Effect of Harvesting Time on the Milling and Physicochemical Properties of Aromatic Rice

M.F. Hossain[1,*], M.S.U. Bhuiya[2], M. Ahmed[2] and M.H Mian[3]

[1]Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh
[2]Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh
[3]Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh

**Corresponding author. Email: faridhossain04@yahoo.com*

Abstract

A field experiment was conducted in *aman* season (July-December) 2006 to study the effect of harvesting time on the quality of aromatic rice. The experiment was laid out in a randomized complete block design with three replications. The experiment consisted of three harvesting time viz., 25 days after flowering (DAF), 30 DAF, 35 DAF. Three aromatic rice varieties namely, Kataribhog, Badshabhog and BRRI dhan34 were included in the experiment. It may be concluded that **t**he aromatic rice harvesting at 30 to 35 days after flowering (DAF) was found to be suitable for higher grain quality in respect of head rice outturn, elongation ration, volume expansion ratio and amylose content. Among the tested varieties, BRRI dhan34 and Badshabhog were suitable in respect of head rice outturn and volume expansion ratio than Kataribhog.

Keywords: aromatic rice, harvesting time, milling quality, physicochemical properties

Introduction

Rice (*Oryza sativa* L.) is the staple food of a vast majority of people around the world (Rohilla et al., 2000). It constitutes 95 % cereal consumed and supplies more than 80% of the calories and about 50% of the protein in the diet of the general people of Bangladesh (Yusuf, 1997). Consumer demand for the fine rice varieties is higher due to its good nutritional quality, palatability, taste, cooking quality and fragrance (Kaul et al., 1982). Most of the consumers prefer fine rice varieties with good cooking quality that have aroma. Due to special flavor and taste aromatic rice is highly favored. This quality of rice receives a premium price in the market and has export potential (Arumugachamy et al., 1992). Nature of sensitivity of aroma is a genetic factor, which is highly affected by environmental conditions (Singh et al., 1998). Grain quality is the combination of several physico-chemical characters of the grain. The quality of rice may be considered from the viewpoint of milling outturn, grain size, shape and the behavior upon cooking, the taste and flavor of cooked rice (Dela Cruz and Khush, 2000). The productivity and quality of the aromatic rice depend on the environmental condition of the area where they are grown and the crop management practices followed to grow the crop. Quality traits of aromatic rice are highly influenced by temperature particularly at the time of flowering, grain filling and at maturity (Rohilla et al., 2000). The information may serve not only as a guide to the selection of proper site for rice production but also the most desirable period for sowing and harvesting (Moumita et el., 2006). Timely harvesting of rice also ensures good quality with higher yield (Ali et al., 1990). Grain yield and its quality depend on the right judgment at harvesting. Farmers usually harvest transplant *aman* rice at or beyond the full maturity stage and keep it in the field quite a long time for drying in Bangladesh (Ali et al., 2000). It is, therefore,

essential to evaluate the performance of indigenous and modern aromatic rice varieties through appropriate harvesting time to get maximum quality. Here we report interesting findings about these.

Materials and Methods

The experiment was conducted at Hajee Mohammad Danesh Science and Technology University Farm, Dinajpur, Bangladesh during *aman* season (July- December) of 2006. The experimental site was a medium high land with loamy soil having a pH value 6.0. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4.0m × 2.5m. The 30 days old seedlings were transplanted at a spacing of 20cm×15cm using three seedlings $hill^{-1}$. All other cultural practices were done uniformly as per recommendation. Flowering time was recorded when 50% panicles flowered. The crop was harvested at three times i.e. at 25, 30 and 35 days after flowering (DAF) as per treatments. Two local and one modern aromatic rice varieties namely, Kataribhog, Badshabhog and BRRI dhan34, respectively were included in the experiment. Whole plots were harvested to obtain grain yield. After drying, required grain samples of appropriate sizes from each plot were taken randomly to record physical and chemical parameters. Samples were milled raw and analyzed for physical and chemical properties. Grain physical and chemical properties were measured at Grain Quality and Nutrition Division Laboratory, Bangladesh Rice Research Institute, Gazipur. 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 and milled rice respectively. Grain length and breadth were measured by slide calipers. Amylose content was determined by the procedure of Juliano (1971). Protein content was calculated from nitrogen and it was determined by the micro Kjeldahl method (Juliano et al., 1968; AOAC, 1970). Volumes of cooked and milled rice were measured by water displacement. Data were analyzed following the ANOVA technique and mean differences were adjudged with Duncan's Multiple Range Test (DMRT). Generally, it was observed that monthly average maximum-minimum day temperature, rainfall, relative humidity gradually decreased from early to late *T. aman* season of Bangladesh (Table 1).

Results and Discussion

Harvesting time and variety effect were found significant to all characteristics studied. All the quality parameters except milling outturn, grain length and volume expansion ratio were significant affected by the interaction of harvesting time and variety.

