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Effects of De-Awning and Moisture Content on Husking Characteristics of Paddy in Rubber-Roll Husker

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Abstract: The effects of de-awning on husking characteristics of paddy varieties (Hashemi and Binam) in a rubber-roll husker were avaluated as function of grain moisture content. In the case of Hashemi variety, the husking ratio significantly decreased from 81.61 to 76.45% and 85.19 to 78.22%, Husking index from 73.88 to 67.71% and 76.59 to 67.93% ; husking time increased from 63.20 to 74.40 and 38.80 to 46.40 sec, respectively for awned and de-awned paddy as moisture content increased from 9.06 to 14.92% w.b. For Binam variety, the husking ratio varied from 80.59 to 71.69% and 83.04 to 73.73%, the husking index from 71.40 to 62.43% and 72.27 to 62.35%; the husking time increased from 54.70 to 63.90 sec and 32.00 to 38.40 sec, respectively for awned and de-awned paddy with increasing moisture content from 8.92 to 14.78% w.b. It is concluded that de-awning has a significant positive effect on husking quality as well as husking time.

Key words: Paddy de-awning · husking characteristics · husking index

INTRODUCTION

Rice (*Oriza sativa* L.) is an important staple food in Iran. It is grown on an area of about 615 thousand ha with a total paddy production of about 3.0 million ton. Main areas of rice cultivation in Iran are located in Mazandaran and Guilan provinces producing 75 percent of Iran's rice crop. Both high yielding and local varieties are grown in the rice cultivated areas in the country. In Guilan province however, the most popular varieties grown are local and aromatic varieties such as Hashemi and Binam. These varieties are characterized by long kernels having awns. The presence of awn influences the physical and morphological characteristics of these types of rice varieties, that causes difficulty in flow through chutes and hopper orifices [1].

Milling is the final step in rice post-harvest processing. It includes pre-cleaning, husking, whitening and grading [2]. In the rice milling process, paddy is first thoroughly cleaned by a paddy cleaner and then the husk is removed by any of the existing huskers. Rubber-roll husker is the most popular machine for husking of paddy in milling operation because of its better performance in quality and quantity in comparison to other husker machines. The performance of a husker is not only governed by the working parameters of the machine (engineering factors) but also the physical and morphological characteristics (varietal properties) of the paddy to be husked [3]. The grains subjected to the husking process must be suitably prepared first so that their physical properties meet the requirements of the process. A recent study showed that the de-awning of paddy influenced such physical properties as the thousand-grain mass, bulk and true densities, angle of repose and static coefficient of friction [1].

Several investigators have already identified many factors affecting husking quality of paddy in rubber-roll husker. Firozi and Alizadeh [4] studied the effects of moisture content and the peripheral speed difference of rolls on husking quality for Binam and Khazar rice varieties [4]. The highest husking ratio was obtained at 8% moisture content compared to 12 and 14% moisture content levels (% w.b.). Payman *et al.* [5] reported that grain moisture content and clearance between husker rolls significantly affected husking index of rice varieties.

Although many factors affecting husking characteristics of paddy in rubber roll huskers have already been studied, however there is no information on the effect of de-awning on husking quality of paddy. There is a general awareness in the milling industry that paddy with awns causes problems contributing to handling and processing, particularly in the husking

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stage, but no quantitative data exist about their effects on husking parameters. The objective of this study was to investigate the effects of de-awning and moisture content of paddy on husking ratio, hausking time and the husking index in rubber-roll husker.

MATERIALS AND METHODS

This study was carried out at the Agricultural Engineering Division, Rice Research Institute, Rasht, Iran. Two varieties of rice having awns namely Hashemi and Binam were selected from popular rice varieties in Iran. Initial moisture content of the grains was determined by oven drying at 103 for 48 h [6] and was 14.78 and 14.92% w.b. for Binam and Hashemi varieties, respectively. The experiment was conducted at moisture content range of 8.92 to 14.92% w.b. To obtain the desired moisture level below the initial moisturte contents, paddy was kept in an oven at a constant temperature of 43°C until the desired mass of the samples were obtaind [7]. De-awned samples of paddy were provided by rubbing the awned paddy between fingers and percentage of de-awning was calculated on the basis of weight of de-awned paddy.

