17%), protein (6.23% to 10.17%), and amylose content (24.65% to 28.11%) were within the expected ranges in all genotypes. Based on grain milling outturn (%) and head rice yield (%), Pajam and Kataribhog were of premium quality. The appearance quality of Ganjia, Binnafu and Nizersail was better due to having negligible chalkiness. Kaaribhog and Binnaful had shorter cooking times (14±1 min). Rata boro, Ganjia and Nizersail had soft (>61 mm gel), whereas Kataribhog and Jirasail showed medium gel consistency (41- 60 mm gel). Most of the varieties had a low gelatinization temperature (GT) except Jirasail (high GT) and Pajam (intermediate GT). Jirasail significantly outperforms all other genotypes in physicochemical, nutritional, and cooking traits and could be a suitable choice for consumers.

Keywords: Cooking property, Chalkiness, Gelatinization, Local cultivar, Milling outturn

Introduction

Rice is considered the world's most important food crop since it is consumed by more than half of the world's population as a staple food and provides over 21% of human caloric needs (Zhao et al., 2020; Sultana et al., 2022). Above 90% of the global rice is produced and consumed in Asia where 60% of the earth's people live, making it the world's largest producer (Khush, 2005; Bandumula et al., 2018; Mohidem et al., 2022). Therefore, emphasis on the production of quality rice in Asia is crucial for ensuring global food security with diminishing natural resources and environmental fluctuations.

The nutritional quality of rice, as a staple food, strongly influences the consumers' health, especially those whose diet mostly consists of rice (Zhao et al., 2020). Furthermore, the grain quality of a rice variety largely determines its economic value and market demand (Sharma & Khanna, 2019). Grain quality is a fairly broad concept that encompasses a variety of traits and is often hard to define comprehensively (Sharma & Khanna, 2019; Sultana et al., 2022). Key parameters for grain quality evaluation are grouped into four aspects: milling, cooking and sensory properties, appearance, and nutritional quality (Sharma & Khanna, 2019; Sultana et al., 2022). Physical appearance (such as grain size, shape and color), biochemical composition (such as amylose content and gelatinization temperature) and nutritional properties (such as micronutrient, protein and lipid content) are the major determinants of rice grain quality (Sharma & Khanna, 2019; Sultana et al., 2022; Thissa Marasingha et al., 2024).

Cooking and nutritional properties of grain are two of the most important aspects of rice quality (Sharma & Khanna, 2019; Sultana et al., 2022). Assessment of nutrient content and cooking and eating properties of rice grain has received top priority as these attributes meet the customer's satisfaction and control rice market price (Zhao et al., 2020; Mohidem et al., 2022; Sultana et al., 2022; Ishfaq et al., 2023). The principal parameters for evaluating the cooking and eating quality are gelatinization temperature (GT), gel consistency (GC), and amylose content (AC) (Sharma & Khanna, 2019; Sultana et al., 2022; Ishfaq et al., 2023). Cooking behavior is one of the important factors affecting the quality of cooked rice. Cooking temperature and time is crucial because it shows impacts on both the softness and stickiness of cooked rice. The cooking qualities of rice, which can be measured in terms of cooking time and grain elongation during cooking, determine its economic value. The quantity of amylose in a rice variety can have a substantial impact on how it cooks and tastes (Asghar et al., 2012; Adu-Kwarteng et al., 2003). It influences the hardness, stickiness, and palatability of cooked rice and impacts water absorption while cooking (Karim et al., 2024).

Bangladesh is the third-largest rice producer in the world (Mohidem et al., 2022). In Bangladesh, rice is consumed by more than 95% of the population and it alone provides 76% of calorie and 66% of total protein requirement of daily food intake (Awal & Siddique, 2011). The demand for high-quality rice is rising due to population growth, changing consumer lifestyles, etc. (Alam et al., 2024). Physicochemical, morphological, and cooking qualities differed widely between varietals (Yadav et al., 2007). The local varieties offer greater variability in grain nutrition, texture, and aroma compared to developed varieties. However, there is a lack of sufficient study on the grain quality of locally available rice cultivars in Bangladesh, making it challenging to select quality grain for healthier diets. Considering all these aspects, the current study was conducted to determine the physicochemical traits and cooking qualities, classify or rank the rice genotypes based on their various quality traits, and evaluate the interrelationship among the grain quality traits of the few selected local rice cultivars in Bangladesh.

Materials and Methods

The study was carried out in the laboratory of the Grain Quality and Nutrition Division (GQN) at the Bangladesh Rice Research Institute (BRRI) located in Joydebpur, Gazipur, as well as in the Prof. Muhammed Hossain Post-Graduate Laboratory of the Department of Biochemistry and Molecular Biology at Bangladesh Agricultural University, Mymensingh-2202, during the period from October 2021 to February 2022. The experiment was conducted with seven local rice genotypes such as Pajam, Kataribhog, Rata boro, Ganjia, Binnaful, Nizersail, and Jirasail collected from the BRRI gene bank.

