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Performance of Legendary Local Fragrant Rice in Bangladesh

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Authors' contributions

All authors were involved in the conception of the idea of the study. All authors helped for collecting the data and first author analyzed the data. All authors interpreted the data and drafted, read, and approved the final manuscript. After all, the second author supervised the research team and reviewed the manuscript to make a good frame work.

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ABSTRACT

Conventional cooking is just enough for rice hunger but, aromatic rice adds special dimension when cooked for its characteristic distinct flavor. Investigation aimed to evaluate the performance of most preferable aromatic rice cultivars in Bangladesh. Five cultivars differ significantly among them for physical, physico-chemical and cooking qualities, respectively. With the comparison of this quality Radhunipagol perform better over Basmati (checked). The use of these rice cultivars may improve the socio-economic condition for its excellent grain quality characteristics, preference and overall acceptability than that of Katarivug, Sarnalota and Tulshimala.

Keywords: Basmati; Radhunipagol; physical; physico-chemical; cooking traits.

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1. INTRODUCTION

Aromatic rice is a delicious exportable excellent product of Bangladesh with distinctive and attractive flavor which creates hunger and it is also very much suitable for better health and digestion. Individual preferences varied, most of the consumer's preferred imported rice but differed in their preferences for the local rice [1]. Aromatic rice (*Oryza sativa* L.) is known for its characteristic fragrance when cooked [2]. Rice grain quality are largely determined by the properties of the milling quality, size, shape and appearance; nutritional value cooking and eating characteristics [3], are influenced by the properties of gelatinization temperature, amylose content, gel consistency test and grain elongation and preferences from one group of consumer to another [4]. And finally, the most important quality parameter is an aroma. Numerous varieties of rice are aromatic, ranging from the famous Basmati to much lesser known Radhunipagal. It can be used just like conventional rice for cooking, but adds a new dimension of flavor and aroma to meals.

Descriptive sensory analysis and instrumental analysis have identified about 200 volatile compounds present in rice. However, after over 30 years of research, little is known about the relationships between the numerous volatile compounds and aroma/flavor. But only one compound, 2-acetyl-1-pyrroline (2-AP) has been confirmed to contribute a characteristic aroma [5]. Aroma in scented rice depends on the levels of *2-acetyl-1-pyrroline* content and it varies with genetic and environmental conditions [6]. Aroma, hardness and roughness depend on temperature and variety specific which affects the sensory properties of cooked rice [7].

With the increase of temperature, starch granules in the transactional endosperm were changed from regular shape and closely and orderly arranged to various shape and chaotically arranged with obvious natural gaps between starch granules, which was closely consistent with the poorer appearance quality under the higher temperature, which indicated that the endosperm chalkiness structure is closely related with appearance quality of aromatic rice [8]. Soft textured, white spots occurring in the middle part on the ventral side (side on which the embryo lies) are called white belly (Abdominal white). A white chalky region extending to the edge of the ventral side and towards the center of the endosperm is called a white centre. A long white streak on the dorsal side is called the white back. The heritability of this character seems to be low, because the various agronomic practices and pre-harvest handling, together with the other maturity factors, are found to influence the expression of chalkiness to some extent [9].

Bhattacharya and Sowbhagya [10], observed that water uptake and cooking time are strongly influenced by size and shape of rice grain and only marginally by gelatinization temperature. Middle East consumers prefer rice with a strong aroma. They believe that rice without a distinct aroma is like food without salt [11]. In context of Bangladesh, with the Middle East preferences the present investigation was done to evaluate the most distinctive and attractive aromatic rice cultivar to impart a better socio-economic condition of farmers by earning more foreign currencies.

2. MATERIALS AND METHODS

The Investigation was conducted in the Laboratory of Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, on December, 2014 to evaluate the most attractive and impressive fragrant local rice cultivars.

2.1 Cultivars Used and Design of Investigation

Five aromatic and scented fine grained rice cultivars were used under this study *viz.,* Basmati, Sarnalota, Katarivug, Radhunipagol and Tulshimala. These were collected from different areas of Bangladesh namely-Kustia as native rice, Sherpur, Kashimpur, Dinajpur and Sreebardi, respectively, after completion of good harvest form field. Basmati was used as checked cultivar. After collection, the rice cultivars were placed for data recording with four replications by following the Completely Randomized Design (CRD).

