Research Journal of Biological Sciences 6 (4): 153-157, 2011
ISSN: 1815-8846

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

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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, Khazar and Sepidroud 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, Khazar and Sepidroud 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 Sepidroud 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, Khazar and Sepidroud 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 large number of human beings sustaining two-third of the world population (Ahmed and Mazad, 1996). 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).

Milling, 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-stages process where the paddy is 1st subjected to dehusking by using a sheller and then to removal of brownish 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 of 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,

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the optimization of the sheller and whitener machines is necessary to maximize HRY and desired kernel whiteness. Many researchers have already identified factors affecting milling quality. Firouzi and Alizadeh (2005) found that the rotor speed of blade-type rice whitener is an important parameter affecting broken rice. Alizadeh and Payman (2004) reported that use of blade-type whitener 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 (1996) found that when a blade-type whitener 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 whitener rotor speed and paddy moisture content. Firouzi *et al.* (2010) studied the effect of the size of perforated screen and balde-rotor clearance on the performance of Englebreg rice whitener. Although many factors affecting rice breakage have already been studied, however there was no information about the effect of paddy dehusking rate on 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 paddy dehusking rate 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 whitener.

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 whitener (Hasan-Mansor 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 bed dryer (Hasan-Mansor 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 (Minaei *et al*., 2007).

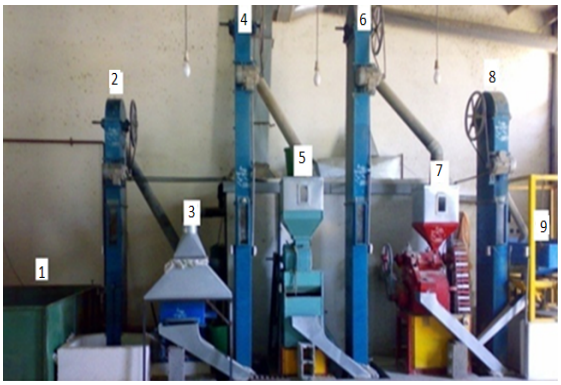

Fig. 1: Main components of a typical milling system used in Iran's rice mills. 1: Paddy dryer; 2: Paddy cleaner elevator; 3: Paddy cleaner; 4: Paddy sheller elevator; 5: Rubber roll sheller; 6: Brown rice elevator; 7: Blade-type rice whitener; 8: Milled rice elevator and 9: Rice grader

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 whitener 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 whitener machines. A rotary indent 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 4×3 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.

