http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 6 (19): 1675-1680, 2003
ISSN 1028-8880

Effect of Drying and Tempering on the Milling Quality of Long Grain Aromatic Paddy Processing in Bangladesh

[1]M. Syedul Islam, [2]M. Abdul Ghani, [3]A.K.M. Saiful Islam and [4]M. Anisur Rahman
[1,3]FMPHT Division, Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh
[2]PETRRA/IRRI, House-39, Road- 23, Block-J, Banani, Dhaka, Bangladesh
[4]DEMFRIPT Project, PROVA, GPO Box–15, Rajshahi-6000, Bangladesh

Abstract: Rice production, processing and consumption are part of culture of the Bangladesh population. However, their experiences are very much limited to parboiled paddy for home consumption. Recently, the country attained almost self-sufficiency in paddy production and heading towards production and export of long grain aromatic rice. The milling yield of locally available aromatic rice processed in automatic mills ranged from 50 to 54%, which may be improved by adopting proper processing technology. Two recently developed aromatic rice i.e. BRRI dhan 37 and BRRI dhan 38 are comparatively longer than the existing aromatic varieties which need better processing technology in order to minimize breakage and improve product quality. An industry level experiment was conducted at a rubber roll type automatic rice mill located at North-west region of Bangladesh for processing BRRI dhan 37 and BRRI dhan 38. The initial moisture content of BRRI dhan 37 and BRRI dhan 38 were 13.39 and 12.86 percents respectively. The paddy was sun dried for 4 hours followed by 20 hours tempering everyday; and were dried for 3, 4, 5, and 6 days. The ranges of temperature and relative humidity during drying of paddy were 34-42 °C and 42-79%, respectively. After two days of drying, the moisture content of the paddy reduced to 9%. However, in the following morning the paddy moisture increased up to 10% due to condensation. But the hardness of the kernel was on increasing trend, which is necessary to reduce breakage during milling. The highest crushing strengths of BRRI dhan 37 and BRRI dhan 38 were found 8.0 and 6.76 kg, respectively at 3 days of drying and tempering which are attributed as the proper milling condition for better head rice recovery. Kernel translucency increased with drying duration irrespective of the variety. The highest milling yield of BRRI dhan 37 was 60.2% when samples were dried for 4 days and the highest milling yield of BRRI dhan 38 was 60.1% when samples were dried for 3 days. The highest head rice recovery based on milled rice, of BRRI dhan 37 was 90.4% when samples were dried for 4 days whereas that of BRRI dhan 38 was 84.1% when samples were dried for 3 days.

Key words: BRRI dhan 37, BRRI dhan 38, long grain paddy, sun drying, tempering, unparboiled, rubber roll huller, milling yield, head rice, crushing strength and kernel translucency

INTRODUCTION

Rice plays a significant role in the economy of Bangladesh. It is the staple food as well as an important source of cash income of the Bangladesh farmers. During the last two to three decades of rice research and development, major emphasis was put to increase production through the development of coarse grain high yielding rice varieties in order to feed the growing population of the country. In recent years, the average annual area under rice productions was 10.17 million ha with an annual average production of 28.03 million tons of paddy. There has been a great success in rice production over the last three decades and the country has recently attained self-sufficiency in coarse grain paddy production. At this stage, production, processing and export of quality rice is a means of augmenting farmers as well as national income. A good number of fine and aromatic rice varieties are being produced in the country for quite a long time in the country. But they are grown and marketed in limited quantities. Aromatic varieties are rated best in quality and produce much higher return than high quality non-aromatic rice in international market. Aromatic rice is mainly used for special dishes in hotels, restaurants and daily meals of upper class people. The dishes are locally called *Polau* and *Biriani*, which is served on special occasions. Demand for fine and aromatic rice in recent years has increased to a great extent for both internal consumption and export. Appearance of milled rice is an important consideration to the consumer. Appearance also depends upon the size and shape of the rice kernel, translucency and chalkiness

Table 1: Physico-chemical properties of some fine and aromatic rice of Bangladesh