2.2 Data Collected

2.2.1 Brown Rice (BR) yield

Hundred (100) grams of rough rice seeds were dehulled using a standard dehusker and the average whole-grain BR yield was determined [12].

2.2.2 Hull percentage

100 g of rice seeds were de-hulled using a standard de-husker and the average whole-grain yield was calculated [13].

2.2.3 Head rice recovery (HRR)

Hundred grams of de-hulled rice grains that had no visible breakage and ¾ size grains were used to determine the head rice recovery. The percentage of HR and broken rice were calculated using the standard formula [12].

2.2.4 Chalkiness of endosperm

The degree of chalkiness was determined using milled rice by observing under stereo-zoom microscope. Based on the observation the chalkiness of the endosperm was classified into white belly (WB), white centre (WC) and white back (WB) [12].

2.2.5 Chalk index determination

Ten de-husked rice grains were placed on light box and visually identified the grain with more than 50% of chalkiness, weighed and percentage of chalkiness was calculated [12].

2.2.6 Aroma

To 5 g of rice 15 mL of water was added, soaked for 10 min and cooked for 15 min, transferred into a Petri dish and placed in refrigerator for 20 min. Then the cooked rice was smelled by a random panel: strongly scented (SS); mild scented (MS); non-scented (NS) [14].Twenty (20) undergraduate and post-graduate students were randomly selected to take the smell from random panel. They were divided into four replications, 5 students in each replication and then the responses from each replication were summarized into SS, MS, and NS as described above.

2.2.7 Water uptake

2 g of samples were taken in graduated test tubes with 10 mL of water and soaked for 30 min. Boiled for 45 min at 77 to 80℃ in a constant temperature water bath. 2-3 test tubes were kept with 10 mL of water as control in the water bath without rice grains. Immediately the tubes were placed in a beaker containing cold water for cooling. The supernatant was poured into graduated cylinder after cooling and note the water level. Water uptake was calculated using the following formula: Water uptake = 100 /2 g × actual water absorbed [13].

2.3 Statistical Package Used

The data obtained for different characters were statistically analyzed following the analysis of variance techniques by using WASP-Web Agri Stat Package 1.0 and the treatment means were compared by Least Significant Difference (LSD) at 5% level of probability.

3. RESULTS AND DISCUSSION

The present study revealed that, aromatic rice cultivars can perform better on the basis of different physical and physico-chemical and cooking attributes in Bangladesh are described under this section.

3.1 Brown Rice Yield (%)

Radhunipagol gave the highest yield at de-husking in Laboratory over Basmati, Sarnalota, Tulshimala, respectively. Katarivug gave lowest yield in Laboratory (Table 1). It means that, Radhunipagol gave maximum amount of brown rice during hulling. The marketing values of rice as an agricultural product depend on its physical qualities after the harvesting [15]. The percentage of whole grain is the most important parameter for the rice processing industry [16]. In lieu of literature, Radhunipagol is preferable for maximum brown rice yield (%).

3.2 Hull (%)

Hull percentage varied significantly among five cultivars (Table 1). Hull percentage ranged from 22.66% to 35.19%. Katarivug gave the highest hull percentage over Tulshimala, Sarnalota and Basmati. But Radhunipagol gave the lower hull percent. Generally, the hulls form 20 to 22% of the rough rice, although variation of 18 to 26% has been recorded [12]. So, the result of our present study is supported by this literature more or less. So, Radhunipagol has better BRY as aromatic rice with lower hull percentage.

3.3 Head Rice Recovery (HRR %)

Radhunipagol gave the maximum percent of head rice recovery over Basmati. Tulshimala and Sarnalota performed with the similar results. But Katarivug gave the minimum head rice recovery

during hulling (Table 1). But, for quality evaluation, HR recovery is one of the most important characters and more than 65% of HR recovery is desirable [17]. Our result is supported by this literature. HR value depends on the grain type, chalkiness, cultivation practices and drying condition [18]. If fine rice has higher broken percentage then its marketability will be reduced. Head rice recover ability is an inherited trait although environmental factors such as temperature and humidity during ripening and post harvest stages are known to influence grain breakage during milling [19].