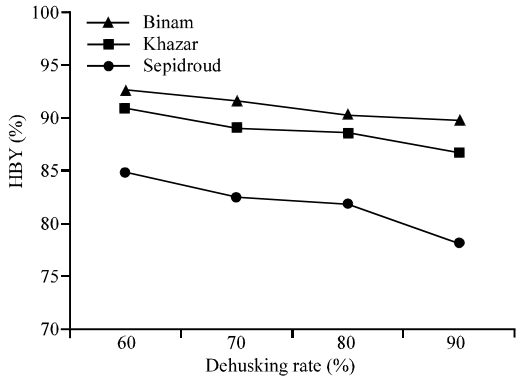

Fig. 2: Effect of dehusking rate on the HBY of the tested varieties

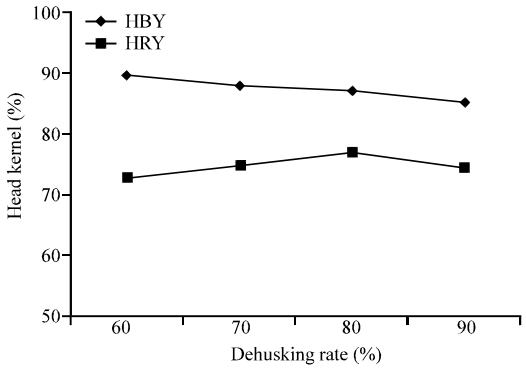

Fig. 3: Independent effect of dehusking rate on the HBY and HRY

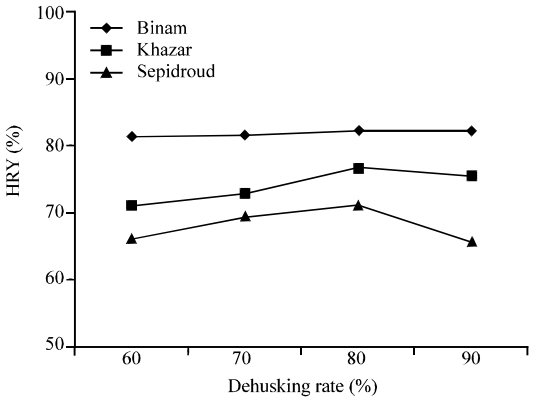

Fig. 4: Effect of dehusking rate on the HRY of the tested varieties

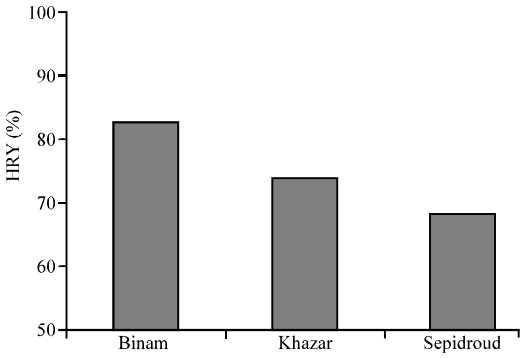

Fig. 5: Comparison of the HRY for the tested varieties

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,

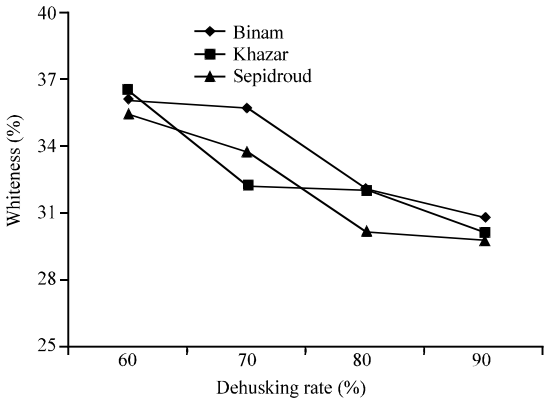

Fig. 6: Effect of dehuking rate on the rice whiteness of different varieties

1985). The results showed that rice whiteness decreased significantly ($p<0.01$) as the paddy dehusking rate increased. The rice whiteness decreased from 36.1-30.8, 36.5-30.1 and 35.4-29.8% for varieties of Binam, Khazar and Sepidroud varieties, respectively as the paddy dehusking rate increased from 60-90%. For Khazar, Binam and Sepidroud were 32.9, 33.1 and 32.2%, respectively (Fig. 6).

In blade-type whitener, the rice whiteness (as a measure of milling degree) depends on such parameters as the rate of paddy input and output rate, the amount of pressure exerted on the grains in whitening chamber and the time of milling. At low dehusking rate, the excessive paddies are in mixtures to brown rice producing high frictional between the grains in the chamber. As a result, the enclosed grains are subjected to substantial pressure forces leading to more bran removal and increased degree of milling.

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, Khazar 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

ACKNOWLEDGEMENT

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

REFERENCES

Ahmed, A. and M.A. Mazad, 1996. Improving the rice post-harvest technology in Bangladesh. Agric. Mech. Asia, Africa Latin Am., 27: 37-43.

Alizadeh, M.R. and M.H. Payman, 2004. Comparative study of rice losses in two common milling systems in Guilan, Iran. Iran. J. Agric. Sci. Tech., 18: 19-26.

Alizadeh, M.R., S. Minaei, T. Tavakoli and M.H. Khoshtaghaza, 2006. Effect of de-awning on physical properties of paddy. Pak. J. Biol. Sci., 9: 1726-1731.

Conway, J.A., M. Sidik and H. Halid, 1991. Quality/value relationships in milled rice stored in conventional warehouse in Indonesia. Proceedings of the 14th ASEAN Seminar on Grain Postharvest Technology, Nov. 5-8, Manila, Philippines, pp: 55-82.

Farouk, S.M. and M.N. Islam, 1995. Effect of parboiling and milling parameters on breakage of rice grains. Agric. Mech. Asia, Africa Latin Am., 26: 33-38.

Firouzi, S. and M.R. Alizadeh, 2005. Investigation on rice breakage in milling with common Englebreg rice whitener in North of Iran. J. Agric. Sci. Islamic Azad Univ., 11: 117-128.

Firouzi, S., M.R. Alizadeh and S. Minaei, 2010. Effect of the size of perforated screen and blade-rotor clearance on the performance of Engleberg rice whitener. Afr. J. Agric. Res., 5: 941-946.

Goodman, D. and R. Rao, 1985. Effect of grain type and milled rice kernel hardness on the head rice yields. J. Food Sci., 50: 840-840.

Minaei, S., M.R. Alizadeh, M.H. Khoshtaghaza and T. Tavakoli, 2007. Effects of de-awning and moisture content on husking characteristics of paddy in rubber-roll husker. Am. Eurasian J. Agric. Environ. Sci., 2: 1-5.

Mohapatra, D. and S. Bal, 2004. Wear of rice in an abrasive milling operation, Part II: Prediction of bulk temperature rise. Biosyst. Eng., 89: 101-108.

Payman, M.H., T. Tavakoli and S. Minaei, 1999. Determination of appropriate clearance between rolls in rubber-roll huskers in milling operations of three common rice varieties in Guilan. Iran. J. Agric. Sci., 5: 37-48.

Pillayar, P. and R. Govindsamy, 1985. Influence of metal and emery huller on the degree of milling and rice temperature. J. Food Sci. Tech. India, 22: 79-82.

Rajkumar, P., N. Varadharaju and V.V. Sreenaryaanan, 2004. Studies on milling outturn of paddy varieties using rubber roll Sheller. Madras Agric. J., 91: 1-4.

Takai, H. and I. Barredo, 1981. Milling characteristics of a friction laboratory rice mill. J. Agric. Eng. Res., 26: 441-448.

Yadav, B.K. and V.K. Jindal, 2008. Changes in head rice yield and whiteness during milling of rough rice (*Oryza sativa* L.). J. Food Eng., 86: 113-121.

Yan, T.Y., J.H. Hong and J.H. Chung, 2005. A prediction of white improved method for the embryo in vertical mill. Biosyst. Eng., 49: 303-309.