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Assessment of the morphometric grain quality and cooking properties of *Bora* rice: An indigenous rice cultivar of Assam, India

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Abstract
Bora rice- a glutinous or sticky rice, is an indigenous rice cultivated in northeast India, particularly Assam and Manipur. The present study investigates the morphometric grain quality and cooking properties of 20 distinct *Bora* rice variety from Assam, India. Morphometric analysis revealed substantial variations in grain size, shape, and kernel measurements, providing high commercial grain quality, better yield and better selection of character for improved rice variety development. Cooking properties, including water uptake, kernel elongation, gruel solid loss, and minimum cooking time, also marks valuable insights for commercial consumer aspects. The findings demonstrate that *Joha bora, Aghoni bora, Nol bora, Dhepa bora, Black rice, Ghee bora, Ronga bora*, and *Malbhog bora* exhibit superior properties compared to other varieties. These insights hold promise for optimizing the utilization of *Bora* rice across diverse culinary and food applications, contributing to food security and culinary diversity.

Keywords: Bora rice, sticky rice, morphometric, grain quality, cooking properties

Introduction

Rice, a widely consumed staple food globally, holds a special significance in Asian countries, particularly in India, China, Indonesia, Bangladesh, Philippines, Vietnam, Thailand, and Myanmar (Prasad *et al*., 2017) [28]. With approximately 80% of rice cultivation concentrated in these regions, the crop has deep cultural roots, featuring prominently in various festivals. According to Food and Agricultural Organization (FAO) in 2015, rice contributed significantly to global cereal production, reaching 500.5 million metric tons from April to June.

India, a major player in rice production, was a leading exporter in 2014, contributing 32% to the global rice export market (Prasad *et al*., 2017) [28]. Assam, a state in the North-East India, stands out as a crucial contributor to the country's rice production. About 70% of Assam's arable land is dedicated to rice cultivation (Singh *et al*., 2003) [36] benefitting from favourable climatic and physiographic conditions that support three distinct growing seasons: ahu, sali, and boro (Ahmed *et al*., 2011) [1].

Within Assam's culinary landscape, *Bora* rice holds a special place. Its low amylose content makes it easy to prepare and be served as an essential ingredient in traditional dishes, such as the "*Komal rice*". About 90% of the rice endosperm is comprised of starch, with varying concentration of amylose and amylopectin (Bonto *et al*., 2021; Zhang *et al*., 2008) [6, 42]. This composition is reported to be significantly influential in the starch's physicochemical properties (Dong *et al*., 2015) [12]. Due to the diverse amylose content, rice starch finds numerous applications in the food industry. It acts as a binding agent, enhances the texture of food products, and even serves as a substitute for fat (Colussi *et al*., 2014) [8]. Additionally, the physicochemical properties of rice starch significantly impact the process of food preparation by influencing the physical and chemical attributes of the final product (Anugrahati *et al*., 2016). Despite the availability of high-yielding varieties, local farmers in rural Assam continue to cultivate *Bora* rice. This enduring popularity stems from its versatility in diverse culinary preparations. From puffed rice and bamboo rice to rice beer, *Bora* rice adds its unique flavour and texture to a variety of beloved Assamese dishes.

According to Lodh *et al*. (2002) [22] the grain characteristics like shape and size is highly influential in international trade as well as consumption of rice. Length, width and their ratio are related to the different characteristics including stickiness or fluffiness of rice grain after boiling (Verma *et al*., (2015) [39]. These properties vary significantly in different varieties (Yadav *et al*., 2007) [40].

Cooking properties, a pivotal aspect of rice quality, have been a subject of in-depth analysis. Rice kernels are eaten after boiling in hot water which in beneficial for its hardness and consumption quality (Bhat and Riar, 2017) [4]. Cooked rice forms a complex of moisture as the plasticizing agent with different biopolymers including starch and protein (Ahmed *et al*., 2011) [1]. Changes in different properties of rice like water absorption or volume expansion of kernels can be occurred which are influenced by cooking time and cooking temperature respectively (Altheide *et al*., 2012) [2].

While soft rice boasts a variety of practical uses for growers, its physicochemical properties remain largely unstudied. Although reports document its low amylose content and associated cooking characteristics (Bhakta *et al*., 2011; Rathi & Sarma, 2012; Shaptadvipa & Sarma, 2009) [3, 30, 34], no comprehensive investigations have explored the link between these features and its physicochemical background. This presents a significant gap in our understanding of this unique rice variety.

Materials and Methods

Plant Material

A field study was conducted for the collection of different varieties of *Bora* rice in different districts of Assam. Twenty distinct *Bora* rice varieties were meticulously collected from diverse agro-climatic zones across Assam, their names and types validated by local communities. Followed by the collection, a comprehensive examination was performed which encompassed of morphological characterization and cooking properties of all 20 varieties.

Table 1: Collected rice samples with its Agro climatic zones of Assam

Sl. No.	Varieties	Collection Site	Cultivar type	GPS Co-ordinates
1.	*Joha bora*	Bajali	Landrace	26.544939, 91.188216
2.	*Nol bora*	Bajali	Landrace	26.544939, 91.188216
3.	*Kola bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
4.	*Ronga bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
5.	*Pokhora bora*	Bajali	Landrace	26.544939, 91.188216
6.	*Aijung bora*	Sipajhar, Darrang	Landrace	26.398052, 91.903228
7.	*Dhepa bora*	Sipajhar, Darrang	Landrace	26.398052, 91.903228
8.	*Dudh bora*	Bajali	Landrace	26.544939, 91.188216
9.	*Dighol Joha bora*	Anandabazar, Baksa	Landrace	26.69804, 91.15142
10.	*Lakhimpuria bora*	Anandabazar, Baksa	Landrace	26.69804, 91.15142
11.	*Upendra bora*	Bajali	Landrace	26.544939, 91.188216
12.	*Tezdefa bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
13.	*Chilothia bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
14.	*Ghee bora*	RRLRRS, Kamrup	Landrace	26.2452, 91.5252
15.	*Chakhaw P. bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
16.	*Malbhog bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
17.	Black Rice	Mangaldoi, Darrang	Landrace	26.393926, 92.039008
18.	*Chikora bora*	RARS, Nagaon	Landrace	26.35037, 92.69225
19.	*Aghoni bora*	RRLRRS, Kamrup	Landrace	26.2452, 91.5252
20.	*Tez bora*	RARS, Nagaon	Landrace	26.35037, 92.69225

