Effect of Paddy Dehusking Rate in Rubber Roll Sheller on the Milling Quality of Different Rice Varieties

Mohammad Reza Alizadeh and Mohammad Hashem Rahmati

1Department of Agricultural Engineering, Rice Research Institute of Iran (RRII),
P.O. Box 41996-13475, Rasht, Gilan, Iran
3Department of Agricultural Machinery Engineering,
Gorgan University of Agricultural and Natural Sciences, Gorgan, Iran

Abstract: In this study, the effect of paddy dehusking rate in rubber, the roll sheller at four levels of 60, 70, 80 and 90% were investigated on some milling properties as Head Brown rice Yield (HBY), Head Rice Yield (HRY) and whiteness of three Iranian rice varieties namely Binam, Khazan and Sepidrourd was examined. The results revealed that the HBY decreased from 92.58-89.72, 90.83-86.61 and 84.83-78.18% for Binam, Khazan and Sepidrourd varieties, respectively as the paddy dehusking rate increased from 60-90%. However, the highest HRY of 82.17% was observed for Binam variety at the dehusking rate of 80% and the lowest value of 65.97% was recorded for Sepidrourd variety at the husking rate of 60%. There was an increasing trend for rice whiteness with decreasing in paddy dehusking rate. It was decreased from 36.1-30.8, 36.5-30.1 and 35.4-29.8 for the varieties of Binam, Khazan and Sepidrourd varieties, respectively as the paddy dehusking rate increased from 60-90%.

Key words: Rice milling, dehusking rate, rubber roll sheller, milling quality, blade-type whitener

INTRODUCTION

Within the worldwide-cultivated cereals, rice (Oryza sativa L.) stand out constituting the basic food for a large number of human beings sustaining two-thirds of the world population (Ahmed and Mazad, 1995). In Asia where 95% of the world’s rice is produced and consumed, it contributes 40-80% of the calories of the people diet. Rice is a major crop in Iran where rice production increased from 1.3 million ton in 1980 to 3.5 million ton in 2007. Main rice cultivation areas are located in the Northern parts of the country producing 75% of Iran’s rice crop. Both local and improved varieties are cultivated in the rice growing regions of the country (Alizadeh et al., 2006).

Millling, an important processing step of paddy (rough rice) is usually done to produce white and polished grain. A typical rice milling system is a multi-stage process where the paddy is first subjected to dehusking by using a sheller and then to removal of brown rice outer layer known as whitening (Yadav and Jindal, 2008). Two types of whitening machines, namely frictional and abrasive types are used for whitening of grain in rice mills. In the frictional type, kernels are exposed to high pressure by a rotor and the husk and soft outer layers or bran are removed by the combination of the pressure and friction. In the abrasive (shearing) mill, the bran removed under the cutting action and by a stationary and a rotating roller of high peripheral speed and low pressure in the whitening chamber (Takai and Barredo, 1981).

Rubber roll sheller and blade-type (frictional type) whitener are typical milling machines used in Iran’s rice mills. In this type of milling system, the outlet of the sheller which is the mixture of brown rice and some paddy is fed to the whitener without any separation. This may be due to that in blade-type whitener, the presence of some paddy and husk cause to increase frictional action in whitening chamber, leading to higher whiteness degree of rice. Therefore, it is important to determine the appropriate paddy dehusking percentage in the rubber roll sheller for various rice varieties to improve milling quality of rice during dehusking and whitening operations.

The milling outturn of paddy depends on such factors as variety, percentage of matured grains, moisture content, drying methods and milling techniques (Rajkumar et al., 2004). The most important parameters during milling are Head Rice Yield (HRY) and kernel whiteness. These two parameters are used to define milled rice in their transactions. The transaction price of rice has been strongly correlated to the size and shape, whiteness and cleanliness of the rice (Conway et al., 1991). Among the parameters affecting rice milling quality,
the optimization of the sheller and whiteners is necessary to maximize HRY and desired kernel whiteness. Many researchers have already identified factors affecting milling quality. Firooz et al. (2005) found that the rotor speed of rice mill whiteners is an important parameter affecting broken rice. Alizadeh and Payman (2004) reported that use of rice mill whiteners as a huller in milling process increased rice breakage compared to rubber roll sheller. Payman et al. (1999) determined the appropriate rubber rolls spacing for increasing husking percentage and reducing rice breakage in the test sheller. Ahmed and Mazad (1999) found that when a blade-type whiteners is used as a single-pass machine, the breakage percentage is increased and the separated bran is mixed with kernels.

Yan et al. (2005) found that rice milling quality significantly affected by whiteners rotor speed and paddy moisture content. Firooz et al. (2010) studied the effect of the size of perforated screen and balde-rotor clearance on the performance of Englebreg rice whiteners. Although many factors affecting rice breakage have already been studied, however there was no information about the effect of the rice milling quality in such a common system as in Iran’s rice mills. Therefore, the objective of this study was to investigate the effect of the rice milling quality on the head rice yield and kernel whiteness to determine the appropriate dehusking percentage in rubber roll. Sheller for different varieties to attain minimum rice breakage during milling process using a blade-type whiteners.