Effect of Harvesting Time

Milling and physicochemical properties:

Harvesting on 35 days after flowering (35 DAF) resulted in highest percentage of milling outturn (71.03%) and lowest milling outturn (67.84%) was obtained from 25 DAF harvesting (Table 2). This result similar to Rahim et al. (1995) who reported that early harvest decreased the milling percentage of grain. Highest percentage of head rice outturn (65.58%) was observed in 35 DAF harvesting and lowest (63.47%) in 25 DAF harvesting. This finding similar to Choudhury and Iqbal (1986), Chowdhury et al. (1999). Grain length was higher (4.30mm) under 30 DAF harvesting that was statistically similar to 35 DAF harvesting and lowest grain length (4.23mm) was found in 25 DAF harvesting. Maximum length breadth ratio (2.67) was observed on 25 DAF harvesting but lower (2.64) in 30 DAF and 35 DAF harvesting. Highest grain elongation ratio (2.11) was found in 30 DAF harvesting that was statistically similar to 35 DAF harvesting. Lowest elongation ratio (1.88) was observed in 25 DAF. This finding agreed with Ali et al. (1993). Volume expansion ration was significantly differing due to harvesting time. Maximum volume expansion ration (4.42) was found in 35 DAF harvesting and minimum (4.14) in 25 DAF harvesting. Highest protein content (6.69%) was obtained from early harvesting (25 DAF) and the minimum (6.47%) from 35 DAF harvesting that was statistically similar to 30 DAF harvesting (Table 2). Similar observation was made

Table 1 Monthly average maximum-minimum day temperature, rainfall and relative humidity of the experimental site in *T. aman* season of 2006.

Weather parameter	Month					
	July	August	September	October	November	December
Max. Temperature (^oC)	33.0	33.4	31.6	32.0	27.6	25.6
Min. Temperature (^oC)	26.6	26.6	25.0	22.6	17.4	13.1
Rainfall (mm)	218	126	340	21	23	08
Relative humidity (%)	81	81	85	80	78	78

Table 2 Effect of harvesting time on the grain quality of aromatic rice.

Treatment	Grain quality property[1/]								
	Milling outturn	Head rice outturn	Grain length	Length breadth ratio	Grain elongation ratio	Volume expansion ratio	Protein	Amylose	Cooking time
	(------ % -------)		(mm)				(------ % -------)		(min)
25 days after flowering (H1)	67.84c	63.47c	4.23b	2.67a	1.88b	4.14c	6.69a	24.41b	13.47a
30 days after flowering (H2)	70.22b	64.99b	4.30a	2.64b	2.11a	4.34b	6.55b	24.74a	13.13b
35 days after flowering (H3)	71.03a	65.58a	4.29a	6.64b	2.09a	4.42a	6.47b	24.98a	13.21b
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV (%)	3.04	3.36	3.99	3.53	3.93	3.06	3.87	3.32	3.22

[1/] In a column, means having common letter(s) do not differ significantly at 5% level of probability.

by Tamaki et al. (1989). Highest amylose content (24.98%) was found in 35 DAF harvesting that was statistically similar to 30 DAF. Lowest amylose content (24.41%) was observed in early harvesting (25 DAF) (Table 2). Cooking time significantly differ due to harvesting time. Higher cooking time (13.47 min) required for early harvested crop (25 DAF) than 30 and 35 DAF harvesting (Table 2). Early harvested crop content higher protein that seemed to restrict starch swelling (25 DAF) as a result increasing cooking time. There was not much variation in cooked rice aroma from all the harvesting time treatment but variation was observed due to varieties as evident from the sensory evaluation method used.

Effect of Variety

Milling and physicochemical properties:

Among the tested varieties, Badshabhog recorded the highest milling outturn (70.38%) and head rice outturn (66.04%). The lowest milling outturn (69.19%) and head rice outturn (63.09%) was found in Kataribhog. Maximum grain length (5.10 mm) was found in Kataribhog and the minimum (3.88 mm) in BRRI dhan34. Kataribhog gave the maximum length breadth ratio (2.99) and minimum (2.47) was found in BRRI dhan34 it was statistically similar to Badshabhog (Table 3). Grain elongation ratio was higher (2.17) in the BRRI dhan34 and lower (1.85) in Kataribhog. Maximum volume expansion ratio was obtained from BRRI dhan34 (4.36) that was statistically similar to Badshabhog and minimum (4.19) was observed in Kataribhog. Protein content was higher (7.01%) in BRRI dhan34 and lower (6.28%) was found in Kataribhog. Highest amylose content (25.28%) was found in BRRI dhan34 and lowest (24.01%) in Kataribhog. Maximum cooking time (14.75 min) was required for Kataribhog and minimum (12.21 min) for Badshabhog (Table 3). There was

variation in aroma in the cooked rice was observed due to varieties as evident from the sensory evaluation method used. Badshabhog was strong in aroma group but Kataribhog and BRRI dhan34 were moderate.

