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Changes in the milling and physicochemical properties of aromatic rice with aging under different storage container

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Abstract: The effect of four different storage structures and storage duration on the milling and physicochemical properties of aromatic rice grain were studied during the eighteen months storage period beginning from January 2005 to June 2006. Four different types of storage container namely, earthen pot (motka), airtight metal container (Tin), plastic bag with pore and airtight plastic container (pot) with two aromatic rice varieties viz. Kataribhog and BRRI dhan37 were used as treatment with four replications in this experiment. Milling and physicochemical properties such as, milling outturn, head rice outturn, 1000 grain weight, grain length, length breadth ratio, grain elongation ratio, volume expansion ratio, protein content and amylose content were recorded at initial stage (before storage) and after eighteen months of storage. Storage container did not significantly affect all the studied parameters except 1000-grain weight and volume expansion ratio. Maximum volume expansion ratio was found in airtight plastic container stored grain that was statistically similar to airtight metal container. Whereas head rice outturn, 1000-grain weight, grain length, grain elongation ratio, volume expansion ratio and cooking time were significantly affected by storage duration. Highest milling outturn, grain elongation ratio, volume expansion ratio and cooking time were found in eighteen months aged grain irrespective of storage container. Aroma intensities decreased with increasing storage duration. All the studied parameters except volume expansion ratio were significantly affected by varieties. The interaction between storage container and duration was insignificant in respect of all grain quality parameters except 1000-grain weight and volume expansion ratio.

Key words: Storage container, storage duration, milling and physicochemical properties, aromatic rice

Introduction

Rice storage facilities are also an acute problem in this country. Farmer's of Bangladesh use various traditional storage structures to store their grains or seeds of various crops including rice such as *dole*, *kolshi*, *motka*, plastic bag, steel drum, kerosene or biscuit tin, polythene bag etc. Grain qualities vary due to the effects of these structures. However, the environment and characteristics of some of these structures are not suitable for grain storage even up to the next few years. It is well known that eating quality of rice undergoes remarkable change during storage. Newly harvested rice when cooked becomes a sticky or pasty mass, swells only slightly and leaves a thick gruel (excess cooking water). These properties change dramatically upon storage for a few months. The rice then swells more easily, the cooked rice becomes more flaky and the gruel becomes thin (Yealandur, 1978). Deterioration of eating quality is mainly related to the change in texture, flavor and taste, especially in texture. These changes are important in evaluation of qualities of rice (Juliano, 1985)**.** Research has shown that rough rice storage history can affect head rice yield and cooking quality of rice. (Hamaker *et al.* 1993; Tamaki *et al.* 1993.). The actual damage of grain occurs under storage conditions of high humidity (above 70%) and high temperature (25-35^{0}C) (Araullo *et al.,* 1977). It has been also reported that the success of grain storage is always dependent on the preservation of its food value, viability and reduction of loss of the stored grain (Mondal *et al.*, 1984). There are few studies on the long –term storage of rough rice. The study on long-term (18 months) storage would reveal more clearly the nature of change in eating quality of aromatic rice. The present work was under taken to assess the efficiency of storage containers like earthen pot, metal container, plastic bag and plastic pot to monitor grain quality of aromatic rice for eighteen months storage period.