**MATERIALS AND METHODS**

This study was conducted at the rice mill of Department of Agricultural Engineering, Rice Research Institute of Iran (RRII), Rasht, Iran. In this experiment, the effect of four levels of paddy dehusking rate of 60, 70, 80 and 90% (±2%) on the Head Brown Rice Yield (HBY), Head Rice Yield (HRY) and whiteness of three Iranian rice varieties namely Binam (local and medium-grain variety), Khazar and Sepidroud (improved and long-grain variety) was investigated. In order to achieve the mentioned dehusking rate, the clearance between the rubber rolls was adjusted until the desired percentage of brown rice at the outlet of the sheller machine was obtained. A typical commercial paddy milling system in Iran’s rice mills, including a rubber roll sheller (ISEKI HP 600, Japan) and a local made blade-type whiteners (Hasan-Marsor Manufacturing Co. Ltd., Iran) was used for the milling process. The schematic representation of a typical milling system in Iran’s rice mills is shown in Fig. 1. The initial moisture content of paddy was measured by the means of a grain moisture meter (Model GMK-303 RS, Korea).

In order to obtain the desired moisture content of paddy, the samples were dried in a batch-type dryer (Hasan-Marsor manufacturing Co. Ltd., Iran) at a constant air temperature of 43±1°C until the desired moisture content of 9% (w.b.) was obtained as a suitable moisture value in milling process (Minaii et al., 2007).

At each level of dehusking rate and for each type of tested variety, 50 kg of dried paddy was loaded to the hopper of rubber roll sheller machine. The outlet of the sheller which is mixture of brown rice and paddy was fed to the whiteners for bran removal. No separator unit was used after the sheller for separating the brown rice and paddy. To obtain the HBY and HRY, three samples of 100 g were randomly chosen from the outlet of the sheller and whiteners machines. A rotary indenter separator (Model TRG058, Satake Test Rice Grader, Japan) was used for separating whole and broken kernels. A kernel having equal to or >75% intact was considered as whole kernel (Farouk and Islam, 1995). Rice whiteness was measured with a whiteness tester (Model C-100, Kett whiteness tester, Japan). At each test, the husk of 50 paddy grains separated manually and the grains were placed on the tester and by the cracked grains were counted. The results gained were subjected to statistical analysis applying randomized 4x3 factorial experiment design (four levels of dehusking rate and three rice varieties) with three replications for each treatment.

**RESULTS AND DISCUSSION**

Effect of paddy dehusking rate on the Head Brown rice Yield (HBY) of the tested varieties is shown in Fig. 2.
The HBY decreased significantly (p<0.01) with increasing paddy dehusking rate in the rubber roll sheller. It was decreased from 92.58-89.72, 90.83-86.61 and 84.83-78.18% for Binam, Khazar and Sepidroud varieties, respectively as the paddy dehusking rate increased from 60-90%. The average HBY of 89.41 and 84.83% was measured at the dehusking rate of 60 and 90%, respectively (Fig. 3).

Decreasing HBY with increasing paddy dehusking rate may be due to that the higher dehusking rate obtained at the smaller clearance between the rubber rolls. This led to higher normal and shear stresses on the grains leading to larger broken kernels during dehusking operation in rubber-roll sheller. Similar results were also reported by the other researchers (Payman et al., 1999).

The effect of paddy dehusking rate on the values of head rice yield (HRY) for the tested varieties is presented in Fig. 4. It was observed that for all of the varieties the highest HRY of 82.17, 76.65 and 71.10% were obtained at the dehusking rate of 80%, however the lowest values of 81.30 and 71.07% at the husking rate 60% for Binam and Khazar varieties and 65.53% at the dehusking rate of 60% for sepidroud variety. It can be shown from Fig. 4 that higher HRY was recorded at higher dehusking rate especially for the two varieties of Binam and Khazar. It could be attributed to that at higher dehusking rate, less paddy grains are in mixture with brown rice at the outlet of the rubber-roll sheller and after feeding this mixture to whitener machine producing lower pressure and friction on grains in whitening chamber leading to lower broken kernels in the blade-type rice whitener.

According to Pillayar and Govindsamy (1985) and Mohapatra and Bal (2004) mechanical and thermal stresses exerted on the grains are major reasons for breaking rice in the whitening process. As shown in Fig. 5, the average HRY for long-grain varieties of Khazar (73.97%) and Sepidroud (68.04%) was significantly lower than that of Binam (81.22%). This may be due to the fact that the long-grain rice varieties are more susceptible for breakage during milling processing (Goodman and Rao,
ACKNOWLEDGEMENT

Researcher is grateful to Rice Research Institute of Iran (RRII) for providing the laboratory facilities and financial support for this research.

REFERENCES


CONCLUSION

The following results were drawn from the study:

- The HBY significantly decreased from 92.58-89.72, 90.83-86.61 and 84.83-78.18% for Binam, Khazan and Sepidroud varieties, respectively as the paddy dehusking rate increased from 60-90%.
- The highest HRY of 82.17% was observed for Binam variety at the dehusking rate of 80% and the lowest value of 65.97% was recorded for Sepidroud variety at the husking rate of 60%.
- The highest HRY value was obtained at the paddy dehusking rate of 80%. At this dehusking rate, the desired kernel whiteness was achieved.