Physical parameters like grain length and breadth were measured using slide calipers. The varieties were milled using a Satake rice machine. Grain milling outturn (%), and head rice yield (%) were calculated according to Graham (2002).

$$\text{Milling outturn (\%)} = \frac{\text{Weight of total milled rice}}{\text{Weight of rough rice}} \times 100$$

$$\text{Head rice (\%)} = \frac{\text{Weight of head rice}}{\text{Weight of rough rice}} \times 100$$

Gel consistency was evaluated based on the consistency of milled rice pasts as gelatinized by boiling in alkali with subsequent cooling and measurement of the gel length (Cagampang et al, 1973). The chalkiness of the rice endosperm was visually observed and classified according to Graham (2002). The water uptake ratio was assessed according to Oko et al., (2012). The grain elongation ratio was determined by following the method of Juliano and Perez (1984). The ratio of the average length of cooked rice grains to the average length of raw rice grains is the grain elongation ratio. The volume expansion ratio was calculated based on the work of Sidhu et al. (1975). The minimum cooking time was measured as per Hettiarachchi et al. (2016). Cooking time was recorded as the optimal duration required until no white core remained. The amylose content (AC) of powdered samples from various varieties was measured using the spectrophotometric method described by Juliano (1971), utilizing a wavelength of 620 nm. An estimate of the gelatinization temperature is indexed by measuring the alkali spreading value (ASV) using the alkali digestion test (Little et al., 1958). The ASV method is based on the disintegration of starch granules present in milled rice kernels in dilute KOH. The degree of disintegration is then visually rated and numerically scored on a scale of 1–7. The scores of ASV value are further indexed to the classification of gelatinization temperature as described in Cruz & Khush (2000). The protein and moisture content was analyzed using a grain analyzer machine (Infratec 1241 Grain Analyzer, FOSS). Data analysis was conducted using the Statistical Tool for Agricultural Research (STAR). Analysis of variance (ANOVA) was performed. A multiple range test was executed with the least significant difference (LSD) at a 5% probability level, and interrelationships among the grain qualities of different varieties were examined using Pearson's comparison test.

Results and Discussion

The average performance of the physicochemical characteristics examined across different local cultivars is detailed in **Table 1**. The highest rough rice length (9.22 mm), brown rice length (6.64 mm), and milled rice length (6.01mm) were exhibited by Jirasail, while Rata Boro has the highest rough rice breadth (2.56 mm) and brown rice breadth (2.39 mm) (**Table 1**). On the other hand, the lowest rough rice length (6.04mm), brown rice length (4.46 mm) and milled rice length (4.21 mm) were found for Binnaful, whereas the lowest rough rice breadth (1.69 mm) and brown rice breadth (1.72 mm) was observed in Jirasail (**Table 1**). The length of grains is a significant quality criterion that might impact the visual appeal and commercial worth of rice. Generally, there is a strong demand for long-grain rice in the Indian subcontinent and the international market (Graham, 2002). Jirasail rice exhibited the highest length breadth ratio (3.69) and Rata Boro had the lowest ratio (1.80) (**Table 1**). According to Cruz & Khush (2000), the length-breadth ratio above 3 indicates a slender shape grain for the Jirasail cultivar. The widely acceptable range for the grain length-breadth ratio is between 2.5 and 3.0, with a minimum grain length exceeding 6 mm (Kaul, 1970). In the case of cooked rice length, the maximum value was found for Ganjia (8.31 mm) while the genotype Binnaful has the lowest length (6.55mm) (**Table 1**). Varieties with greater cooked rice elongation are preferred for specific culinary purposes (Islam et al., 2024).

The moisture content of studied varieties ranged between 11.10 to 12.17%, whereas the values of protein content ranged from 6.23 to 10.17% (**Table 1**). Lower seed moisture content to 12 - 14% is safe for

Table 1. Mean performances of selected local rice cultivars based on eleven grain quality traits

SL	Genotype	RRL	RRB	BRL	BRB	MRL	MRB	LBR	CRL	MC (%)	PC (%)	AC (%)
1	Pajam	7.10d	2.09b	5.18d	1.97c	4.71d	1.92c	2.46c	6.79c	11.17c	10.17a	24.77d
2	Kataribhog	7.78c	1.92bc	5.79bc	1.84d	5.02cd	1.77d	2.84b	7.40b	12.00a	6.23e	25.86c
3	Rata Boro	6.91d	2.56a	4.84e	2.39a	4.26e	2.37a	1.80d	7.26b	12.17a	7.57d	24.65d
4	Ganjia	8.30b	2.41a	5.91b	2.27b	5.40b	2.17b	2.49c	8.31a	11.27c	9.07b	26.94b
5	Binnaful	6.04e	1.87cd	4.46f	1.79de	4.21e	1.77d	2.39c	6.55c	11.90a	6.57e	25.50c
6	Nizersail	7.96bc	2.06b	5.65c	2.05c	5.06c	1.99c	2.54c	7.26b	11.10c	8.87b	28.11a
7	Jirasail	9.22a	1.69d	6.64a	1.72e	6.01a	1.63e	3.69a	7.61b	11.60b	8.10c	27.39b
CV (%)		1.82	3.20	1.61	1.57	2.31	2.01	2.94	1.81	0.74	2.69	1.34
Max		9.22	2.56	6.64	2.39	6.01	2.37	3.69	8.31	12.17	10.17	28.11
Min		6.04	1.69	4.46	1.72	4.21	1.63	1.80	6.55	11.10	6.23	24.65
Mean		7.62	2.09	5.49	2.00	4.95	1.94	2.60	7.31	26.17	8.08	11.60
LSD(.05)		0.2433	0.1169	0.1545	0.0552	0.2004	0.0683	0.1340	0.2315	0.2729	0.38020	0.3372