In order to study the effects of de-awning and moisture content on husking quality of the two varieties, 150g awned and de-awned paddy at each moisture content level was husked using the laboratory rubber rolls husker (Satake Co. Ltd., Japan). After husking, the unhusked paddy was handpicked and separated from the brown rice and weight of each part was measured. The percentage of head brown rice was determined by hand-sorting of broken kernels. A kernel having equal to or more than 75% intact tissue was considered as whole kernel [8]. The husking ratio of awned and de-awned paddy at different moisture contents was determined using the following relation [9]:

$$H_r = 100(1 - W_2 / W_1) \tag{1}$$

Where;
H_r = Husking ratio%
W_1 = Mass of sample before husking, g
W_2 = Mass of unhusked paddy in the final product, g

To determine the husking time of the samples, the time needed to dehusk paddy was measured using a timer and the average of three replications was recorded. The clearance between the rubber rolls and the peripheral speed difference were adjusted according to findings of a previous study [5]. These were kept consatat during all experiments. The husking index of paddy in rubber-roll husker was calculated using the following equation [9]:

$$H_i = 100(1 - W_2 / W_1)(W_3 / W_1 - W_2 - W_4) \tag{2}$$

Where;
H_r = Husking index, %
W_1 = Mass of sample before husking, g
W_2 = Mass of unhusked paddy in the final product, g
W_3 = Mass of brown rice in the final product, g
W_4 = Mass of husks in the final product, g

The obtained data was statistically analayzed using a Randomized Complete Block Design (RCBD) of 2×2×4 factorial experiment with three replications in each treatment and the means were compared using Duncan's Multiple Range Test (DMRT) at the 5% level.

RESULTS AND DISCUSSION

Husking ratio: Results of the effects of de-awning and moisture content on husking ratio of paddy are presented in Fig. 1. Data revealed that the husking ratio of awned and de-awned paddy in Hashemi variety decreased from 81.61 to 76.45% and 85.19 to 78.22%, respectively as moisture content increased from 9.06 to 14.92% w.b. In the case of Binam, the husking ratio varied from 80.59 to 71.69% and 83.04 to 73.73%, respectively as the moisture content increased from 8.92 to 14.78% w.b. There was high significant ($p<0.01$) effect of de-awning and moisture content on husking ratio. The analysis of variance further confirms the observations regarding the effect of main variables on the husking ratio. The effect of variety (A), de-awning (B) and moisture content (C) significantly affected the husking ratio at 1% level. However, the first and second order interactions between the variables were not statistically significant (Table 1).

The husking ratio of grains in a rubber-roll husker depends on the physical properties of the paddy to be husked and the operational conditions of the husker such as the clearance between rolls and the peripheral speed difference of the fast and slow rolls. Since the working parameters of the machine were considered constant during the experiments, then it can be said that the variations in husking ratio are related to de-awning and moisture content of the paddy. In all the varieties tested, the highest husking ratio was obtained at the 9% moisture content level and the lowest at 15% as shown in Fig. 1. This behaviour of decrease in husking ratio with increasing moisture content is probably due to the fact

Table 1: Analysis of variance for husking characteristics of awned and de-awned paddy at different moisture contents

Source of Variation (SV)	DF	Mean Square (MS) Husking ratio	Husking time	Husking index
Replication	2	0.0332^{ns}	2.4300^{ns}	1.2280^{ns}
Variety (A)	1	0.3040**	855.1400**	72.6400**
Type of paddy (B)	1	0.1770**	6907.2000**	1.0290^{ns}
Moisure content (C)	3	0.4016**	168.8000**	59.8980**
A×B	1	0.0006^{ns}	23.8000^{ns}	0.8390^{ns}
A×C	3	0.0173^{ns}	1.9600^{ns}	0.8720^{ns}
B×C	3	0.0029^{ns}	12.1700^{ns}	1.0910^{ns}
A×B×C	3	0.0024^{ns}	0.7500^{ns}	0.3200^{ns}
Error	30	6.9000	0.0060	0.7310