RARS- Regional Agricultural Research Station; RRLRRS- Regional Rainfed Lowland Rice Research Station

Morphometric assessment of grain quality traits

Grain – kernel size, shape and grade

For assessment of grain quality, 10 fertile rice grains were selected randomly from each sample and their length, width and area were measured in millimeter scale. As per IRRI (1996), grain length was classified as very long (>7.50 mm), long (6.51-7.50 mm), medium (5.51-6.50 mm) and short (<5.5 mm). From the ratio of length to width of the grains, grain shape was determined, and grains were classified as slender (>3.0 nm), medium (2.1-3.0 mm) and bold (<2.0 mm) following the classification of IRRI (1996).

The grains of all the varieties were classified into different grades on the basis of the average length-breadth ratio of the grain as long slender (Length > 6.00 mm, L/B > 3.0), short slender (L < 6.00, L/B > 3.0), long bold (L > 6.00 mm, L/B < 3.0), medium slender (L < 6.00 mm, 2.5 < L/B >3.0) and short bold (L < 6.00 mm, L/B < 2.5) respectively (Ramaiah Committee, 1969). The size of the kernels was also determined in the same way.

Cooking Properties

To estimate the cooking properties of collected *bora* rice varieties with authentication, three replicates of each variety were taken in 2 test tubes and were subjected to the following procedure.

Water uptake

2 g of rice kernel was weighed and taken in a test tube containing 10 ml distilled water and cooked in a water bath for 35 minutes at 77°C. After 35 minutes the content of the test tubes was filtered and volume of the unabsorbed water was measured. By subtracting the volume of the unabsorbed water from the total volume (10 ml) volume of the absorbed water was obtained. Apparent water uptake on cooking (ml/100 g rice) was calculated by multiplying the absorbed water volume by 50 (Verma *et al*., 2015) [39].

Kernel elongation after cooking and kernel elongation ratio and length-breadth ratio

The length of 10 whole rice kernels was measured using millimetre scale which were then cooked at 77°C for 35 minutes in a water bath. Then the length of the cooked kernels was measured and the kernel elongation after cooking was determined. Kernel elongation ratio was calculated by dividing the average length of cooked kernel by the average length of the raw (uncooked) rice (Juliano, 1971) [19].

Gruel solid loss

2 g of rice grain samples were cooked in 20 ml of distilled water at 90°C till their minimum cooking time. The gruel obtained (after filtration of the distilled water in which rice were cooked) was washed repeatedly for 3 to 5 times and the final volume was made 50 ml by adding distilled water. These were then allowed to dry completely in an oven at 110˚C.

After drying, the remaining solids were weighed to determine the percentage of solids lost from the original gruel. (Verma *et al*., 2015) [39].

Minimum cooking time

2 g of rice kernels were taken in a test tube containing 20 ml distilled water and placed and kept in a water bath at 90°C until they were completely cooked. The minimum time required for cooking was calculated by pressing the cooked rice kernels between two glass slides till no white core was left at regular time intervals (Verma *et al*., 2015) [39].

Statistical analysis

The statistical analysis was performed using MS-Excel and R program. Data arrangement and calculation were performed using MS-Excel. ANOVA and DMRT was performed using agricolae, tidyverse, dplyr R packages (R Core Team, 2021) In addition, the ggplot2 package was also used for the graphical representation and visualisation.

Results

Documentation of *Bora* Rice

Twenty *bora* rice varieties collected from five major *bora* rice growing districts of Assam such as Bajali, Baksa, Darrang, Kamrup and Nagaon along with GPS co-ordinates of the collected site were analyzed in this study (Table 1). All the collected varieties were processed immediately for the experiment to prevent the loss of rice grain viability. First of all, morphometric characterization was determined and quality traits like grain and kernel length, width, and color along with the uses of these rice varieties were determined.

Fig 1: Documentation of 20 varieties of *bora* rice: A. *Joha bora*, B. *Nol bora*, C. *Ghee bora*, D. *Ronga bora*, E. *Pokhora bora*, F. *Aijung bora*, G *Dhepa bora*, H. *Dudh bora*, I. *Dighol Joha bora*, J. *Lakhimpuria bora*, K. *Upendra bora*, L. Black Rice, M. *Chilothia bora*, N. *Kola bora*, O. *Chakhaw bora*, P. *Malbhog bora*, Q. *Tezdefa bora*, R. *Chikora bora*, S. *Aghoni bora* and T. *Tez bora*

Morphometric characterization of rice grains

Grain length, width, length to width ratio and area

Measurements of the morphological character include length, width, grade, and area of the grains. The morphological analysis of *bora* rice varieties revealed variations in the measured parameters. The length of the grains ranged from 6.47 mm to 9.56 mm. *Lakhimpuria bora* showed the lowest grain length (6.47 mm) and *Joha bora* showed the highest (9.56 mm). The size of the grain also varied from short, medium, long to very long. The size of the variety Lakhimpuria was very medium, whereas Joha was long.

Similarly, the width varied from 2.18 mm to 3.19 mm for *Ronga bora*. Among all the varieties *Aghoni bora* (2.18 mm) was found to have the highest width, while *Ronga bora* showed the lowest width (3.19 mm).