Note: Genotypes with the same letters are statistically similar, and those with different letters are statistically different.
RRL =Rough rice length; **RRB**=Rough rice breadth; **BRL**= Brown rice length; **BRB**=Brown rice breadth; **MRL**=Milled rice length; **MRB**=Milled rice breadth; **LBR**=Length breadth ratio; **CRL**= Cooked rice length; **MC**=Moisture content; **PC**=Protein content; **AC**= Amylose content.

packaging and storage (Manigbas et al., 2022). The genotype Pajam exhibited the highest protein percentage (10.17%) followed by the genotype Ganjia (9.07%) and Nizersail (8.87%) respectively (**Table 1**). Factors such as environmental conditions and methods of cultivation and preservation may contribute to the variations in nutrient accumulation within grains (Liu *et al.,* 2015; Zhang *et al.,* 2019). Generally, a variety having less than 7% protein content in brown rice is not recommended for release.

Amylose content, an important quality metric is critically correlated to the glycemic index, gelatinization temperature, and cooking time (Sultana *et al*., 2022; Ishfaq *et al*., 2023; Karim *et al*., 2024). In the current study, the highest amylose content (AC) was found in Nizersail (28.11%) followed by Jirasail (27.39%), while the lowest AC content was observed in Rata Boro (24.65%) followed by Pajam (24.77%) (**Table 1**). Rices with very low amylose content (1-2%) are waxy, sticky, and firm and do not expand in volume (Cruz & Khush, 2000; Sultana, *et al*., 2022; Ishfaq *et al*., 2023). Intermediate amylose rices (20-25%) cook moist, and tender and do not harden after cooking. Rices with high amylose content (> 25%) have high expansion volume, are non-sticky but become hard on cooking, and are generally less preferred (Cruz & Khush, 2000; Sultana *et al*., 2022; Ishfaq *et al*., 2023). Intermediate and low amylose rices, usually have soft gel consistency and are preferred. However, high amylose rice is slower to digest and has a lower glycemic index, which is beneficial for individuals managing diabetes or metabolic conditions (Ishfaq *et al*., 2023; Karim *et al*., 2024).

In the current study, Kataribhog, Ganjia, Binnaful, Nizersail and Jirasail were high amylose rice (**Table 1**, **Fig. 1**). Southeast Asians typically favor long grains with a soft gel consistency and intermediate amylose content. At the same time, South Asians usually prefer long grains with a hard gel consistency and high amylose content (Sultana et al., 2022; Ishfaq et al., 2023).

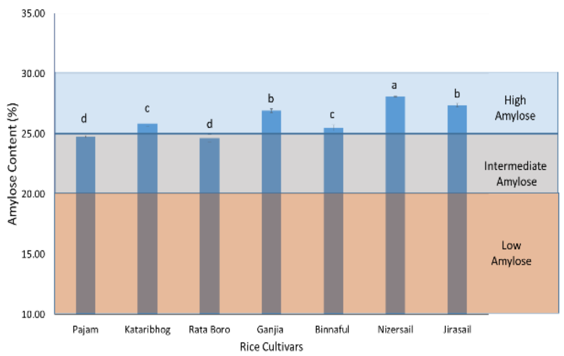

Fig. 1. Amylose content (%) variations and their categorization among different local rice cultivars. Data were arranged with error bars (±) and Tukey′s test ranked at a 1% level of significance.

Based on the score derived from the mean performance of the studied rice cultivars on various physicochemical traits (**Table 1**), a rank table was constructed (**Table 2**). Considering all traits on the concept of popular quality features of rice grain, Jirasail was found as the best-ranked performer (**Table 2**).

Correlation among various studied traits is presented in **Table 3**. According to the correlation matrix, amylose content, rough rice length and breadth, brown rice length and breadth, milled rice length and breadth, and cooked rice length had a positive relationship with protein (**Table 3**). Moreover, amylose content was positively related to the length and length-breadth ratio of rough rice, brown rice, and milled rice, and to cooked rice length (**Table 3**). Therefore, protein and amylose content influence the physical properties of the grain. The protein content of rice grain has been reported to influence the linear elongation of rice during cooking (Cruz & Khush, 2000).