Interaction Effect of Harvesting Time and Variety

Milling and physicochemical properties:

Maximum head rice outturn (66.80%) was obtained from thirty days after flowering harvested Badshabhog (H_2V_2) and minimum (60.77%) from Kataribhog when harvested 25 days after flowering (Table 4). Highest length breadth ratio (3.00) was observed in Kataribhog when harvested 35 DAF that was significantly similar to all harvesting time. Maximum elongation ratio (2.25) was obtained from BRRI dhan34 when harvested 30 DAF and minimum (1.69) was obtained from Kataribhog when harvested 25 DAF. BRRI dhan34 content higher protein (7.24%) when harvested 25 DAF (H_1V_3) and the minimum (6.25%) in Kataribhog when harvested 35 DAF (H_3V_1) that was statistically similar to H_1V_1, H_2V_1, H_2V_2 and H_3V_2. Badshabhog content highest amylose (25.28%) on 35 DAF harvesting that was statistically similar to H_1V_3, H_2V_2, H_2V_3 and H_3V_3. Cooking time maximum (15.00 min) required for Kataribhog when harvested early (25 DAF) that was similar to 30 DAF harvesting for the same variety (Table 4).

Conclusions

The low head rice outturn at early harvest primarily due to the presence of many immature, green, chalky grains, which were easily broken during milling. Maximum volume expansion ration was found in 35 DAF harvesting, probably this could happen due to higher amylose content than early harvested crop. Highest protein content obtained from early than later harvesting. Tamaki et al. (1989) stated that the early maturing stage, the protein content of the rice kernels was very high but it decreased with maturity up to 30-35 days after heading. Lowest amylose content was observed in early harvesting (25 DAF). They reported that amylose content became constant after 30 DAF in nonwaxy rice. Early harvested crop content higher protein that seemed to restrict starch swelling (25 DAF) as a result increasing cooking time. Rohilla et al. (2000) reported that delay in harvesting after maturity may reduce aroma. Main compound of aroma 2-Acetyl-1-pyrolire (2AP) concentration in the brown rice reached a peak at 4 or 5 weeks of heading (WAH) (Itani et al., 2004). From the experiment it may be concluded that the aromatic rice harvesting at 30 to 35 days after flowering was found to be suitable for higher grain quality in respect of head rice outturn, elongation ration, volume expansion ratio and amylose content. Among the tested variety irrespective of harvesting time BRRI dhan34 and Badshabhog were suitable in respected of head rice outturn, volume expansion ratio than Kataribhog.

Table 3 Effect of variety on the grain quality of aromatic rice.

Treatment	Grain quality property[1/]								
	Milling outturn	Head rice outturn	Grain length	Length breadth ratio	Grain elongation ratio	Volume expansion ratio	Protein	Amylose	Cooking time
	(------ % -------)		(mm)				(------ % -------)		(min)
Kataribhog (V1)	69.19c	63.09c	5.10a	2.99a	1.85c	4.19b	6.28c	24.01c	14.75a
Badshabhog (V2)	70.38a	66.04a	3.84c	2.49b	2.05b	4.34a	6.43b	24.86b	12.21c
BRRI dhan34 (V3)	69.78b	64.40b	3.88b	2.47b	2.17a	4.36a	7.01a	25.28a	12.85b
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV (%)	3.04	3.36	3.99	3.53	3.93	3.06	3.87	3.32	3.22

[1/] In a column, means having common letter(s) do not differ significantly at 5% level of probability.

Table 4 Interaction effect of harvesting time and variety on the grain quality of aromatic rice.

Treatment[1/]	Grain quality property[2/]								
	Milling outturn	Head rice outturn	Grain length	Length breadth ratio	Grain elongation ratio	Volume expansion ratio	Protein	Amylose	Cooking time
	(------ % -------)		(mm)				(------ % -------)		(min)
H1V1	67.09	60.77g	5.06	2.98a	1.69g	4.04	6.38e	23.95b	15.00a
H1V2	68.33	65.30b-d	3.81	2.57b	1.89f	4.17	6.53d	24.19b	12.42d
H1V3	68.11	64.35e	3.83	2.44d	2.05d	4.21	7.24a	25.10a	13.00c
H2V1	69.83	63.43f	5.11	2.97a	1.92ef	4.19	6.26e	23.91b	14.96a
H2V2	70.45	66.80a	3.89	2.47cd	2.14c	4.40	6.36e	25.11a	12.17d
H2V3	70.38	64.75de	3.91	2.49c	2.25a	4.42	7.04b	25.22a	12.25d
H3V1	70.65	65.08c-e	5.14	3.00a	1.94e	4.34	6.25e	24.16b	14.29b
H3V2	71.60	66.03b	3.83	2.43d	2.12c	4.46	6.39de	25.28a	12.04d
H3V3	70.84	65.61bc	3.90	2.47cd	2.21b	4.46	6.76c	25.12a	13.29c
Level of significance	NS	0.01	NS	0.01	0.01	NS	0.01	0.05	0.01
CV (%)	3.04	3.36	3.99	3.53	3.93	3.06	3.87	3.32	3.22

[1/] H1=25 days after flowering (25 DAF), H2=30 days after flowering (30 DAF), H3= 35 days after flowering (35 DAF); V1=Kataribhog, V2=Badshabhog, V3=BRRI dhan34

[2/] In a column, means having common letter(s) do not differ significantly at 5% level of probability.

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