Variety	Milling yield (%)	Length (mm)	Breath (mm)	L/B ratio	Shape	Amylose content (%)	Protein content (%)	Elongation ratio	Vol. Expansion ratio
Short bold aromatic									
BR5	71	3.6	1.71	2.1	SB	26.0	9.1	1.6	3.4
BRRI Dhan34	73	3.7	1.60	2.3	SB	23.0	10.2	1.4	4.0
Kalijira	72	3.7	1.55	2.0	SB	22.7	6.3	1.4	3.4
Chinigura	-	3.95	1.46	2.7	SB	-	-	-	-
Medium slender aromatic									
BRRI Dhan37	74	5.0	1.51	3.3	MS	23.8	10.3	1.2	3.7
BRRI Dhan38	73	5.4	1.59	3.4	MS	22.6	8.8	1.3	3.7
Katharibhog	69	5.1	1.60	3.4	MS	22.8	8.3	1.3	3.4
Bashmati(BD)	72	5.4	1.74	3.1	MS	24.7	7.3	1.3	3.4

SB: Short Bold MS: Medium Slender, Source: BRRI, 2000 and Tony, 1997.

of the grain. The appearances of most Bangladeshi fine and aromatic rice are good looking, white, translucent, soft, tasty and sticky after boiling. The physical dimensions of rice kernels are of vital important to those engaged in the rice industry and trading in international market. Rice varieties may be classified based upon two physical parameters i.e. length and shape. Length is a measure of the rice kernels in its greatest dimension, while the shape is determined by the length breath ratio. The fine and aromatic rice of Bangladesh may be classified into short bold and medium slender categories. Since 1970, Bangladesh Rice Research Institute (BRRI) developed and released 41 different varieties of rice, among them 4 varieties are aromatic. The physico-chemical properties of those varieties and some prominent local varieties are presented in Table 1.

Moisture content of paddy is one of the determinants for better head rice recovery. The recommended safe moisture level of paddy ranged from 14-16% at which paddy can resist maximum compressive strength (Omar and Yamashita, 1987a; Prasad and Gupta, 1973; Sathel, 1935). Head rice recovery decreased at high moisture level particularly for long variety (Stipe, 1971). Kunze and Hall (1967) reported that moisture gradients were more effective in producing stress cracks than were temperature gradients. Tempering drying gave shorter drying time and less fissuring, hence safer with less grain loss and greater energy saving. Drying temperatures between 35°C and 45°C showed less fissuring effect, depending on varieties. Drying temperatures of more than 45°C resulted in more grain fissure, which cause more grain loss (Omar and Yamashita, 1987b). In the field, alternate drying and wetting cycles due to sun and dew induce cracks in the matured grains. Cracks are induced in the rice kernel if the cut crop left in the field for drying. The cracks are developed in the kernel because they were subjected to hydro-thermal stress. In the day time, the paddy temperature increased substantially, however, at night they become moistened due to dew, which produces hydro- thermal stress in the grain, and hence the kernel inside the hull cracks (Mahadevappa *et al.,* 1969; Mathews and Sapadaro, 1976). In Bangladesh, particularly in the northern region where mostly the long grain and aromatic paddy is produced, the farmers laid the cut crop in the field for drying, which in turn created favorable environment to produce fissures in the grains due to hydro-thermal stress.

There are two milling systems for fine and aromatic rice available in Bangladesh. The smaller mills, which use the Engle berg hullers, are often involved in custom milling. The second milling system involves rubber roll type automatic rice mills and the smaller Chinese automatic mills (output 700-1000 kg h^{-1}), which have started to become popular. Presently rice mills located in different parts of Bangladesh have been processing only locally available short grain aromatic rice; and milling yield of those varieties ranged form 50-54%. Recently, Bangladesh Rice Research Institute developed two aromatic rice varieties i.e. BRRI dhan 37 and BRRI dhan 38. These varieties are comparatively longer than the existing aromatic varieties, which need better processing technology in order to minimize breakage and improve product quality. Therefore, industry level experiment was undertaken through participatory approach among researcher, mill owner, operator and NGO (Non-Government Organization) personnel with an objective to improve the processing technology of long grain aromatic paddy in automatic rice mills through appropriate techniques of drying and tempering.