The milling outturn and head rice yield along with their respective classifications are presented in **Table 4**. Milling outturn refers to the total amount of head rice and broken rice obtained from a specific quantity of rough rice. The milling outturn is categorized into premium (>70%), grade 1 (65.1% to 70%), grade 2 (60.1% to 65%), and grade 3 (55.1% to 60%) respectively (Manigbas *et al.,* 2022). The results revealed that Pajam (70.73%) and Kataribhog (72.95%) had premium category milling outturn, while the genotype Rata boro (55.22%) falls in the grade 3 category (**Table 4**). The other cultivars exhibited lower milling outturn values than the reference values (**Table 4**).

According to the classification described by Manigbas *et al.* (2022), grade 1 type (48% to 56.9%) head rice yield was found for Ganjia (48.56%) and Binnaful (49.10%), whereas Nizersail (47.4%) and Rata boro (45.10 %) possessed grade 2 (39.0% to 47.9%) category (**Table 4**). Pajam (67.76%) and Kataribhog (69.08%) were in the premium category (≥ 57.0%) based on head rice yield (**Table 4**).

From a marketing perspective, milling outturn is a critical criterion for assessing rice quality. Milling outturn serves as a vital indicator of rice grain size, primarily evaluated through head rice yield percentage (Abdala et al., 2016). As noted by Brosen et al. (1984), the head rice yield, defined as grains comprising 75-80% of the entire grain kernel, is a determinant of milling quality. Therefore, Pajam and Kataribhog can be considered as the better choices for profitable marketing.

Table 2. Ranking of the cultivars based on the mean performance of eleven physicochemical grain quality traits

Serial No.	Genotype	RRL	RRB	BRL	BRB	MRL	MRB	LBR	CRL	MC%	PC%	AC%	Total Score	Rank
1	**Pajam**	4	2	4	3	4	3	5	5	3	2	1	36	6
2	**Kataribhog**	5	3	5.5	4	4.5	4	6	6	1	4	3	46	2
3	**Rata boro**	4	1	3	1	3	1	4	6	1	5	1	30	7
4	**Ganjia**	6	1	6	2	6	2	5	7	3	3	2	43	4
5	**Binnaful**	3	3.5	2	4.5	3	4	5	5	1	4	3	38	5
6	**Nizersail**	5	2	5	3	5	3	5	6	3	3.5	4	44.5	3
7	**Jirasail**	7	4	7	5	7	5	7	6	2	4.5	2	56.5	1

RRL =Rough rice length; **RRB**=Rough rice breadth; **BRL**= Brown rice length; **BRB**=Brown rice breadth; **MRL**=Milled rice length; **MRB**=Milled rice breadth; **LBR**=Length breadth ratio; **CRL**= Cooked rice length; **MC**=Moisture content; **PC**=Protein content; **AC**= Amylose content.
Note: The higher the total score the higher the rank of quality performance of 7 local rice cultivars.

Table 3. Correlation Matrix among thirteen traits of selected local rice cultivars

Parameters	PC	MC	AC	RRL	RRB	LBR	BRL	BRB	LBR	MRL	MRB	LBR
MC	-0.8170											
AC	0.1519	-0.5064										
RRL	0.2661	-0.3555	0.7057									
RRB	0.2766	0.0488	-0.3277	-0.2213								
LBR	-0.0282	-0.1859	0.6196	0.7920	-0.7562							
BRL	0.1970	-0.3221	0.6904	0.9727	-0.3317	0.8361						
BRB	0.2876	-0.0064	-0.1891	-0.1235	0.9482	-0.6605	-0.2430					
LBR	-0.0618	-0.1486	0.5500	0.7474	-0.7636	0.9680	0.8309	-0.7309				
MRL	0.2541	-0.3840	0.7078	0.9465	-0.3783	0.8470	0.9584	-0.2924	0.8233			
MRB	0.2562	0.0670	-0.2645	-0.2392	0.9641	-0.7396	-0.3508	0.9793	-0.7891	-0.4023		
LBR	-0.0279	-0.1987	0.5539	0.7404	-0.7783	0.9719	0.8042	-0.7317	0.9776	0.8490	-0.8087	
CRL	0.1765	-0.1815	0.4894	0.7224	0.3081	0.2649	0.7651	0.3753	0.2443	0.6585	0.2614	0.2533

RRL =Rough rice length; **RRB**=Rough rice breadth; **LBR**=Length breadth ratio; **BRL**= Brown rice length; **BRB**=Brown rice breadth; **MRL**=Milled rice length; **MRB**=Milled rice breadth; **LBR**=Length breadth ratio; **CRL**= Cooked rice length; **MC**=Moisture content; **PC**=Protein content; **AC**= Amylose content.