Materials and Methods

The study was conducted at the Agronomy laboratory of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bagladesh during January 2005 to June 2006. Four different types of storage container namely, Earthen pot (*motka*), airtight metal container (Tin), plastic bag with pore and airtight plastic container (pot) with two aromatic rice varieties viz. Kataribhog and BRRI dhan37 were used as treatment in a CRD design with four replications. After proper drying 5-6 kg rice grain were put in each storage structure and kept undisturbed for eighteen months from January 2005 to June 2006 in laboratory conditions. Grain samples were tested for physicochemical properties before storage and after eighteen months of storage. After drying, required of grain samples of appropriate sizes from each container were taken randomly to record physicochemical parameters. Samples were milled raw and analyzed for physicochemical properties. Grain physicochemical properties were measured at Grain Quality and Nutrition Division Laboratory, Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. Milled rice outturn was determined by dehulling 200g rough rice in a Satake Rice Mill, followed by 75 second polishing in Satake Grain Testing Mill TM-05. Head rice outturn was determined by separating broken from milled rice by hand. Milled rice outturn and head rice outturn were expressed as percentage of rough rice. Digital slide calipers measured grain length and breadth. Protein content was calculated from nitrogen and it was determined by the micro Kjeldahl method (Juliano *et al.*, 1968. Aroma of cooked kernels was tested by the procedure of Sood and Siddiq (1978). Volume of cooked and milled rice was measured by water displacement. Data were analyzed following the ANOVA technique and mean differences were adjudged with Duncan's Multiple Range Test (DMRT).

Results and Discussion

Storage container did not significantly affect all the studied parameters except 1000-grain weight and volume expansion ratio (Table 1). Maximum volume expansion ratio (5.13) was found in plastic container stored grain that was statistically similar to metal container. Minimum

volume expansion ratio (4.63) was found in stored grain in plastic bag. Changes during storage include increases in grain water absorption and volume expansion (Tsugita *et al.*1983). Highest 1000-grain weight (12.34g) was found in metal container stored grain that was statistically similar to plastic container but lowest 1000-grain weight (12.16g) was found in earthen pot grain that was statistically similar to plastic bag. There was not much variation in aroma in the cooked rice from all storage containers but variation was observed due to varieties and storage duration as evident from the sensory evaluation method used (Data was mentioned in Table 1). Head rice outturn, 1000-grain weight, grain length, grain elongation ratio, volume expansion ratio and cooking time were significantly affected by storage duration (Table 1).

Table 1. Influence of storage container and storage duration on the milling and physicochemical properties of aromatic rice varieties

Treatment	Milling and physicochemical properties									
	Milling outturn (%)	Head rice outturn (%)	1000-grain weight (g)	Grain length (mm)	Length Breadth ratio	Grain elongation ratio	Volume expansion Ratio	Protein (%)	Amylose (%)	Cooking time (min)
Storage container										
C_1	70.37	62.47	12.16b	5.24	2.93	1.91	4.83bc	6.24	24.17	17.50
C_2	70.58	62.90	12.34a	5.22	2.94	1.94	4.95ab	6.24	24.21	17.83
C_3	70.44	62.29	12.17b	5.25	2.95	1.89	4.63c	6.24	24.23	17.42
C_4	70.31	62.93	12.30a	5.21	2.96	1.93	5.13a	6.25	24.23	18.00
Level of significance	NS	NS	0.05	NS	NS	NS	0.01	NS	NS	NS
Storage duration										
D_1	70.50	61.67	12.52	5.27	2.93	1.87	4.30	6.26	24.25	16.50
D_2	70.35	63.63	11.97	5.19	2.96	1.96	5.47	6.24	24.17	18.88
Level of significance	NS	0.01	0.01	0.01	NS	0.01	0.01	NS	NS	0.01
Variety										
V_1	70.82	66.25	10.85	4.99	2.82	1.80	4.85	6.32	24.62	16.00
V_2	70.03	59.05	13.64	5.48	3.08	2.03	4.92	6.18	23.80	19.38
Level of significance	0.05	0.01	0.01	0.01	0.01	0.01	NS	0.01	0.01	0.01
CV (%)	4.57	4.04	2.19	3.21	2.26	2.83	5.41	2.69	2.10	3.26

In a column, means having common letter(s) do not differ significantly at 5% level of probability. Storage container: C_1- Earthen pot (*Motka*), C_2- Metal container (Tin), C_3- Plastic bag, C_4- Plastic container (Pot); **Storage duration:** D_1-0 month (before storage), D_2-18 months(after storage); Variety: V_1- Kataribhog, V_2- BRRI dhan 37