Grain length to width ratio i.e., the grade determines an important characteristic of rice which is the grain shape. The grade, which indicates the overall quality, showed a range from 2.33 mm for *Ronga bora* to 3.79 mm for *Aghoni bora*.

Aghoni bora was recorded to be the highest in case of grade with a long slender grain shape. The variety *Ronga bora* showed the lowest grade with a long bold grain shape.

The area, representing the size of the grains, ranged from 13.705 mm² for *Ghee bora* to 19.030 mm² for *Pokhora bora* (Fig. 2).

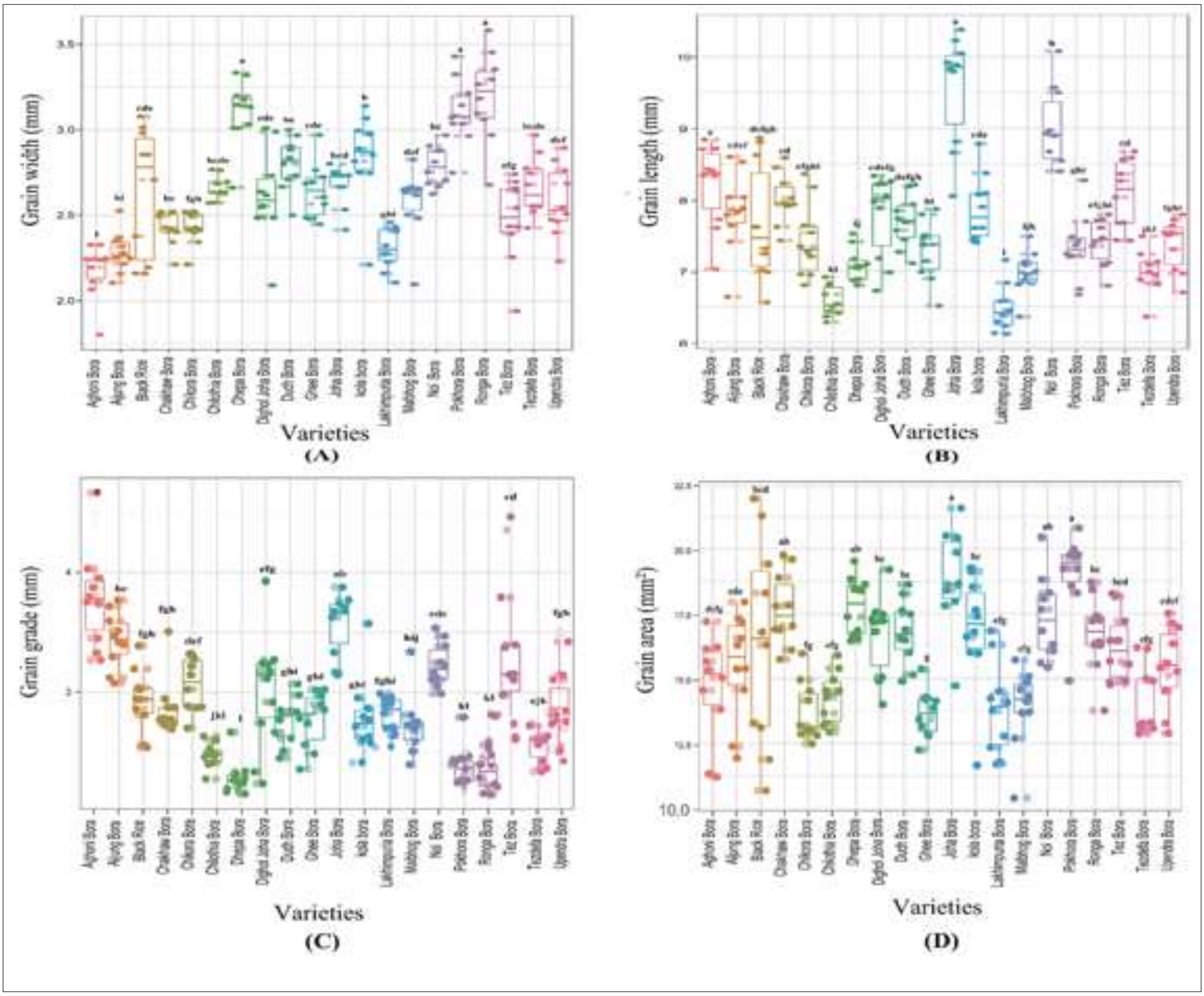

Fig 2: Boxplot showing **v**ariation of grain parameters with respect to 20 varieties (A) Variation of grain width with respect to 20 different varieties; (B) Variation of grain length with respect to 20 different varieties; (C) Variation of grain grade with respect to 20 different variet ies; (D) Variation of grain area with respect to 20 different varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test. The jitter points indicate the data point of each variable of the specific cultivar obtained from three biological replicates.

Kernel length, width, length to width ratio (grade) and area

The measurements of the rice kernels include length, width, grade, and area of the grains. The analysis of morphological characteristics among 20 *bora* rice varieties exhibited variations in the measured parameters. The length of the kernels ranged from 4.715 mm to 6.970 mm. The variety *Ronga bora* showed the lowest length (4.715 mm), while *Nol bora* (6.970 mm) showed the highest value for kernel length.

Similarly, the width varied from 1.644 mm for *Aghoni bora* to 2.606 mm for *Dhepa bora*. On the basis of kernel length, kernel shape was recorded. The shapes of the kernel varied between spherical to semi-spherical types. The spherical kernels were less than 2.0 mm whereas the semi-spherical kernels were more than 2.0 mm.

The grade, indicating the overall quality, ranged from 1.957 mm to 3.377 mm. The highest value of grade was recorded in *Aghoni bora* followed by lowest in the *Dhepa bora*.

The area, representing the size of the grains, ranged from 8.330 mm² for *Ghee bora* to 12.1781 mm² for Black Rice (Fig. 3).