MATERIALS AND METHODS

Industry level experiment on long grain fine rice processing was conducted in M/s Minar Auto Rice Mill, Namosankarbati area of Chapai Nawabganj district through participatory approach among researcher, mill owner, operator and NGO personnel during May, 2003. Rice mill owner and mill operators have long experience on rice processing technology. Therefore, it was essential to conduct research through participatory method in order to find out the improved processing technology of long grain aromatic rice. Initially, a baseline survey of M/s

Minar Auto Rice Mill was conducted to observe the parameters i.e. drying capacity, milling capacity, head rice recovery, percentage of broken rice, husking efficiency etc. Both parboiled and unparboiled rice was processed in the mill. Basically, they processed chinigura as unparboiled rice. Parboiled as well as a part of unparboiled paddy was sun dried in mill yard. One Lousiana State University (LSU) type mechanical drier with capacity of 12000 kg was installed in the mill yard. In LSU type drier, about 8 hrs times is needed to make the paddy in optimum quality suitable for milling. The milling parameters of chinigura as unparboiled rice were: maximum input capacity 2400 kg h^{-1}, output capacity 1344 kg h^{-1}, milling yield 50-54%, co-efficient of husking 71%, broken rice 20-24%. In sun drying, chinigura needs about 5-7 days to make the paddy suitable for quality milling. The paddy was dried in low temperature and the moisture content was maintained about 11-12%. The paddy was dried up to a maximum removal of white portion (white belly) of the kernel. The removal of white portion is important for two reasons i.e. to maximize the translucent area of kernel and to minimize breakage during milling. Although less time is required in LSU type drier but more head rice can be obtained from the paddy dried under sunshine. Two varieties of fine rice i.e. BRRI dhan 37 and BRRI dhan 38 were used in the experiment. The paddy was procured from the grower during January 2003 and kept in the mill yard storehouse for about two months. At the time of procurement, the moisture content of the paddy was 14%.

The treatments were set as follows with three replications:

T_0 = without sun drying;
T_1 = 4 h sun drying followed by 20 h tempering by stacking for 3 days;
T_2 = 4 h sun drying followed by 20 h tempering by stacking for 4 days;
T_3 = 4 h sun drying followed by 20 h tempering by stacking for 5 days;
T_4 = 4 h sun drying followed by 20 h tempering by stacking for 6 days.

An amount of 30 kg paddy was used for each treatment. Paddy was spread on the drying floor and stirring activity was done at half an hourly intervals. Women labourer was engaged to dry the paddy whereas male labourer was engaged in weighing, bagging and carrying of paddy. Samples were taken at an hourly interval from each treatment to measure the moisture content, temperature, relative humidity, hardness and translucency of the kernel (Plate 1). Laboratory type rubber roll huller was used to dehusk the paddy to measure hardness and translucency of the kernel. Milling experiment for all treatments was conducted in same day. Minar Auto Rice mill is a large mill with high milling capacity, but the sample size was very small. It was very difficult to get finished product if each sample was passed

