

## EFFECT OF CLEARANCE ON MECHANICAL DAMAGE OF PROCESSED RICE

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### Abstract

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The effect of rubber rolls in husking machine (Yanmar type) on rice cultivars of Tarm Hashemi (TH) and Daillman Mazandarani (DM) were tested during husking at three clearances of 0.4, 0.6 and 0.8 mm between cylinders. The experiments were carried out in a factorial experiment under complete randomized design with three replications. The results showed that the TH cultivar was significantly better than the DM in all studied conditions. The results showed broken rice of 6.239% and 6.729%, cracked grain percentage of 3.787% and 4.671%, brown rice (husked rice) of 82.049% and 80.113%, husking efficiency of 84.719% and 83.152% and head rice yield of 70.633% and 69.202% for TH and DM, respectively. The clearance of 0.8 mm was significantly superior to the levels of 0.4 and 0.6 mm in all studied conditions.

Keywords: mechanical damage, processed rice, rice, rice quality, rubber rolls husker

### INTRODUCTION

Rice is an important crop, which is in the third rank after wheat and barley in terms of area planted and production and it is considered a vital food material for more than half of the world's population. Its importance as a food crop has been increased with the increase of population. It is estimated that the rice production in Iraq is grossly inadequate to meet the populations. The strategy is dealt with through importing from the neighbouring states.

Milling is an important step of rice processing (rough rice), which is usually done in order to produce white and polished grain (Al Sharifi *et al.*, 2016a). A common rice milling system is a multi-stage process where the rice is first subjected to husking by using a husker. Abu Al Khair *et al.*, (2005) reported that the organizing machine has a direct effect on the productivity of the machine. The more the organization of the machine, the higher productivity because of the low percentage of break-up and this is reflected positively on the increase of machine productivity due to the increase the efficiency of the existing

work. Al Saadi *et al.*, (2012) explained that the type of machine and the moisture content of the grain have significant effect on the energy consumed and concluded that the energy consumed depends on the type of machine. Whenever the organization of the machine is good, less energy is consumed, higher moisture content decreases and the capacity of the machine is high.

Al Sharifi *et al.*, (2016b) studied the engineering properties of rough rice, brown and milled rice to determine the influence of the rice processing operations on physical and mechanical properties of rice cultivars of Tarm Hashemi (TH) and Daillman Mazandrani (DM). They concluded that the husking machine has a significant effect on the rice supplied for manufacture. Represented in the broken rice, head rice, brown rice, these ratios increased with the good organization for husking machine.

In a research rice is first thoroughly cleaned by a rice cleaner machine and then the husk is removed by any of the existing husker (Ohtsubo *et al.*, 2005). Rubber roll husker is the most popular machine for husking of rice in the milling operation because of its better performance in quality and

quantity in comparison to other kind of huskers. The performance of a husker is not only governed by the working parameters of the machine, but also the physical and morphological characteristics varietal properties of the rice. The effect of clearance between the cylinders has a significant effect on the breakage of rice. The effect of different types of crunches and whitening machines on the rice grains were tested on two varieties of Amber 33 and Abasiya. The results showed that there is a significant effect to the machine type as well as the type of rice on efficiency husking and head rice (Al Maamouri and Al Sharifi, 2008).

Truong *et al.*, (2007) explained that the cause of the cracking is harvesting, drying, moisture content and concluded that cracked and weak grain is Almswohl for breakage during manufacturing stages. Williams *et al.*, (2002) studied the effect of clearance between the cylinders has a significant effect the more clearance between the cylinders leads to a percentage of breakage and they concluded that the excess clearance proportion gives less break unlike little clearance is due to an increase in the mechanical effort, which involved a rice grain during the milling. Chaitep *et al.*, (2008) reported that compressive load resistance of rice grain based on its characteristic of yield strength of which can be expressed as relationships of the shear strength. Two similar experiments both parallel and cross grain positions are conducted on the rough rice to brown rice and determine power consumption of the machines as well as lowering the broken rice during the rice mill processes (Iguaz *et al.*, 2006). The breakage of rice in milling process is influenced by several factors. Besides rice variety, management of post-harvest operations and specially drying conditions, also affect the extent of kernel damage. Kernel breakage is closely related to fissure development in different stage of harvesting and post harvesting operations. Among factors affecting on the broken kernels during milling process, final moisture content of rice is one of the important influencing parameters on the quantitative and qualitative of milling.