3

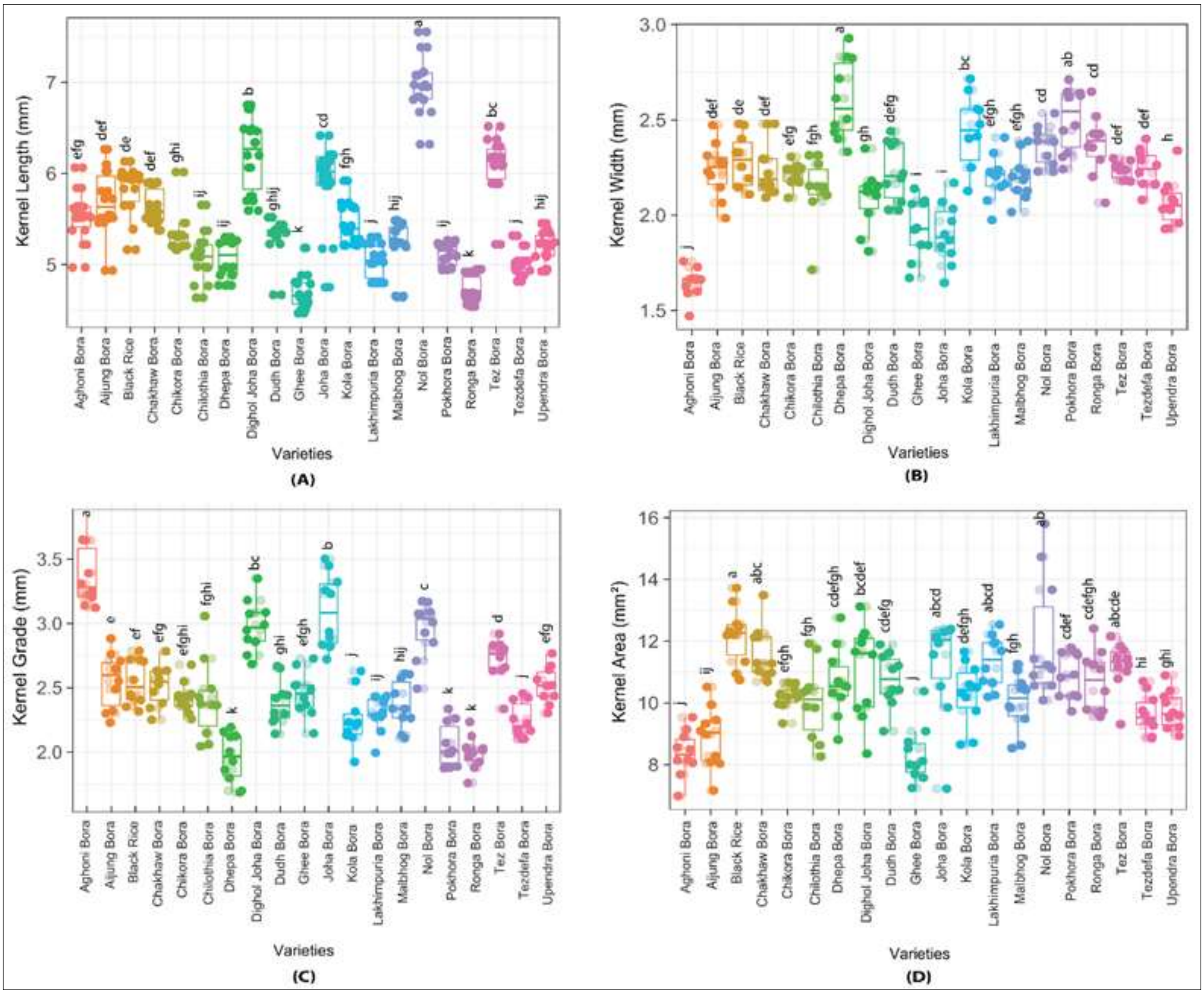

Fig 3: Boxplot showing variation of kernel parameters with respect to 20 different varieties (A) Variation of kernel length with respect to 20 different varieties; (B) Variation of kernel width with respect to 20 different varieties; (C) Variation of kernel grade with respect to 20 different varieties; (D) Variation of kernel area with respect to 20 different varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test. The jitter points indicate the data point of each variable of the specific cultivar obtained from three biological replicates.

Grain size and shape

The size and shape of the experimented rice grains were classified according to the guidelines of IRRI (1996). The size of the *bora* varieties was determined based on their length and recorded as very long (10), long (9) and medium (1). The shape of the varieties was classified as slender (5) and medium (15).

Kernel size and shape

The size and shape of the kernel were also determined on the basis of the kernel length and length to width ratio according to the method of Rosta (1975). The size of the kernels of the investigated *bora* varieties were found to have long (1), medium (7) and short (12). The shape of the kernels could be categorized into medium and bold in nature. 17 varieties were recorded to show medium kernels, while the rest 3 showed bold kernels.

Cooking properties

Water uptake (WU)

The softness or hardness of rice kernels can be determined by the amount of water up taken by them. The water uptake analysis revealed variations in the water absorption capacity among 20 *Bora* rice varieties. The water uptake per gram ranged from 0.148 ml/g for *Chilothia bora* to 0.968 ml/g for *Ghee bora*. Notably, *Ghee bora* exhibited the highest water uptake per gram, indicating its ability to absorb water efficiently. On the other hand, *Chilothia bora* showed the lowest water uptake among the tested varieties.