Table 2. Influence of storage container and storage duration on the milling and physicochemical properties of aromatic rice varieties

Treatment	Milling and physicochemical properties									
Container x Duration	Milling outturn (%)	Head rice outturn (%)	1000-grain weight (g)	Grain length (mm)	Length Breadth ratio	Grain elongation ratio	Volume expansion ratio	Protein (%)	Amylose (%)	Cooking Time (min)
C_1 D_1	70.50	61.67	12.52a	5.27a	2.93	1.87c	4.3d	6.26	24.25	16.50d
C_1D_2	70.24	63.27	11.81c	5.21ab	2.93	1.95ab	5.36b	6.23	24.08	18.50bc
C_2 D_1	70.50	61.67	12.52a	5.27a	2.93	1.87c	4.3d	6.26	24.25	16.50d
C_2 D_2	70.67	64.13	12.16b	5.18b	2.95	2.01a	5.61b	6.23	24.17	19.17ab
C_3D_1	70.50	61.67	12.52a	5.27a	2.93	1.87c	4.30d	6.26	24.25	16.50d
C_3D_2	70.38	62.92	11.83c	5.23ab	2.97	1.91bc	4.97c	6.23	24.22	18.33c
C_4D_1	70.50	61.67	12.52a	5.27a	2.93	1.87c	4.30d	6.26	24.25	16.50d
C_4D_2	70.13	64.19	12.07b	5.16b	3.00	1.98a	5.96a	6.25	24.20	19.50a
Level of sign.	NS	NS	0.05	NS	NS	NS	0.01	NS	NS	NS
CV (%)	4.57	4.04	2.19	3.21	2.26	2.83	5.41	2.69	2.10	3.26

* In a column, means having common letter(s) do not differ significantly at 5% level of probability, Storage container: C_1- Earthen pot (*Motka*), C_2- Metal container (Tin), C_3- Plastic bag, C_4- Plastic container (Pot); Storage duration: D_1-0 month (before storage), D_2-18 months(after storage).

Highest head rice outturn (63.63%), grain elongation ratio (1.96), volume expansion ratio (5.47) and cooking time (18.88 min) were found in eighteen months aged grain irrespective of storage container. In general, head rice yield increased with storage duration for all the storage conditions. This confirmed results from Pearce *et al.* (2001). Long-stored rice expands more during cooking and increases in its surface area as compared to newly

harvested rice. Amylose content was not significantly varied due to storage duration. Yelandur (1978) reported similar result. They reported that the total amylose content seemed to remain unchanged in the samples during storage up to 1.5 years. Aroma intensities decreased with increasing storage duration. Similar result was reported by Meullenet *et al*., (2000). They reported that aroma notes decreased with increasing storage duration.

All the studied parameters except volume expansion ratio were significantly affected by varieties (Table 1). Between the one local and one modern aromatic variety, Kataribhog recorded the highest milling outturn (70.82%) and lowest (70.03%) in BRRI dhan37. Head rice outturn was the highest (66.25%) in Kataribhog and lowest (59.05%) in BRRI dhan37. Thousand grain weight (13.64g), grain length (5.48 mm), length breadth ratio (3.08), grain elongation ratio (2.03) and cooking time (19.38 min.) were higher in BRRI dhan37. Slightly higher aroma was found in Kataribhog than BRRI dhan37.

The interaction between storage container and duration was insignificant in respect of all grain quality parameters except 1000-grain weight and volume expansion ratio (Table 2).

Therefore, it may be concluded that better quality grain is found in respect of grain physicochemical properties under eighteen months stored grain in airtight metal and plastic container. The superior performance of aged grain might also be owing to improvement in physical, chemical properties of grain and microbiological environment of storage container through maintain moisture level. The results confirm the earlier findings of Meullenet *et al.*, 2000. They also reported that rice quality could be optimized by carefully controlling some of the post harvest conditions such as rough rice storage moisture content, storage temperature and duration.

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