3.4 Chalkiness of Endosperm

Radhunipagol performed similar view on kernel with Basmati. From the present study, it means that, very minute areas of chalk (White centre) were present in Radhunipagol and Basmati. In (Table 2), there were seems a more portions (White belly) of chalk in the endosperm of Katarivug and Tulshimala. Sarnalota contains large areas of chalk (White back) than that of other cultivars. The chalky grains reduce the palatability of cooked products, thus the presence of more than 20% chalkiness in rice kernels is not acceptable in world markets [20]. Grain shape and endosperm opacity are major attributes that determine the appearance quality. The greater amount of chalkiness in the grain indicates that it is more prone to grain breakage during milling, which results in lower HR recovery [21].

3.5 Chalk Index Determination (%)

The rice varieties having minimum amount of chalkiness are considered as good quality grains in comparison with chalky once which decrease the rice grain quality [22]. Our present study showed that, with the comparison of chalkiness of endosperm, Radhunipagol performed same trend in case of chalk index determination (%), since it contains lowest percent of chalk on endosperm, which was similarly found with Katarivug. Basmati contains more chalk over Radhunipagol and Katarivug. But Tulshimala and Sarnalota contains highest amount of chalk in the endosperm, those were statistically similar (Table 2). But chalk index determination of better cultivar exceeds the acceptable limit of chalkiness in endosperm, the limit announced by [20].

Table 1. Physical traits of local aromatic rice cultivars

Rice cultivar	Brown rice yield (BRY) (%)	Hull (%)	% Head rice recovery (HRR)
Basmati	74.39 b	24.79 d	62.88 b
Sarnalota	69.12 c	29.88 c	57.13 c
Katarivug	63.09 d	35.19 a	50.23 d
Radhunipagol	77.21 a	22.66 e	66.38 a
Tulshimala	67.28 c	33.22 b	55.79 c
LSD (0.05)	2.411	1.691	2.03
Significance level	**	**	*

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.; ** indicate significant at 5% and 1% level of probability, respectively.*

Table 2. Physico-chemical and cooking traits of local aromatic rice cultivars

Rice cultivar	Chalkiness of endosperm	Chalk index determination (%)	Aroma	Water uptake (%)
Basmati	White centre	35.23 b	MS	22.21 c
Sarnalota	White back	38.79 a	MS	34.38 a
Katarivug	White belly	31.86 c	OTB	29.05 b
Radhunipagol	White centre	30.25 c	SS	21.80 c
Tulshimala	White belly	39.96 a	OPS	33.09 a
LSD (0.05)		2.133		2.450
Significance level		*		*

SS: Strongly Scented; MS: Mild Scented; OPS: Optimal Scented; OTB: Other than Basmati; WB: White belly; WB: White back; WC: White centre. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 % level of probability.; indicate significant at 5% level of probability.*

3.6 Aroma

Context of present study, the performance of aromatic rice significantly depends on its aromaticity, which was determined by aroma grading on smell. Literature showed that, Radhunipagol got maximum aroma score (2.6) than other landraces tested by a human panel of rice experts [23]. The present study (Table 2) revealed that, Radhunipagol gave more aroma than that of checked (Basmati). Tulshimala gave the optimum aroma on smelling. Basmati and Sarnalota perform same trends on aroma during smelling. But Katarivug contains aroma that is other than Basmati rice. [5], reported that Basmati rice contains more aroma than the traditionally cultivated scented rice varieties. [5], reported that in Basmati rice 2-acetyl-1-pyrroline (2-AP) is the major aromatic compound which is responsible for the fragrance and quantity of 2-AP varies with varieties and climatic conditions. We found that, Radhunipagol emits more aroma than Basmati (Checked).

3.7 Water Uptake (%)

The cooking quality significantly depends on the water up taken by rice during boiling. From perspectives of present result, Radhunipagol takes much lower water during cooking, which was statistically similar with Basmati followed by Katarivug. Sarnalota and Tulshimala take higher amount of water during cooking (Table 2). Increasing the soaking temperature decrease the cooking time and water uptake also due to the stronger structure of rice starch as a result of gelatinization process [24]. Water uptake is considered an important economic attribute of rice as it gives indirect measure of volume increase on cooking. Water uptake shows a positive and significant influence on grain elongation, while volume expansion did not influence grain elongation as reported by [25]. Our results ranged from 218 to 343%. [26], reported that the good cooking rice varieties have water absorption value ranging between 174 and 275%, whereas majority of those showing pasty appearance have value as high as from 300 to 570%. He concluded that high water absorption is relatively less desirable characteristics and it would be desirable to select a variety or hybrid with moderate water absorption.