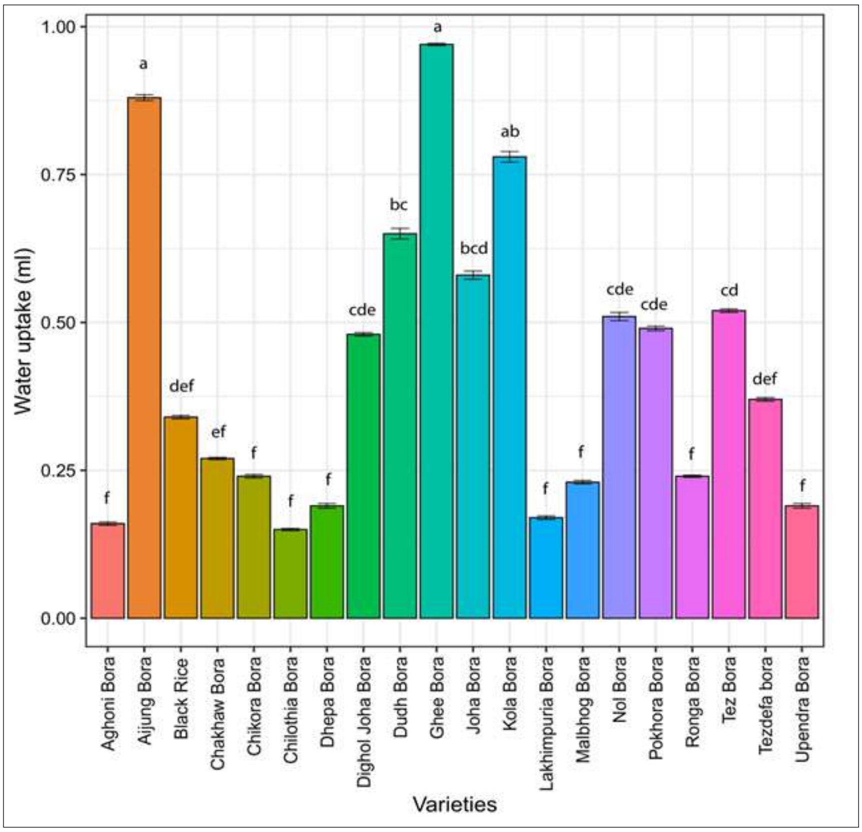

Fig 4: Water uptake of *bora* rice varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test.

Gruel Solid Loss (GSL)

Gruel solid loss refers to the amount of solid material lost during the preparation of gruel, which is a common method of consuming rice. Among the samples analysed, *Tezdefa bora* exhibited the lowest gruel solid loss, with only 0.066 grams lost. This suggests that *Tezdefa bora* retains a higher proportion of its solid content during gruel preparation. Other varieties that showed relatively low gruel solid loss include *Tez bora*. On the other hand, *Ghee bora* had the highest gruel solid loss, with a significant amount of 0.434 grams lost during the preparation process. This indicates that *Ghee bora* undergoes a substantial reduction in solid content when transformed into gruel. Similarly, *Dighol Joha bora* and *Chilothia bora* also exhibited relatively high gruel solid loss.

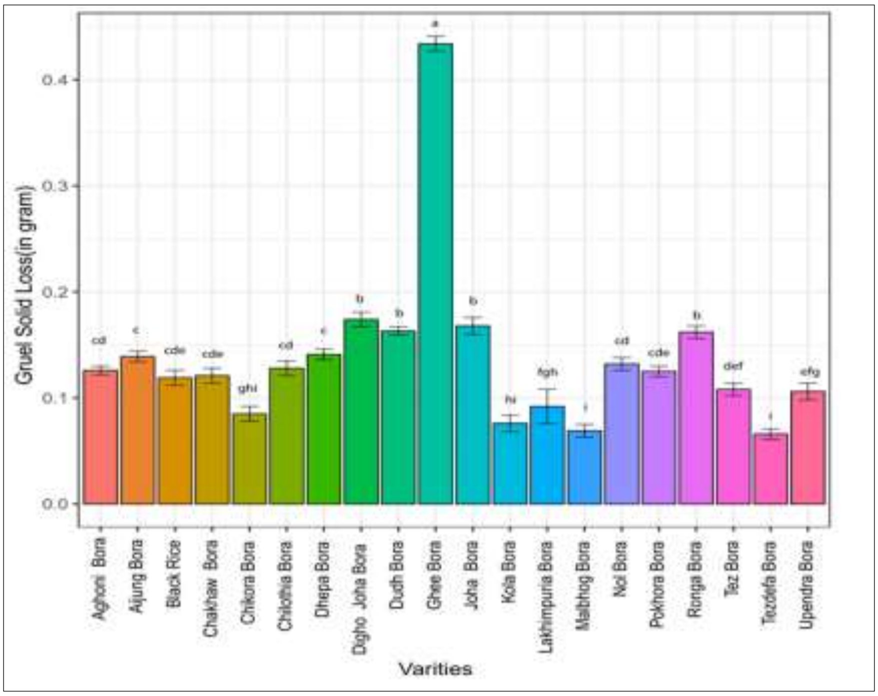

Fig 5: Gruel solid loss of 20 *bora* rice varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test.

Minimum Cooking Time (MCT)

The minimum cooking time is an important factor to consider in determining the convenience and efficiency of preparing rice for consumption. The variety *Joha bora* showcased the shortest cooking times, requiring just 10 minutes to cook. The highest cooking time was recorded in the variety *Tezdefa bora* and *Chikora bora*, which took around 33 minutes to cook.