Table 4. Performance and categorization of grain milling outturn (%) and head rice yield (%) in selected local rice cultivars

Genotypes	Milling Outturn		Head Rice Yield	
	%	Category	%	Category
Pajam	70.73	Premium	67.76	Premium
Kataribhog	72.95	Premium	69.08	Premium
Rata boro	55.22	Grade 3	45.10	Grade 2
Ganjia	50.23		48.56	Grade 1
Binnaful	51.89		49.10	Grade 1
Nizersail	50.35		47.4	Grade 2
Jirasil	48.45		21.87	

A critical factor related to grain appearance quality is chalkiness (Sultana *et al.*, 2022; Ishfaq *et al.*, 2023). Variations in chalkiness were observed among the studied rice cultivars (**Fig. 2**). The genotype Rata boro (44.52%) and Jirasail (27.52%) show chalkiness, while almost no chalkiness was observed in Nizersail (0.057%), Ganjia (0.62%) and Binnaful (0.63%) (**Fig. 2**).

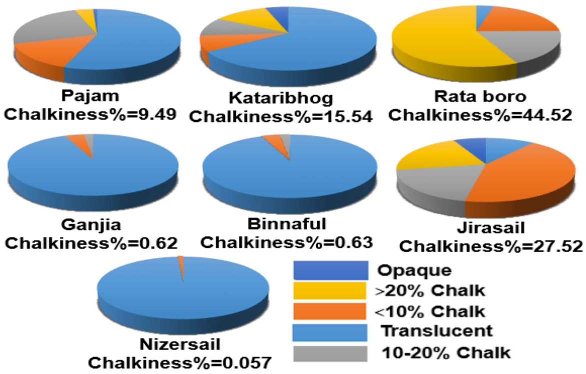

Fig. 2. Weight basis variations of chalkiness (%) in different local rice cultivars

Accumulation of chalkiness in grain could be due to irregular packing of air space with various metabolites, especially at the grain-filling stage (Del and Gonsalo, 1968; Graham, 2002; Ashida et al., 2009; Sultana et al., 2022). Therefore, the chalky areas are not as hard as the translucent areas and the grains with chalkiness are more prone to breakage during milling (Graham, 2002; Sultana et al., 2022). Despite having no effect on nutritional content, chalkiness is an important determinant of consumers' and traders' preferences. The greater the chalkiness, the lower the market acceptability (Cruz & Khush, 2000).

To evaluate the cooking quality of the studied rice varieties, several parameters were measured (**Table 5**). The time required for cooking was comparatively higher in Ganjia (20.5±1 min) and lower in Kataribhog along with Binnaful (14min ±1) (**Table 5**). Due to taking less time, Kataribhog and Binnaful can be considered the better performers in reducing fuel consumption as well as costs.

The quantity of water absorbed during cooking is measured as the water uptake ratio. The highest water uptake ratios were found in Nizersail (4.06) and the lowest in Jirasail (2.99) (**Table 5**). Water absorption plays a crucial role in determining the taste and texture of rice. The higher water uptake generally indicates superior quality. Rice varieties that absorb more water during cooking tend to be softer, while those that absorb less are categorized as harder varieties (Marasingha et al., 2024). Whenever cooking is performed, rice is swollen due to water absorption. The ratio of cooked rice to uncooked rice is measured using volume expansion ratio (VER). The highest VER was found for Binnaful (4.9) and the lowest was for Pajam (3.6) (**Table 5**).

Table 5. Performances of selected local rice cultivars based on cooking quality traits

Genotypes	Cooking Time (min±1)	Water uptake ratio	VER	Grain elongat-ion ratio
Pajam	15.5	3.36	3.6	1.4
Kataribhog	14	3.23	3.7	1.4
Rata boro	15.5	3.24	3.7	1.7
Ganjia	20.5	3.68	4	1.5
Binnaful	14	3.24	4.9	1.5
Nizersail	16	4.06	4.5	1.4
Jirasail	16.5	2.99	4.4	1.2

In the case of grain elongation, Rata boro cultivar had the highest elongation (1.7) while the lowest was found for Jirasail (1.2) (**Table 5**). The grain elongation ratio is a measure of kernel elongation after cooking resulting from the swelling of starch by water uptake (Karim et al., 2024). In earlier reports, water uptake showed a positive and significant correlation to grain elongation, while volume expansion did not influence grain elongation (Halim et al., 2023).

The gel consistency (GC), alkali spreading values (ASV) and gelatinization temperature (GT) of seven local rice varieties were determined (**Table 6**). Gel consistency assesses the cold paste viscosity of cooked milled rice flour, serving as an indicator for differentiating the cooked rice texture of high amylose genotypes (Graham, 2002; Sultana et al., 2022). The results in **Table 6** revealed that Rata boro, Ganjia and Nizersail were in the soft category (gel length more than 61 mm), Kataribhog and Jirasail were in the medium category (gel length 41 mm to 60 mm), while Pajam and Binnaful were in hard category (gel length 40 mm or less), as described by Graham (2002) and Sultana et al. (2022).