The main goal of this research is to study the effect of husking machine (Yanmar) on rice, TH and DM cultivars at different clearances between cylinders.

## MATERIALS AND METHODS

This study was conducted in 2015 to evaluate the performance of husking machine (Yanmar). The experiments were done at three levels of clearances between cylinders at levels of 0.4, 0.6 and 0.8 mm. The TH and DM cultivars was selected for the experiments and the samples were taken by the probe and collected on the form of heap, which the number of heaps were six and each heap weight was 160 kg, according to the method used by (Al Sharifi, 2010). The rice samples were cleaned by using sieves to remove all foreign matters, broken and immature grains. Then 1000 g random

samples were taken from each heap. The initial moisture content of rice grain was determined by oven drying methods at 103 °C for 48h (Sacilik *et al.*, 2003). The rice of TH and DM cultivars were kept in an oven at temperature of 43 °C and monitored carefully for determining the moisture content of grain at 12-14%. The samples were taken and placed in the precision divider to get a sample of 200 g weight and then the samples were carefully sealed in polyethylene bags. The rubber roll M-ST 50, power of AC220 V, Single phase 400 W, 1900 rpm main shaft and 1000 rpm movable shaft, size of rubber roll 1.1\2"×4", dimensions 700×700×310 mm and weight 37 kg for Yanmar machine (Fig. 1 and Fig. 2) was adjusted on 0.8mm clearance between cylinders at linear speed of 4.7 m/s and the samples of 200g weight were placed in the machine. Then the sample was taken out of the machine and placed in a cylindrical insulating device from a Yanmar type with operating time which was adjusted to 2 min. The angle of inclination was 25 degrees insulating the broken and full grain for all sizes. The cracked grain percentage, the breakage proportion, brown rice, percentage of head rice and husking efficiency were calculated for each running test.

### Breakage grain

The Eq. 1 was used to calculate the percentage of the broken rice in the separation process of the broken grain from the whole grains (Gbabo and Ndagi, 2014).

$$P_{Br} = \frac{W_{br}}{W_s} \times 100 \quad (1)$$

Where:

$P_{Br}$ : proportion of breakage rice (%),  
 $W_{br}$ : weight of breakage grain(g) and  
 $W_s$ : weight of rice sample used (g).

### Cracked grain

The overexposure of mature rice to fluctuating temperature and moisture conditions leads to development of fissures and cracks in individual kernel. Cracks in the kernel are the most important factor contributing to rice breakage during milling. This causes in reduction of milled rice recovery and head rice yield, which is calculated by using Eq. 2 (Ali and Shatti, 2006).

$$P_{Cg} = \frac{W_{cg}}{W_s} \times 100 \quad (2)$$

Where:

$P_{Cg}$ : proportion cracked grain (%),  
 $W_{cg}$ : weight cracked grain (g) and  
 $W_s$ : weight sample the original (g).

### Brown rice

Brown rice or husked rice = rice from which the husk has been removed. The Eq. 3 represents the amount of grain produced by the process of husking which included percentage of breakage and

percentage of cracked grain (Al Wakel and Abdul Karim, 1999):

$$P_{obr} = \frac{W_{br}}{W_s} \times 100 \quad (3)$$

Where:

$P_{obr}$ : percentage of brown rice (%),  
 $W_{br}$ : weight of brown rice (g) and  
 $W_s$ : weight of rice sample used(g).

### Head rice

Head rice is the milled rice, which its length is greater or equal to three quarters of the average length of the whole kernel. Percentage of head rice in Eq. 4 represents the amount of whole grain resulting from the husking process and broken grains and cracked grain percentage (Ali and Shatti, 2006).

$$P_{Fg} = \frac{W_{Fg}}{W_s} \times 100 \quad (4)$$

Where:

$P_{Fg}$ : proportion of whole grain (%),

$W_{Fg}$ : weight whole grain (g),  
 and  $W_s$ : weight of rice sample used (g).