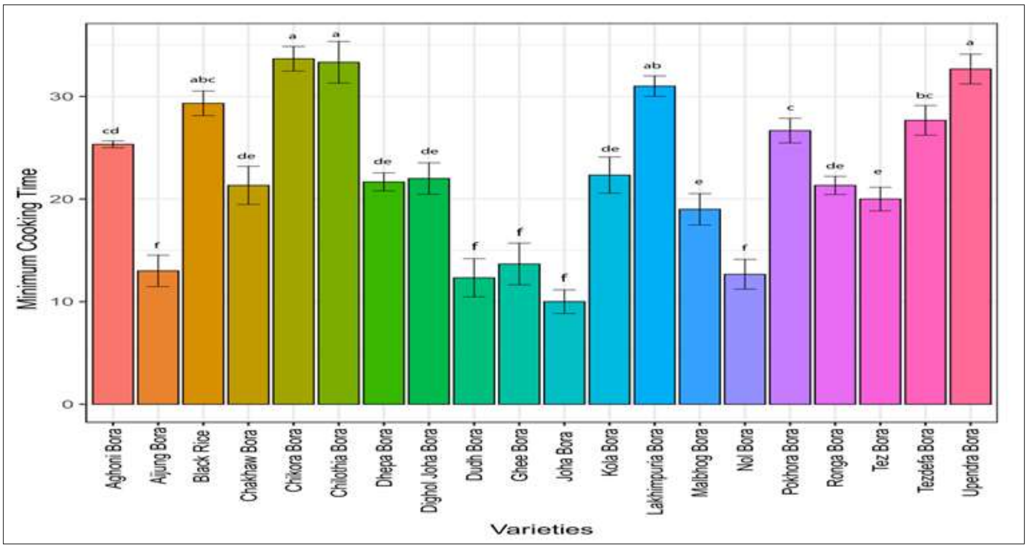

Fig 6: Minimum Cooking Time of *bora* rice varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test.

Kernel Length to Width Ratio (KLWR), Kernel Elongation Ratio (KER)

Kernel Length to Width Ratio (KLWR) varied in the range of 2.019 mm to 3.26 mm. Among the samples, the highest KLWR value was observed in *Aghoni bora*, which recorded a value of 3.26 mm while the lowest KLWR value was seen in the variety *Pokhora bora*.

Kernel Elongation Ratio provides information about the extent of increase in length of the kernels after absorbing water during cooking. In case of Kernel Elongation Ratio (KER), *Dhepa bora* showed the highest value at 1.1785, indicating that it has a higher capacity for absorbing water during cooking. Other varieties like *Upendra bora*, *Ghee bora*, and *Tez bora* also displayed notable KER values following the lowest KER value of 0.903 mm in *Nol bora*.

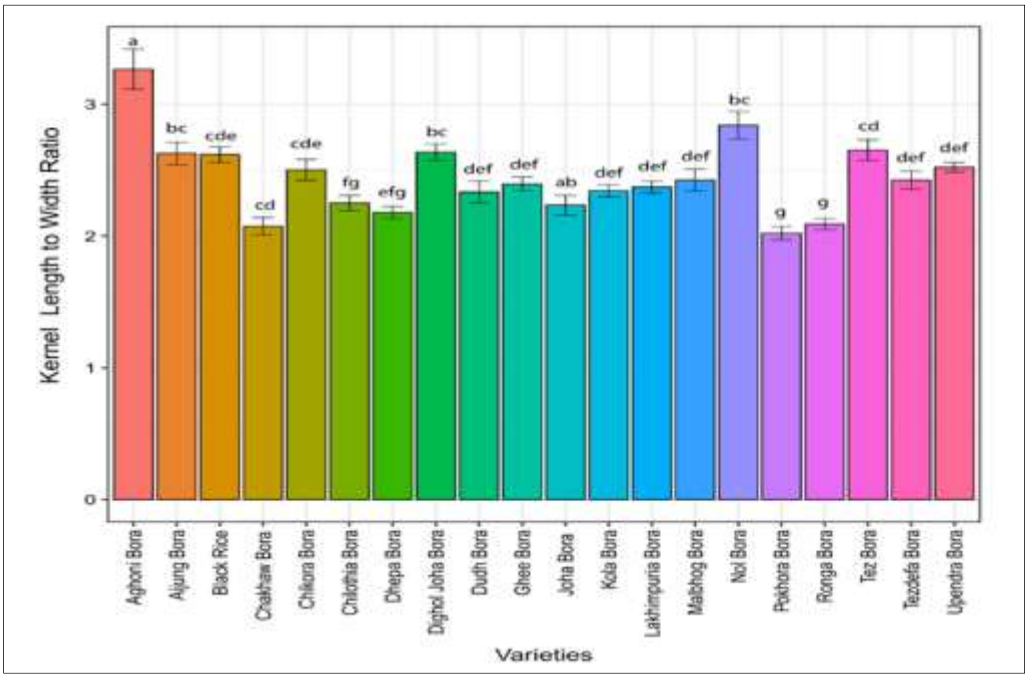

Fig 7: Kernel length to width ratio (KLWR) of *bora* rice varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test.

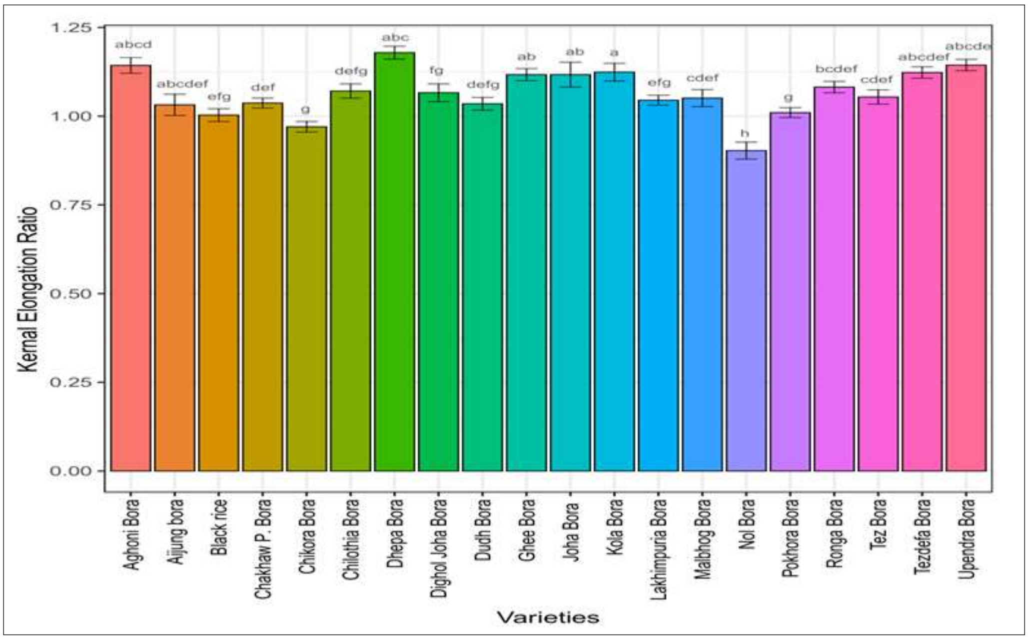

Fig 8: Kernel elongation ratio (KER) of *bora* rice varieties. Data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's (DMRT) post hoc test.