Plate 1: Paddy drying and data collection

Plate 2: Milling output of BRRI long grain aromatic rice

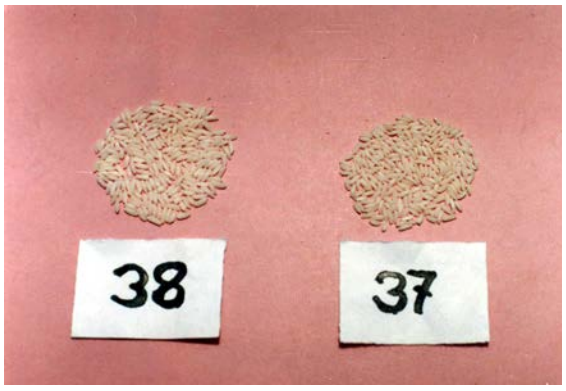

Plate 3: Rice samples of BRRI dhan 37 and BRRI dhan 38

through all the steps of the mill as normally followed for bulk processing of short-bold type aromatic paddy i.e. chinigura and kalijira. So, by-pass system was developed for processing the paddy. Each sample was passed through the vibratory sieve to separate dust, chaff and inert matter. Clean paddy was passed through the rubber roll huller. Major dehusking operation was done in first pass; therefore, it was not necessary to pass the material again in rubber roll huller. The admixture of brown rice and husk from the rubber roll huller was passed through another vibratory sieve where blower was attached to separate the husk from the brown rice and the husk was dumped in a separate room. After sieving, brown rice was passed directly into polisher where bran and milled rice was separated (Plate 2). Sample was collected from milled rice for laboratory analysis i.e. to measure head rice recovery, broken rice and kernel translucency. Milled rice was a mixture of head and broken rice. The milled rice was passed through another sieve to separate broken and head rice. As the temperature of the milled rice was high (75°C), material was spread on the floor for cooling. Stirring by shovel was done to decrease the cooling time. Finally, milled rice was normally sieved in order to separate head and broken rice. Well-sieved rice of BRRI dhan 37 and BRRI dhan 38 were presented in (Plate 3).

RESULTS AND DISCUSSION

The initial moisture contents of BRRI dhan 37 and BRRI dhan 38 were 13.93 and 12.86%, respectively. The temperature and relative humidity ranged 34 to 42°C and 42 to 79%, respectively, at 10:00 and 13:00 hours in the last week of May, 2003. During sun drying, moisture content, crushing strength and kernel translucency values were monitored everyday. After two days of drying, the moisture content of both the varieties reduced to 9%, however, in the following morning the grain moisture content increased up to 10% due to condensation.

Crushing strength: Before starting the drying experiment, the crushing strength of BRRI dhan 37 and BRRI dhan 38 were 0.9 and 1.2 kgf, respectively. With the drying duration, the crushing strengths of both the varieties increased and attained the maximum values at 3 days of drying and decreased at successive days of drying. The highest values of crushing strengths for BRRI dhan 37 and BRRI dhan 38 were 8.00 and 6.76 kgf, respectively, when they were dried for three days (Fig. 1). The highest crushing strength was the indicator of a particular variety that it can resist maximum compressive force against breaking during milling. Therefore, three days of mill yard drying may be attributed as the optimum drying requirement for both the varieties before processing at automatic mills. The lowest values of crushing strengths for BRRI dhan 37 and BRRI dhan 38 were 5.00 and 4.60 kgf, when they were dried for 5 and 4 days, respectively. The crushing strength curve of BRRI dhan 37 is always leading over BRRI dhan 38 indicated that BRRI dhan 37 produced more head rice than that of BRRI dhan 38.

Kernel translucency: Before starting the drying experiment, the kernel translucency of BRRI dhan 37 and BRRI dhan 38 were 43 and 35%, respectively. The kernel translucency increased with the drying duration for both the varieties; and attained the maximum values of up to 95 and 89% for BRRI dhan 37and BRRI dhan 38, respectively, when they were dried for 6 days (Fig. 2). Kernel translucency is more effective in determining the quality of milled rice than the amount of head rice recovery. Therefore, the paddy was milled before attaining the maximum translucency level as it induced more breakage due to over drying.

Milling yield: Paddy without mill yard drying, the moisture content of both the varieties was 12% wet basis and the milling yields were 57.5 and 55.12% for BRRI dhan

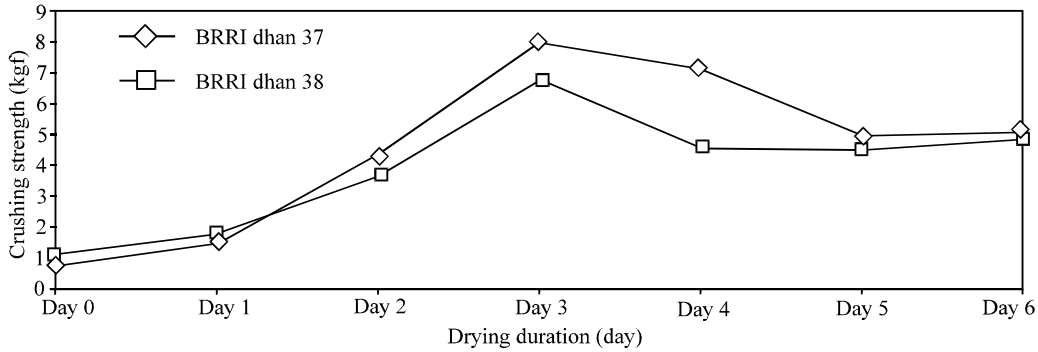

Fig. 1: Effect of drying period on crushing strength of BRRI dhan 37 and BRRI dhan 38