4. CONCLUDING REMARKS

Aromatic rice has export-worthy bright future in Bangladesh. But only grain quality and varietal screening need to be improved to change the status of aromatic rice production in Bangladesh. Basmati is most preferable aromatic rice in Indian-subcontinent. Five rice cultivars varied significantly with physical, physic-chemical and cooking traits, respectively. But our present study shows that, Radhunipagol may be substitutable of Basmati in Bangladesh. Because, it retains all the qualities which were retained by Basmati as more or less same pattern. Since the fate of aromatic rice attractively depends on aromaticity. So from this perspective, Radhunipagol can perform better over Basmati. Grain chalkiness is much clear in Radhunipagol to give transparent appearance. Cooking water uptake (%) is also lower for Radhunipagol. The overall grain quality can be improved by following the options mentioned at below:

- Knowledge of these physical properties of rice cultivars is of fundamental importance during the harvesting of grains, transporting, design and dimensioning of correct storage procedure, manufacturing and operating different equipments used in post harvesting main processing operations of these products [27].
- A gene with homology to Betaine Aldehyde Dehydrogenase (BAD) has significant polymorphisms in the coding region of fragrant genotypes relative to non fragrant genotypes [28]. BAD2, BADEX7-5 and SCUSSR1 markers can be used for aroma detection among recombinant inbred lines and there is a strong correlation among aroma, BAD2 and chromosome 8 [29]. By which the development of high yielding aromatic rice can be possible in future from local legendary cultivars through gene injects.
- Chalkiness mainly, white belly can be decreased with increasing drying time [24].
- Drying at low temperature for low final moisture content could be able to keep higher head rice yield [30].

5. LIMITATION OF THE PRESENT STUDY

All the basic and scientific research need more and more trails to draw the final conclusions; it may be more than 2/3 years. But, in our present study we only give the mean data from two simultaneous experiments with same pattern and same procedures. So, from our side it may be the main limitation for our present manuscripts but, although the present results got from two trials but it contains all the original and sincere