Correlation analysis of the grain quality traits and cooking properties

The correlation analysis was performed among the morphology of analysed grain quality traits and cooking properties of *bora* rice varieties. Significant positive correlations were found between grain length and kernel grade, as well as between grain length and water uptake. Significant Negative correlations were found in case of grain width and grain grade, kernel width and grain grade, minimum cooking time and water uptake and minimum cooking time and grain length.

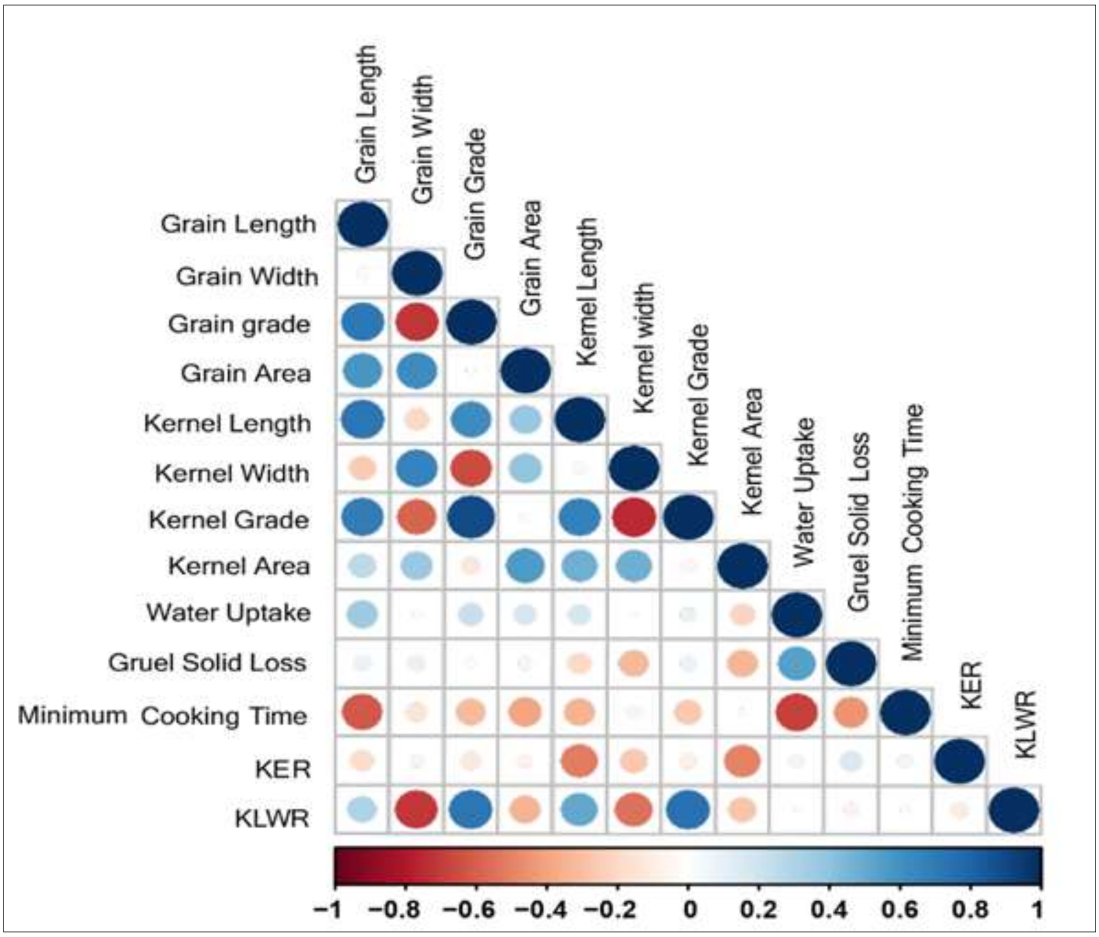

Fig 9: Correlation analysis among the morphometric and cooking properties of *bora* rice varieties

Discussion

In this study, the analysis of morphometric grain quality and cooking properties of 20 *bora* rice varieties revealed distinct ranges of values for each of the properties which further could be related in terms of their similarity or variance. Each property carries a unique and distinct importance to assess the nutritional value and efficiency of rice.

Morphometric characterization of *bora* rice

The morphological analysis of *bora* rice varieties delved into key parameters encompassing length, width, grade, and area of both grains and kernels. Variations were observed in these measured characteristics, indicating the diverse nature of *bora* rice varieties. Grain length ranged from 6.476 mm to 9.560 mm, with *Lakhimpuria bora* displaying the shortest grains (6.476 mm) and *Joha bora* the longest (9.560 mm). Additionally, grain size varied, with Lakhimpuria categorized as very medium and Joha as long. Width exhibited variations from 2.180 mm to 3.194 mm, with *Aghoni bora* having the widest grains (2.180 mm) and *Ronga bora* the narrowest (3.194 mm). The grain length to width ratio, or grade, ranged from 2.327 mm to 3.786 mm, showcasing diverse grain shapes. *Aghoni bora*, with a grade of 3.786 mm, presented a long slender grain shape, while *Ronga bora* had the lowest grade, indicating a long bold grain shape. Similar findings regarding the grain length, breadth, and their ratio have been reported for a limited selection of aromatic rice varieties (Meena *et al*., 2010; Samal *et al*., 2014; Lahkar and Tanti, 2017). The area of the grains, representing their size, ranged from 13.705 mm² to 19.030 mm².