**Significant at 1% level, * Significant at 5% level, ns = non significant, DF= degrees of freedom

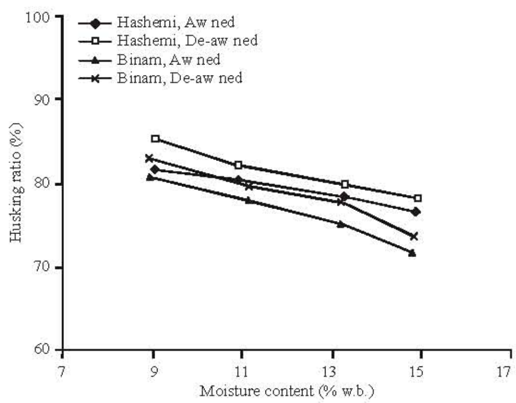

Fig. 1: Effect of de-awning and moisture content on husking ratio of paddy in rubber-roll husker for Hashemi and Binam varieties

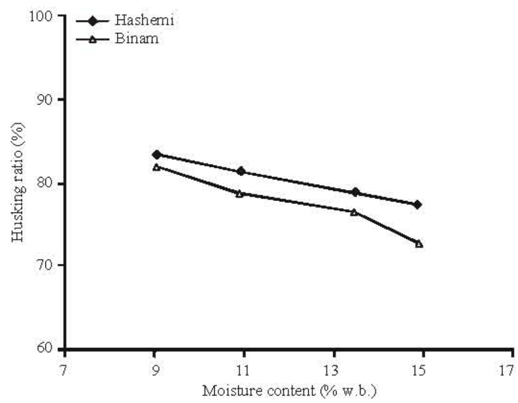

Fig. 2: Effect of moisture content on husking ratio for Hashemi and Binam varieties

that at high moisture level the husk is more firmly attached to the kernel and does not easily split [10]. Similar treneds were reported by other researchers for different rice varieties [4, 5]. It can be seen (Fig. 2) that at each moisture content level, the husking ratio of Hashemi was higher than that of Binam variety. This may be attributed to the Hashemi grains being longer than Binam, resulting in a higher contact area for Hashemi compared to Binam.

Husking time: The analysis of variance showed that variety (A), de-awning (B) and moisture content (C) significantly affected hulling time of the paddy samples in the rubber-roll husker at 1% level (Table 1). However, interaction effects of the independent variables were not significant. It was observed that for each type of paddy (awned and de-awned), husking time of the samples increased with increasing moisture content. The husking time of the awned and de-awned paddy of Hashemi grains increased from 63.20 to 74.40s and 38.80 to 46.40s, respectively as moisture content increased from 9.06 to 14.92% w.b. In the case of Binam variety, it increased from 54.70 to 63.90 and 32.00 to 38.40 sec, respectively as the moisture content increased from 8.92 to 14.78% w.b. At each moisture content level studied, the hulling time of awned paddy was significantly ($p<0.01$) higher than that of de-awned paddy (Fig. 3). This is due to the increased adhesion between the awned grains, resulting in a higher friction for awned grains. The study showed that de-awning decreased such frictional properties as angle of repose and coefficient of friction of paddy. Awns tend to cling to each other, bridge-over and cause grain to adhere in a mass, resulting difficulty on the flowing of grains through the orifice of the paddy hopper [1].

Hulling index: Effect of de-awning and moisture content on husking index is presented in Fig. 4. The husking index of awned and de-awned paddy of Hashemi variety ranged

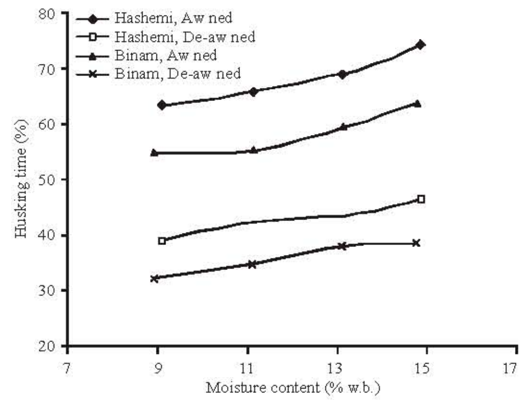

Fig. 3: Effect of de-awning and moisture content on husking time of paddy in rubber-roll husker for Hashemi and Binam varieties