Table 6. Classification of the selected local rice cultivars based on gel consistency with alkali spreading values and gelatinization temperature types

Genotypes	Gel Consistency		Obtained ASV	Gelatinization Temperature	
	Obtained (mm)	Category		Temperature Range (°C)	Category
Pajam	35	Hard	5.3	70-74	Intermediate
Kataribhog	51	Medium	6.6	55-69	Low
Rata boro	83	Soft	6	55-69	Low
Ganjia	88	Soft	5.7	55-69	Low
Binnaful	26	Hard	6.4	55-69	Low
Nizersail	63	Soft	5.6	55-69	Low
Jirasail	58	Medium	3	75-79	High

The features of the studied varieties in GC and alkali digestion tests are presented in **Fig. 3** and **Fig. 4**, respectively.

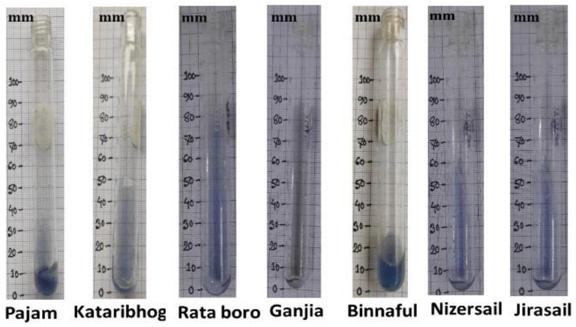

Fig. 3. Gel consistency values of selected local rice cultivars

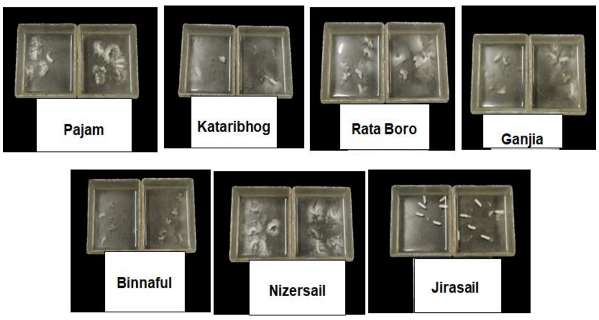

Fig. 4. Alkali spreading values of selected local rice cultivars

The interaction of starch polymers in the aqueous phase influences the formation of weak and rigid gels. Rice exhibiting soft gel consistency is generally preferred by consumers, prompting breeders to focus on developing rice genotypes with this characteristic (Moses et al., 2025).

GT is the cooking temperature at which the starch granules of grain begin to swell irreversibly in hot water with a simultaneous loss of crystallinity and birefringence (Graham, 2002; Sultana et al., 2022). At this point, the granule bursts and amylose molecules leach into the surrounding water, which causes rice grains to stick together (Karim et al., 2024). The degree of spreading of milled rice kernels in a weak alkali solution is very closely correlated with GT (Cruz and Khush, 2000). Rices with low GT disintegrate completely, whereas rices with intermediate GT show only partial disintegration and rices with high GT remain largely unaffected in the alkali solution. In the current study, the alkali spreading values (ASV) of all the studied cultivars, except Jirasail (3), varied between 5.3 and 6.6 (**Table 6**). Based on the alkali spreading scores, alkali digestion types and gelatinization temperature types are categorized (Ishfaq et al., 2023; Sultana et al., 2022; Manigbas et al., 2022). According to the ASV-based classification described by Ishfaq et al., (2023), all cultivars in the present study exhibited intermediate and high alkali digestion features, while only Jirasail showed low digestion in alkali (**Table 6**).

The GT of the rice varieties is also classified as low (55-69°C), intermediate (70-74°C) and high (more than 74°C) (Graham, 2002). According to our results, all cultivars possessed low GT whereas Pajam and Jirasail had intermediate and high GT, respectively (**Table 6**). Rice varieties with an intermediate alkali spreading value (ASV) are favored globally due to their excellent cooking properties, which include water absorption, moisture retention, volume expansion, and softness after cooking (Moses et al., 2025). A low and intermediate GT variety, as indicated by the ASV score, serves as an important economic indicator of cooking and eating quality, as reduced cooking times can lead to significant savings in fuel and energy costs.

Conclusion

Precise measurement of rice grain quality parameters is crucial for successful rice breeding. Grain quality preferences differ from man to man around the world. In the current study, the assessment of grain qualities of seven local rice cultivars (Pajam, Kataribhog, Rata boro, Ganjia, Binnaful, Nizersail, and Jirasail) was performed with the purpose of their subsequent categorization and interrelationship evaluation. Long grains are generally preferred. The highest rough rice length, brown rice length and milled rice length were exhibited by Jirasail indicating a slender shape grain for the Jirasail. The moisture level of all cultivars was in the range (11.10 to 12.17%) suitable for storage. The protein content in good cultivars should be greater than 7% which was observed in all varieties except Kataribhog and Binnaful. An intermediate level of amylose content is preferable mostly in rice-growing areas worldwide. Pajam and Rata boro were intermediate amylose rice (20-25%), while Kataribhog, Ganjia, Binnaful, Nizersail and Jirasail were high amylose (>25%) rice. Rice with high amylose is beneficial for diabetic conditions due to its slower digestion and lower glycemic index value.