### Husking efficiency

The husking efficiency was determined by using Eq. 5 (Minaei *et al.*, 2007).

$$P_E = \frac{W_s - W_{RU}}{W_s} \times 100 \quad (5)$$

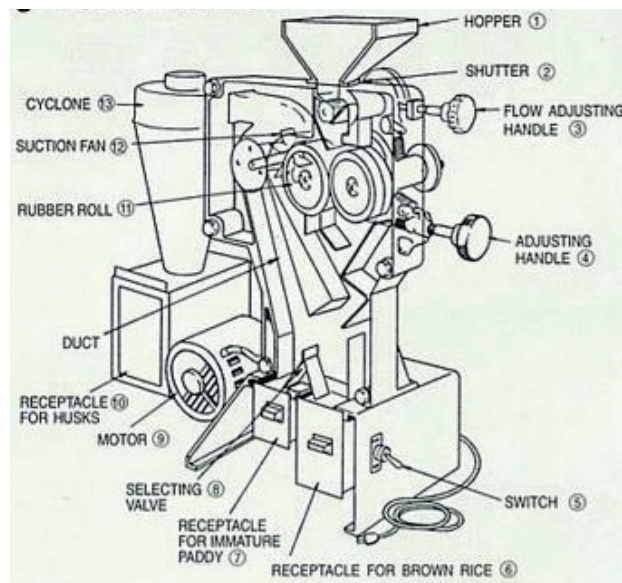
Where:

$P_E$ : husking efficiency, (%),  
 $W_{RU}$ : weight of rice unpeeled (g) and  
 $W_s$ : weight of rice sample used (g).

The same method was used with the same cultivars (TH and DM) to test Yanmar type machine at grain moisture content in the range 12-14%, and clearances of 0.4 mm and 0.6mm in three replications. The results were analysed statistically using the complete randomized design CRD and for each factor the difference among treatments was tested according to the L.S.D test (Alsahoeke and Cream, 1990).



1: The machine (Yanmar type) which is used for hulling rice

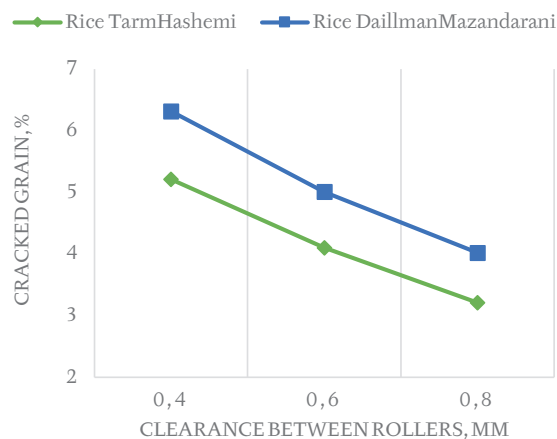


2: The schematic diagram of the Yanmar type machine which is used for hulling rice

I: The effect of clearance on percentage of cracked grain for two rice cultivars.

Cultivar	Clearance between cylinders, mm			Means of cultivar, %
	0.4	0.6	0.8	
Tarm Hashemi	5.21	4.10	3.21	4.177
Daillman Mazandarani	6.313	5.009	4.023	5.115
L.S.D=0.05				0.043
Means of clearance, %	5.765	4.555	3.619	
L.S.D=0.05		0.101		

L.S.D means significant different



3: The effect of clearance on the percentage of cracked grain for two rice cultivars

## RESULTS AND DISCUSSION

### Cracked grain

The influence of clearance between cylinders on percentage of cracked grain is shown in Tab. I for both TH and DM cultivars. The clearance at 0.4 mm showed the highest cracked grain of 5.765%, while the lowest broken rice of 3.619% was for 0.8 mm clearance, because at higher clearance between cylinders the pressure on the grain in the hulling chamber is lower and leads to decrease the cracked grain percentage. These findings are consistent with the findings of (Troung *et al.*, 2007). It is indicated that the cracked grain of the TH cultivar (4.177%) is significantly better than DM cultivar (5.115%). These results are consistent with the results of (Williams *et al.*, 2002). The level of the breakage grain at different conditions is shown in Fig. 3 for both rice cultivars.