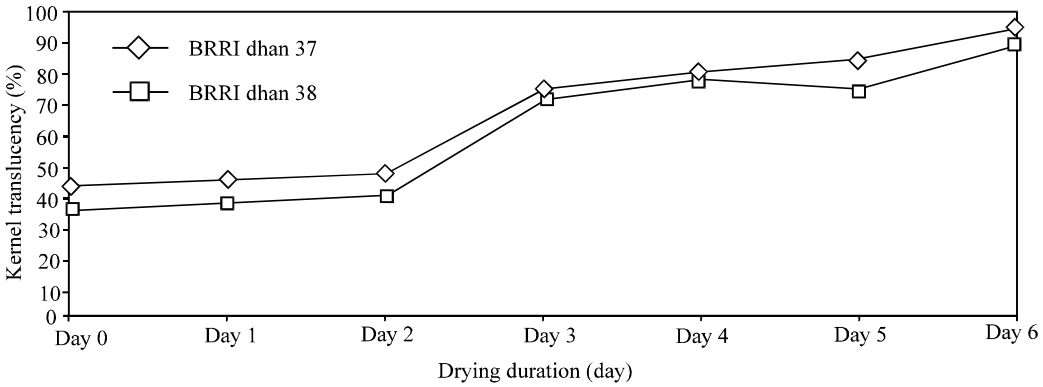

Fig. 2: Effect of drying period on the kernel translucency of BRRI dhan 37 and BRRI dhan 38