data. We suggest the future scientists who will conduct the experiment with aromatic rice should include the more cultivars and should conduct the research more than 2 or 3 years or 3 or 4 seasons in different location to verify the findings of our present study which will be better for aromatic rice growers and eaters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tomlins KI, Manful JT, Larwer P, Hammond L. Urban consumer preferences and sensory evaluation of locally produced and imported rice in West Africa. Food Qual Preference. 2005;16(1):79-89.
2. Abdul MS, Muaharaf H, ATMJ M, Hosneara H, Monirul I, Shamsher A, Shamsul HP. SSR marker-based molecular characterization and genetic diversity analysis of aromatic landreces of rice (*Oryza sativa* L.). J Biosci Biotechnol. 2012;1(2):107–116.
3. Tan YF, Li JX, Yu SB, Xing YZ, Xu CG, Zhang Q. The three important traits for cooking and eating quality of rice grains are controlled by a single locus in an elite rice hybrid, Shanyou 63. Theor Appl Genet. 1999;99(3-4):642-648.
4. Sellappan K, Datta K, Parkhi V, Datta SK. Rice caryopsis structure in relation to distribution of micronutrients (iron, zinc, β-carotene) of rice cultivars including transgenic Indica rice. Pl Sci. 2009;177(6): 557-562.
5. Champagne ET. Rice aroma and flavor: A literature review. Cereal Chem. 2008; 85(4):445-454.
6. Nadaf AB, Krishnan S, Wakte KV. Histochemical and biochemical analysis of major aroma compound (2-acetyl-1-pyrroline) in basmati and other scented rice (*Oryza sativa* L.). Curr Sci Bangalore. 2006;91(11):1533.
7. Yau NJN, Huang JJ. Sensory analysis of cooked rice. Food Qual Preference. 1996;7(3):263-270.
8. Xu ZJ, Xiao LZ, Liu H, Ren YH, Li ZL. Effect of temperature during grain filling stage on endosperm structure and appearance quality of aromatic rice. Int Adv Mater Res. 2012;460:286-289.
9. Kaul AK. Earlier generation testing for quality characters. II. Rice. Indian J Genet Pl Breed. 1970;303:237-243.
10. Bhattacharya KR, Sowbhagya CM. Water uptake by rice during cooking. Cereal Sci Today. 1971;16:420-424.
11. Seraj S. Morphological, physio-chemical and SSR linked molecular characterization of some exotic aromatic rice lines. Doctoral Dissertation. Department of Genetics and Plant Breeding. Bangladesh Agricultural University, Mymensingh-2202; 2013.
12. Dela CN, Khush GS. Rice grain quality evaluation procedures. In: Singh RK, Singh US, Khush GS, editors. Aromatic rices. Publisher, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi and Calcutta. 2000;15-28.
13. Anonymous. Laboratory manual on rice grain quality procedure. Directorate of Rice Research, Rajendranagar, Hyderabad, India. 2004;1-20.
14. Sood BC, Siddiq EA. A rapid technique for scent determination in rice. Indian J Genet. 1978;38:268-271.
15. Ghadge PN, Prasad K. Some physical properties of rice kernels: Variety PR-106. J Food Process Technol. 2012;3:175.
16. Marchezan E. Grãosinteirosemarroz (Whole rice kernels in rice). Lavoura Arrozeira. 1991;44:3-8. Frence.
17. Bhonsle SJ, Sellappan K. Grain quality evaluation of traditionally cultivated rice varieties of Goa, India. Recent Res Sci Technol. 2010;2(6):88-97.
18. Dipti SS, Bari MN, Kabir KA. Grain quality characteristics of some Beruin rice varieties of Bangladesh. Pakistan J Nutr. 2003;2(4):242-245.
19. Shobha RN. Quality considerations in developing rice hybrids. In: Winter school on advances in hybrid rice technology. Org. DRR, Hyderabad, India. 2003;145-159.
20. Cheng FM, Zhong LJ, Wang F, Zhang GP. Differences in cooking and eating properties between chalky and translucent parts in rice grains. Food Chem. 2005; 90(1):39-46.
21. Khush GS, Paule CM, De la Cruz NM. Rice grain quality evaluation and improvement at IRRI. In Proceedings of the workshop on chemical aspects of rice grain quality. International Rice Research Institute, Manila, Philippine. 1978;21-31.

22. Zhang Z, Zhang S, Yang J, Zhang J. Yield, grain quality and water use efficiency of rice under non-flooded mulching cultivation. Field Crops Res. 2008;108(1): 71-81.
23. Jana A, Bhattacharyya N, Bandyopadhyay R, Tudu B, Mukherjee S, Ghosh D, Roy JK. Fragrance measurement of scented rice using electronic nose. Int J Smart Sens Intell Syst. 2015;8(3).
24. Soponronnarit S, Nathakaranakule A, Jirajindalert A, Taechapairoj C. Parboiling brown rice using super heated steam fluidization technique. J Food Eng. 2006;75(3):423-432.
25. Sood BC, Saddiq N. Current status and future outlook for hybrid rice technology in India. Hybrid Rice Technology, Directorate of Rice Research, Hyderabad. 1986;1-26.
26. Zaman FU. Genetic studies on some of the cooking and nutritive qualities of cultivated rice (*Oryza sativa* L.). Doctoral dissertation, Ph. D. Thesis. University of Muzaffarpur, Bihar, India; 1981.
27. Ghadge PN, Vairagar PR, Prasad K. Some physical properties of chickpea splits (*Cicer arietinum* L.). Agricultural Engineering International, the CIGR Ejournal, X. Manuscript FP 07 039; 2008.
28. Bradbury LM. Identification of the gene responsible for fragrance in rice and characterisation of the enzyme transcribed from this gene and its homologs. Doctoral Dissertation, School of Environmental Science and Management, Southern Cross University, Lismore, NSW Australia. 2009; 91.
29. Kumari P, Ahuja U, Jain S, Jai RK. Fragrance analysis among recombinant inbred lines of rice. Asian J Pl Sci. 2012; 11(4):190.
30. Hasmi J, Shimizu N, Kimura T. Physical and cooking properties of aromatic rice during drying process by batch type dryer. ASAE Annual Meeting Report. American Society of Agricultural and Biological Engineers, St. Joseph, Michigan. 2006; 066199.

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