Transitioning to the kernel measurements, kernel length varied from 4.715 mm to 6.970 mm, with *Nol bora* exhibiting the longest kernels (6.970 mm) and *Ronga bora* the shortest (4.715 mm). Kernel width ranged from 1.644 mm to 2.606 mm, with *Aghoni bora* having the narrowest kernels (1.644 mm) and *Dhepa bora* the widest (2.606 mm). The grade, indicative of overall quality, ranged from 1.96 mm to 3.38 mm, showcasing diverse kernel shapes. *Aghoni bora* exhibited the highest grade, signifying a superior long slender kernel shape, while *Dhepa bora* had the lowest grade, indicating a different, possibly bolder, kernel shape. The kernel area spanned from 8.33 mm² to 12.18 mm². Other researchers have observed similar results in rice, highlighting the significant variability among landraces due to their unique seed morphology and adaptability to local environments (Patra *et al*., 2000; Deb, 2000; Singh *et al*., 2005; Chakravorty & Ghosh, 2011; Mishra & Sinha, 2012; Tirkey *et al*., 2013; Semwal *et al*., 2014) [26, 11, 35, 41, 24, 38, 33]. This substantial diversity is attributed to distinct seed characteristics and the landraces' ability to thrive in specific local environmental conditions (Frainkel *et al*., 1995; Hore, 2005) [15].

Utilizing the guidelines of IRRI (1996) for classification, the experimented rice grains were categorized based on size (very long, long, medium) and shape (slender, medium). Similarly, the kernel size and shape, determined by kernel length and length to width ratio following Rosta's method (1975), revealed categories of long, medium, and short sizes, along with distinctions between medium and bold shapes. These comprehensive findings underscore the extensive morphological diversity inherent in *Bora* rice varieties, providing valuable insights for future breeding and improvement programs.

Cooking properties

The preferences of consumers depend mainly on the cooking properties of rice, as rice is consumed after cooking (Isono *et al*., 1994; Bhattacharjee *et al*., 2002; Thomas *et al*., 2013) [17, 5, 37]. The cooking properties of rice, including water uptake, kernel elongation after cooking, gruel solid loss, and minimum cooking time, were investigated in 20 *Bora* rice varieties. Cooking properties are vital determinants of rice quality, influencing both the palatability and convenience of consumption. The water uptake (WU) analysis provided insights into the softness or hardness of rice kernels among 20 *Bora* rice varieties. Variations were observed in the water absorption capacity, with *Ghee bora* exhibiting the highest water uptake per gram (0.968 ml/g), suggesting its efficient water absorption. Conversely, *Chilothia bora* displayed the lowest water uptake, indicating differences in the hydration characteristics among the tested varieties.

Gruel Solid Loss (GSL) further highlighted distinctions in solid content retention during gruel preparation. *Tezdefa bora* demonstrated the lowest GSL, retaining a significant portion of solid material, while *Ghee bora* exhibited the highest loss, indicating a substantial reduction in solid content during the gruel-making process. These findings provide valuable insights into the textural characteristics of *Bora* rice varieties during cooking and gruel preparation. Comparable findings were reported Hirannaiah *et al*. (2001) [14] in some pigmented rice varieties.

Minimum Cooking Time (MCT) emerged as a crucial parameter for assessing the efficiency of rice preparation. *Joha bora* demonstrated the shortest cooking time at 10 minutes, reflecting its quick-cooking nature. In contrast, *Tezdefa bora* and *Chikora bora* required the longest cooking times, taking approximately 33 minutes because of the presence of a thick bran layer, it took longer to cook (Juliano and Bechtel, 1985) [18]. This information is essential for consumers seeking convenience in rice preparation, and it also reflects the diversity in cooking attributes among the *Bora* rice varieties.

Kernel Length to Width Ratio (KLWR) served as an indicator of kernel shape, with *Aghoni bora* displaying the highest KLWR (3.26 mm), while *Pokhora bora* exhibited the lowest. The Kernel Elongation Ratio (KER) provided insights into the extent of kernel elongation during cooking. *Dhepa bora* demonstrated the highest KER (1.1785), indicating a significant increase in length during the cooking process. Conversely, *Nol bora* displayed the lowest KER (0.903 mm). These results suggest variations in the water absorption and elongation capacities of the *Bora* rice variet ies, influencing their texture and appearance after cooking. Both Length and Breadth ratio influence the elongation of rice after cooking (Singh *et al*., 2005; Danbana *et al*., 2011) [35, 10].

The correlation analysis revealed the relationships among the parameters of all the varieties of *bora* rice. Correlation value clearly indicates the relationship in grain length and uptake of water, which is similar to the findings of Altheide *et al*. (2012) [2]. Similarly, the significant negative relationship between grain length, width, kernel length and cooking time, clearly indicates the significance of grain quality traits in terms of cooking property of the rice variet ies.

Conclusion

The comprehensive analysis of morphometric grain quality and cooking properties of *bora* rice varieties highlights the remarkable diversity within this rice group. These variations emphasize the importance of selecting appropriate *bora* rice varieties based on specific applications and consumer preferences. While all *Bora* rice varieties exhibited commendable properties, a select few, namely *Joha bora*, *Aghoni bora*, *Nol bora*, *Dhepa bora*, Black rice, *Ghee bora*, *Ronga bora*, and *Malbhog bora*, showcased slightly superior attributes. These findings offer valuable insights for the selection, utilization, and promotion of specific *bora* rice varieties, paving the way for future research to refine variet ies and optimize their applications in diverse culinary and food contexts.

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