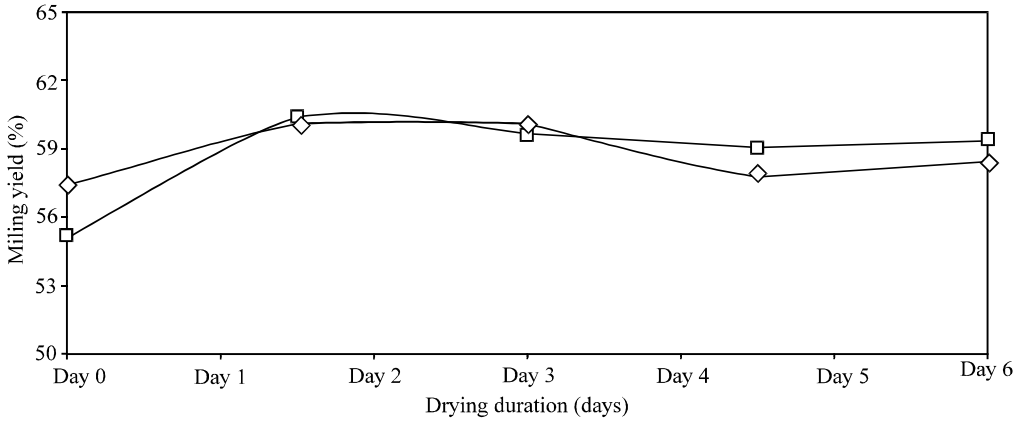

Fig. 3: Effect of drying on milling yield of BRRI dhan 37 and BRRI dhan 38

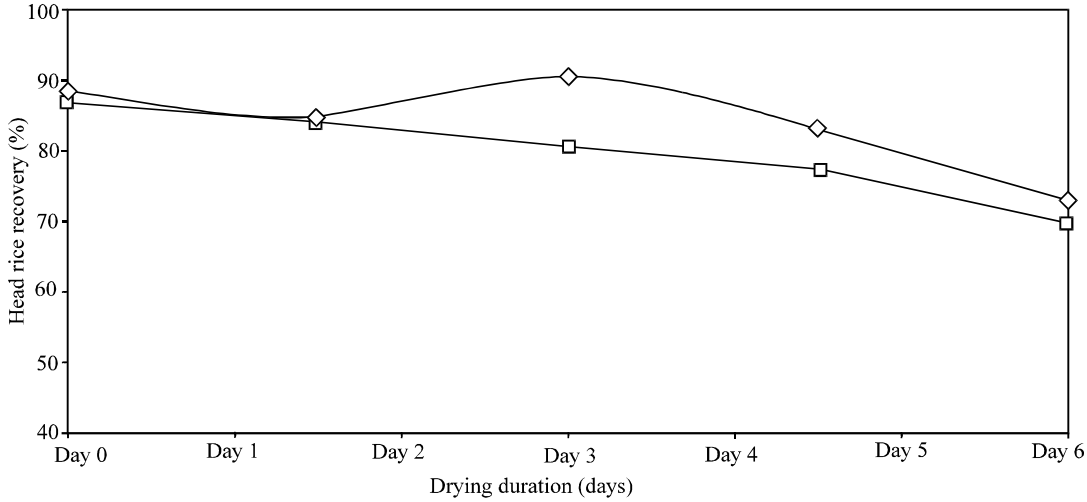

Fig. 4: Effect of drying on head rice recovery of BRRI dhan 37 and BRRI dhan 38

37 and BRRI dhan 38, respectively. The highest milling yields of BRRI dhan 37 and BRRI dhan 38 were 60.02 and 60.34% at the drying level of three days (Fig. 3). After three days of drying, the milling yield for both the varieties declined as the kernel become brittle due to over drying. As a consequence, some portion of the kernel was lost with bran in the form of powder.

Therefore, three days of drying may be attributed as the optimum level of drying for maximum milling yield irrespective of the paddy variety.

Head rice recovery: The head rice recovery of BRRI dhan 37 and BRRI dhan 38 with no mill yard drying were 88.39 and 86.52%, respectively. But the head rice had a significant amount of grain with portion in the central part. The highest head rice recovery as acceptable quality for BRRI dhan 37 was 90.37% and for BRRI dhan 38 was 84.09% when they were dried for 4 and 3 days, respectively (Fig. 4). Starting from 3 to 6 days of drying duration, the trend of head rice recovery curve for BRRI dhan 37 indicated that it attained a peak at 4 days of drying and then decreased sharply. However, the head rice recovery curve for BRRI dhan 38 decreased gently with drying duration. Therefore, 3 and 4 days of mill yard drying may be attributed as the optimum levels of drying in order to maximize head rice recovery for BRRI dhan 37 and BRRI dhan 38, respectively.

REFERENCES

BRRI., 2000. Adhunic Dhaner Chash. Bangladesh Rice Research Institute, Gazipur, Bangladesh.

Kunze, O.R. and C.W. Hall, 1967. Moisture adsorption characteristics of brown rice. Trans. ASAE., 10: 448-450, 453.

Mahadevappa, M., M.K. Bhashyam and H.S.R. Desikachar, 1969. The influence of harvesting date and traditional threshing practices on grain yield and milling quality of paddy. J. Food Sci. Technol., 6: 263-266.

Mathews, J. and J.J. Sapadaro, 1976. Breakage of long-grain rice in relation to kernel thickness. Cereal Chem., 53: 13-19.

Omar, S.J. and R. Yamashita, 1987a. Rice, Drying, husking and milling- Part II Husking. Agricultural Mechanization in Asia and Africa and Latin America, 18: 53-56.

Omar, S.J. and R. Yamashita, 1987b. Rice, Drying, husking and milling- Part I drying. Agricultural Mechanization in Asia and Africa and Latin America, 18: 43-46.

Prasad, S. and C.P. Gupta, 1973. Behavior of paddy grains under quasi-static compressive loading. Trans. of ASAE., pp: 328-330.

Sathel, G., 1935. Breaking of rice milling in relation to the condition of the paddy. Tropical Agric., 12: 255-261.

Stipe, D.R., F.T. Wratten, and N.P. Miller, 1971. Effects of various methods of handling brown rice on milling and other quality parameters. 63rd Annual Progress Report, Rice Experiment Station, Lousiana, USA, pp: 79-96.

Tony, S., 1997. The export potential of traditional rice varieties for Bangladesh, Department for International Development (DFID), UK.