In terms of milling outturn and head rice yield, Pajam and Kataribhog were premium category grain. In the milling industry, obtaining high head rice recovery is the most challenging issue. Therefore, the selection of Pajam and Kataribhog cultivars would be profitable for both the farmers and millers. Chalkiness in rice usually does not hamper nutrients or taste. However, consumers always prefer translucent grain. It influences market demand and costs. In this regard, Nizersail, Ganjia and Binnaful would be better choices for traders due to their very low chalkiness. Kataribhog and Binnaful had lower cooking time, making them a good choice in reducing fuel consumption and costs. The higher water uptake ratios of Nizersail indicate that cooked rice will be softer due to absorbing more water. According to gel consistency, Rata boro, Ganjia and Nizersail were in the soft category, which is generally preferred by consumers. Kataribhog and Jirasail were in the medium category. Rice varieties with a high GT require more water, energy, and time to cook than those with a low or intermediate GT. Rice with a high GT becomes excessively soft and tends to disintegrate when overcooked. Except Jirasail, all cultivars exhibited intermediate and high alkali digestion features. Consequently, all cultivars were with low GT whereas pajam and Jirasail had intermediate and high GT, respectively.

According to the mean performance of several physicochemical properties, the best performer was Jirasail whose moisture content and protein content were within the expected level. Despite having a high amylose content and chalkiness in this variety, it showed an acceptable level of gel consistency and gelatinization temperature. Considering physicochemical, nutritional and cooking quality traits, Jirasail variety could be the better choice for consumers.

References

Abdala, A.J., Bokosi J.M., Mwangwela, A.M., Mengzi, T.R. 2016. Correlation and path co-efficient analysis for grain quality traits in F1 generation of rice (*Oryza sativa* L.). *Journal of plant breeding and Crop Science*, 8:109-116.

Adu-Kwarteng, E., Ellis, W. O., Oduro, I., & Manful, J. T. 2003. Rice grain quality: a comparison of local varieties with new varieties under study in Ghana. *Food control*, *14*(7):507-514.

Alam, M., Lou, G., Abbas, W., Osti, R., Ahmad, A., Bista, S., Ahiakpa, J.K. and He, Y. 2024. Improving rice grain quality through ecotype breeding for enhancing food and nutritional security in Asia–Pacific region. Rice, 17(1):47.

Asghar, S., Anjum, F. M., Amir, R. M., & Khan, M. A. 2012. Cooking and eating characteristics of Rice (*Oryza sativa* L.)-A review. *Pakistan Journal of Food Sciences*, *22*(3):128-132.

Ashida, K., Iida, S. Yasui, T. 2009. Morphological, physical and chemical properties of grain and flour from chalky rice mutants. *Cereal Chemistry* 86:225-231.

Awal, M. A., & Siddique, M. A. B. 2011. Rice production in Bangladesh employing by ARIMA model. *Bangladesh Journal of Agricultural Research*, 36(1):51-62.

Bandumula, N. 2018. Rice production in Asia: Key to global food security. Proceedings of the National Academy of Sciences, India Section B. *Biological Sciences*, 88:1323-1328.

Biswas, S. K., Banu, B., Kabir, K. A., Begum, F. Choudhury, N.H. 1992. Physicochemical properties of modern and local rice varieties of Bangladesh. *Bangladesh Rice Journal*, 3(1&2): 128-131.

Brorsen, B. W., Grant, W. R., & Rister, M. E. 1984. A hedonic price model for rough rice bid/acceptance markets. *American Journal of Agricultural Economics*, *66*(2):156-163.

Cagampang, G. B., Perez, C. M., & Juliano, B. O. 1973. A gel consistency test for eating quality of rice. *Journal of the Science of Food and Agriculture*, 24(12):1589-1594.

Chemutai, L.R., Musyoki, M.A., Kioko W.F., Mwenda, N.S., Muriira, K.G., Piero, N.M. 2016. Physicochemical characterization of selected rice (*Oryza sativa* L.) genotypes based on gel consistency and alkali digestion. *Biochemistry and Analytical Biochemistry*, 5:285.

Cruz, N. D., & Khush, G. S. 2000. Rice grain quality evaluation procedures. Aromatic rices, 3, 15-28.

Del Rosario, A. R., Briones, V. P., Vidal, A. J., Juliano, B.O. 1968. Composition and endosperm structure of developing and mature rice kernel. Cereal Chem., 45:225-235.

Graham R. 2002. A Proposal for IRRI to Establish a Grain Quality and Nutrition Research Center. IRRI Discussion Paper Series No. 44. Los Baños (Philippines): International Rice Research Institute, p15

Halim, A. A. B. A., Rafii, M. Y., Osman, M. B., Chukwu, S. C., & Oladosu, Y. 2023. Physicochemical Properties and Tissue Structure of High Kernel Elongation Rice (*Oryza sativa* L.) Varieties as Affected by Heat Treatment. Foods, 12(11), 2207.