### Broken rice

The influence of clearance between cylinders on percentage of breakage rice is shown in Tab. II for both cultivars. The clearance at 0.4 mm showed the highest broken rice of 7.818%, while the lowest broken rice of 5.880% was for 0.8 mm clearance, because the ease grain flow leads to the decrease the proportion of breakage of grain, with increased clearance between cylinders. It is indicated that the broken rice of the TH cultivar (6.391%) is significantly better than DM cultivar (7.295%).

These results are consistent with the results of (Ohtsubo *et al.*, 2005). The level of the breakage grain at different conditions is shown in Fig. 4 for both rice cultivars.

### Brown rice percentage

The influence of the clearance between cylinders on percentage of brown rice is shown in Tab. III. The clearance at 0.8 mm showed the highest brown rice of 81.167%, while the lowest brown rice 79.607% was for 0.4 mm clearance. The TH cultivar with average of 80.915% was significantly better than the DM cultivar with average of 79.931%, because of the difference in the percentage of husk weight. The results are similar to the result of (Alsharifi *et al.*, 2016a). The levels of the brown rice at different conditions are shown in Fig. 5 for both rice cultivars.

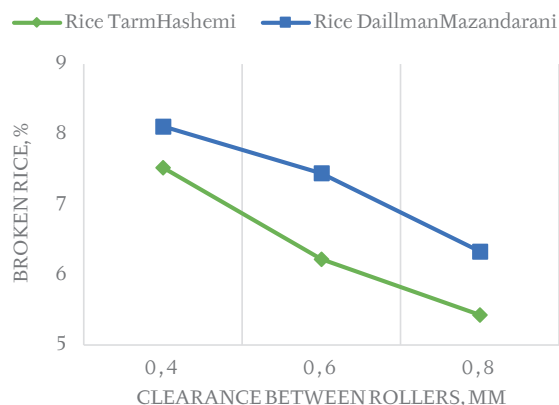
### Husking efficiency:

The influence of the clearance between cylinders on husking efficiency for both TH and DM cultivars is shown in Tab. IV. The clearance at 0.8mm showed the highest husking efficiency of 83.959%, while the lowest husking efficiency of 80.533% was for 0.4 mm clearance. The decrease of the husk efficiency is due to blockage cavities of the machine at low clearance. These results are consistent with the results gained by (Chung *et al.*, 2003). The TH cultivar (82.612%) was significantly better than the DM cultivar (81.397%).

II: The effect of clearance on percentage of breakage grain for two rice cultivars.

Cultivar	Clearance between cylinders, mm			Means of cultivar, %
	0.4	0.6	0.8	
Tarm Hashemi	7.526	6.219	5.429	6.391
Daillman Mazandarani	8.108	7.445	6.331	7.295
L.S.D = 0.05				0.055
Means of clearance, %	7.817	6.832	5.880	
L.S.D = 0.05		0.103		

L.S.D means significant different

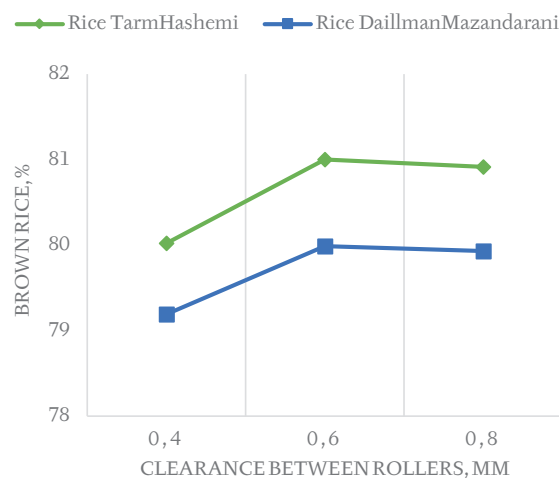


4: The effect of clearance on the percentage of breakage grain for two rice cultivars

III: The effect of clearance on percentage of brown rice for two rice cultivars.