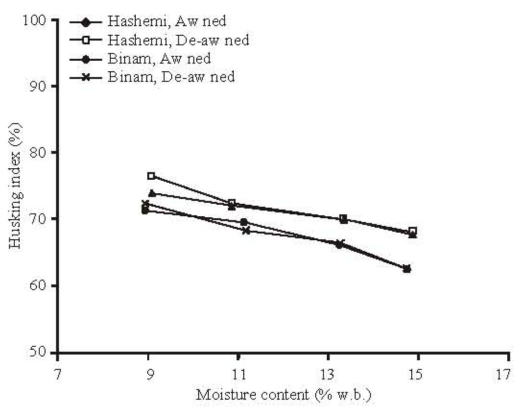

Fig. 4: Effect of de-awning and moisture content on husking index of paddy in rubber-roll husker for Hashemi and Binam varieties

from 73.88 to 67.71% and 76.59 to 67.93%, respectively as moisture content increased from 9.06 to 14.92% w.b. It varied for Binam variety from 71.40 to 62.43% and 72.27 to 62.35%, respectively as moisture content increased from 8.92 to 14.78% w.b. Statistical analysis showed that the effect of de-awning on husking index was nonsignificant wheras the effect of moisture content was significant at 1% level. The interaction effects of the independent variables were not significant. (Table 1). The mean values of husking index for awned and de-awned paddy decreased from 72.64 to 65.07% and 74.43 to 65.14%, respectively with increase of moisture content from 9.06 to 14.92% w.b. (Fig. 5). It was seen that moisture content was inversely related to husking index which decreased with increasing moisture content both for awned and de-awned paddy. The minimum husking index at higher

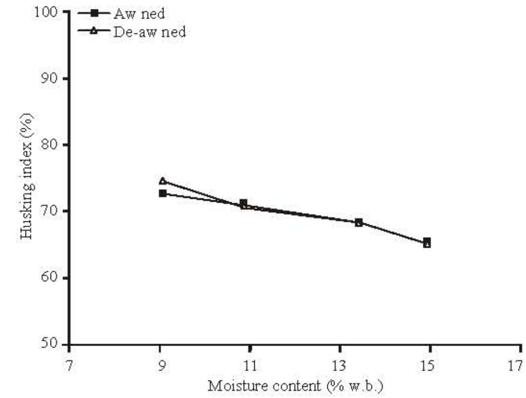

Fig. 5: Effect of de-awning and moisture content on husking index of paddy

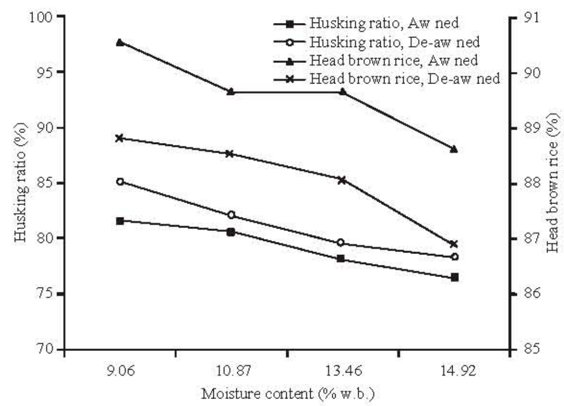

Fig. 6: Husking ratio and head rice of awned and de-awned paddy after husking in rubber-roll husker

moisture content could be attributed to the decreased husking ratio as well as head rice (Fig. 6). At higher moisture content, hardness of grains decreased which resulted in more breakage [4, 11].

CONCLUSIONS

Results of the study revealed that grain moisture content and de-awning had significant effects on husking quality of paddy varieties studied in the rubber-roll husker. Higher husking ratio and husking index were observed for de-awned paddy at lower moisture content levels. Results also indicated a decreasing trend in husking time with decreasing moisture content. The husking time of awned paddy was significantly higher than that of de-awned paddy at each level of moisture content. Due to the high adhesion friction of the awned paddy and consequent arching and clogging problems through hopper orifice of the husker, de-awning of the paddy would be necessary for facilitating the grain flow and maintaining reliable performance of the machine.

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