Hettiarachchi, H. A. P. W., Ribeira, S. P., Prasantha, B. D. R., & Wickramasinghe, H. A. M. 2016. Diversity of physical and cooking quality characters of selected traditional and improved rice varieties in Sri Lanka. *Sri Lankan Journal of Biology*, 1(1).

Ishfaq, J., Soomar, A. M., Khalid, F., & Abbasi, Y. 2023. Assessing rice (*Oryza sativa* L.) quality: A comprehensive review of current techniques and future directions. *Journal of Agriculture and Food Research*, 14:100843.

Islam, M. A., Hasan, M. M., Akter, T., & Islam, S. M. S. 2024. Agronomic performance and grain quality assessment of small-grain aromatic rice advanced breeding lines in Bangladesh. *Agrobiological Records* 17: 30-41.

Juliano, B. O., & Perez, C. M. 1984. Results of a collaborative test on the measurement of grain elongation of milled rice during cooking. *Journal of Cereal Science*, 2(4): 281-292.

Juliano, B.O. 1971. A simplified assay for milled rice amylose. Cereal Sci. Today, 16: 334-340.

Karim, M. D., Abuhena, M., Hossain, M. D., & Billah, M. M. 2024. Assessment and comparison of cooking qualities and physio-chemical properties of seven rice varieties in terms of amylose content. *Food Physics*, 1: 100014.

Kaul, A.K. 1970. Early generation testing for quality characteristics. II. Rice. *Indian Journal of Genetics and Plant Breeding*, 30 (1):237-243.

Khush, G. S. 2005. What it will take to feed 5.0 billion rice consumers in 2030. *Plant molecular biology*, 59: 1-6.

Little, R.R., Hilder, G. B. & Dawson, E. H. 1958. Differential effect of dilute alkali on 25 varieties of milled white rice. *Cereal Chemistry*, 35:111-126.

Liu, Q., Wu, X., Ma, J. & Xin, C. 2015. Effects of cultivars, transplanting patterns, environment, and their interactions on grain quality of japonica rice. *Cereal Chemistry*, 92: 284-292.

Manigbas, N.L., Padolina, T.F., Desamero. N.V., Rigor, A.T. & Masajo, T.M. 2022. Rice Breeding Operations Manual of the Philippine Rice Research Institute. Science City of Muñoz, Nueva Ecija. Philippines: Philippine Rice Research Institute.

Mohidem, N. A., Hashim, N., Shamsudin, R. & Che Man, H. 2022. Rice for food security: Revisiting its production, diversity, rice milling process and nutrient content. *Agriculture*, 12(6): 741.

Moses, M.O., Aishat, A.B. & Olanrewaju, O. M. 2025: Suitability of Dimensional, Physical and Physicochemical Properties of Selected Eight Improved Rice (*Oryza sativa* L.) Varieties for Extrusion Cooking. *Food Biophysics*, 20: 1-17.

Oko, A. O., Ubi, B. E. and Dambaba, N. 2012. Rice cooking quality and physico-chemical characteristics: a comparative analysis of selected local and newly introduced rice varieties in Ebonyi State, Nigeria. *Food and Public health*, 2(1): 43-49.

Sharma, N., & Khanna, R. 2019. Rice grain quality: current developments and future prospects. Recent advances in grain crops research, 5772: 89367.

Sidhu, J. S., Gill, M. S., & Bains, G. S. 197). Milling of paddy in relation to yield and quality of rice of different Indian varieties. *Journal of Agricultural and Food Chemistry*, 23(6): 1183-1185.

Sultana, S., Faruque, M., & Islam, M. R. 2022. Rice grain quality parameters and determination tools: a review on the current developments and future prospects. *International Journal of Food Properties*, 25(1): 1063-1078.

Thissa Marasingha, M. M. M., Samarakoon, E. R. J., Senarathne, B. M. K., & Samarasinghe, H. G. A. S. 2022. Comparative Assessment of Grain Quality Characteristics and Cooking Parameters of White Rice (Oryza sativa Indica and *Oryza sativa* Japonica) Varieties Cultivated in Sri Lanka. *Engineering Proceedings*, 67(1): 58.

Yadav, R. B., Khatkar, B. S., & Yadav, B. S. 2007. Morphological, physicochemical and cooking properties of some Indian rice (*Oryza sativa* L.) cultivars. *Journal of Agricultural Technology*, *3*(2): 203-210.

Zhang, H., Hou, D.P., Peng X. L., Shao, S.M., Jing, W. J., Gu, J.F. & Yang, J.C. 2019: Optimizing integrative cultivation management improves grain quality while increasing yield and nitrogen use efficiency in rice. *Journal of Integrative Agriculture*, 18: 2716-2731.

Zhao, M. & Lin, Y. 2020. Chen, H. Improving nutritional quality of rice for human health. Theor. Appl. Genet., 133: 1397–1413.