Cultivar	Clearance between cylinders, mm			Means of cultivar, %
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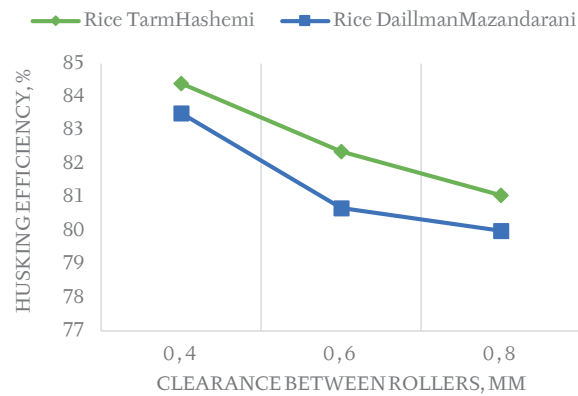


5: The effect of clearance on the percentage of brown rice for two rice cultivars

## IV: The effect of clearance on husking efficiency for two rice cultivars.

Cultivar	Clearance between cylinders, mm			Means of cultivar, %
	0.4	0.6	0.8	
<b>Tarm Hashemi</b>	84.406	82.367	81.064	82.612
<b>Daillman Mazandarani</b>	83.511	80.678	80.001	81.397
<b>L.S.D=0.05</b>				0.068
<b>Means of clearance, %</b>	83.959	81.523	80.533	
<b>L.S.D=0.05</b>		0.124		

L.S.D means significant different

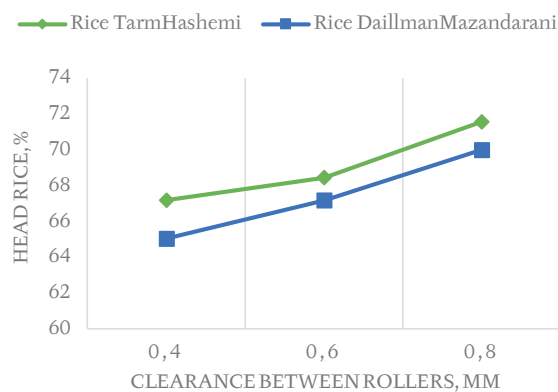


6: The effect of clearance on husking efficiency for two rice cultivars

## V: The effect of clearance on head rice percentage for two rice cultivars.

Cultivar	Clearance between cylinders, mm			Means of cultivar, %
	0.4	0.6	0.8	
<b>Tarm Hashemi</b>	67.183	68.448	71.559	69.063
<b>Daillman Mazandarani</b>	65.052	67.181	70.007	61.413
<b>L.S.D=0.05</b>				0.047
<b>Means of clearance, %</b>	66.118	67.815	70.783	
<b>L.S.D=0.05</b>		00.99		

L.S.D means significant different



7: The effect of clearance on the percentage of head rice for two rice cultivars



This is due to the difference between cultivars kernel lengths. The longest kernel is subjected to more share and friction forces between husk rolls than the shorter one. These results are in correspondence with the results achieved by (Al Wakel and Abdul Karim, 1999). The level of the husking efficiency at different conditions is shown in Fig. 6 for both rice cultivars.

### Head rice yield

The influence of the clearance between cylinders on husking efficiency for both TH and DM cultivars

is shown in Tab. V. As increasing the clearance leads to increase of the head rice percentage, the results were 66.118, 67.815 and 70.783% at different clearance, because effort on grain decreases with the increasing the clearance between cylinders, hence percentage of breakage grain decreased and percentage of whole grain increases. The TH cultivar (69.063%) was significantly better than the DM cultivar (61.413%), because of the difference on the percentage of husk weight. The results agreed with the finding of (Ali and Shatti, 2006). The levels of the head rice at different conditions are shown in Fig. 7 for both rice cultivars.

## CONCLUSION

The effect of clearance between cylinders on mechanical damage of processed rice for two cultivars of Tarm Hashemi and Daillman Mazandarani was studied. The TH cultivar was significantly better than the DM cultivar in all studied conditions. The clearance of 0.8 mm was significantly superior to the other two clearances of 0.4 and 0.6 mm. The results showed better conditions for the overlap between the rice TH cultivar and 0.8mm clearance as compared to the overlap of the rice DM with other clearances. All the interactions were significantly different and the best results have come from the overlap between TH cultivar and 0.8 mm clearance in all studied conditions.

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