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EFFECT OF MOISTURE CONTENT, CLEARANCE AND MACHINE TYPE ON SOME QUALITATIVE CHARACTERISTICS OF RICE (TARM HASHEMI) CULTIVAR

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Abstract

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This research includes the using of two types of machines (Satake and Yanmar),under three levels of clearance between cylinders 0.4 , 0.6 and 0.8 mm and three levels of moisture content 10–12%, 12–14% and 14–16%. Are considered for the test cracked grain percentage, brown rice percentage, husking efficiency, head rice percentage and broken rice percentage. The results indicate that the Satake type machine is significantly better than the Yanmar type machine in all studies properties. While clearance 0.8 significant superiorly than two levels 0.4, 0.6 mm in all studies properties, In addition moisture content 10–12% is superior significantly than two levels 12–14%, 14–16% in all studied properties. The overlap between the Satake type machine and grain moisture content 10–12% superior significantly and also overlap between the Satake type machine and clearance 0.8. in all studied properties. The best results have come from the triple overlap among Satake type machine, grain moisture 10–12%, and clearance 0.8 mm in all studies properties.

Key words: machine , grain moisture, clearance, husking, quality, rice

Introduction

Rice (*Oryza sativa* L.) is one of the leading food crops of the world and is second only to wheat in terms of annual production for food use. is crucial to food security for at least half the world population. New varieties with high yield potential, good quality and high resistance to biotic and abiotic stresses are needed in order to meet the demand for more food arising from the rapid human population growth and concurrent decrease in arable land (Lee, 2015). Reported that brown rice with 15 and 17% moisture contents has relatively higher values for all quality tests as compared to those of the other rice samples with the exception of cracked brown rice ratio. The cracked brown rice ratio increased with the increase in moisture content ($p < 0.05$), whereas hardness of the brown rice decreased with the increase in moisture content ($p < 0.05$). These results suggest that paddy rice with 15–17% moisture content produce high quality brown rice (Al Maamouri et al., 2008). Studied the effect of moisture content on the rice breakage during the milling process the samples used are with moisture content of 12 to 16% and concluded that rice breakage decreased with decrease of paddy moisture (Jia et al., 2005). The principal constituent of brown rice is the starch, whose properties are higher hardness and brittleness of brown rice with low moisture content, which is easy to appear the crack and broken rice during the rice milled. Moreover, the rice with a low glabrous degree,as the similar reason, also causes the energy consumption increasing (Chung et al., 2003). Explored that the comparison of milling efficiency factors between experimental results and simulation results. The differences of hulling efficiency, milling efficiency, milled paddy recovery between experiment and simulation are 0.4, 0.7, 0.4%, respectively. Although the simulation results are

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a little lower than experimental ones, they are close. The materials produced in the processes of simulation are compared with those in experiment (Shoughy, 2008). Concluded that the brown rice whose moisture content was 12.5%, was used as raw material. The brown rice was grouped,then moisturized differently and milled. While milling, the energy consumption, the rate of broken rice and the crack rate were tested. It is confirmed that the stress crack owing to the moisture added to the brown rice can be avoided when the moisture amount added once is limited to no more than 1.5%. It is also proved that the energy consumption can be reduced, the yielding rate of rice can be increased and the quality of rice can be improved (Al Sharifi et al., 2010). Have showed that broken grain size which is less than a quarter of the length of the pill and back are due to several factors, including the organization of machine and moisture grain during the manufacturing stage in addition to the mechanical stresses experienced by the grain harvest in the pre-manufacturing stage.

Materials and Methods

The experiment has been carried out in the laboratory of Tehran University in season of 2014–2015 using two types of hulling machines experiment (Satake and Yanmar) (Figure I and II) is a main factor are under three grain moisture levels 10–12%, 12–14% and 14–16%.The secondary factors are three clearance levels 0.4, 0.6 and 0.8 mm which are under secondary factors, random samples are taken paddy cultivar (Tarm Hashemi) by probe and collected on a form of heaps and the number of heaps are six. Each heap weight 160 kg, according to the method used by (Alshrifi et al., 2009). Paddy is cleaned to remove all exotic matters,broken and immature grains using sieves. Then the random samples are taken from per heaps weight 1000 gm. The initial moisture content of paddy grain is determined by oven drying methods at 103°C for 48 h according to the method used by (Sacilik et al., 2003). The paddy is kept in an oven at temperature of 43°C and monitored carefully of Tarm Hashemi cultivar when determining the moisture content of grain 14-16% the sample is taken and place in Precision divider to get a sample of weight 200 gm, then the samples are carefully sealed in polythene bags. Then organization of the Satake type machine on clearance between cylinders 0.8 mm and speed 4.7 m\sec. This sample which weight 200 g is placed in the Satake type machine to remove the husk from paddy grain (Figure I).

After taking out the sample from the machine, it is placed in cylindrical insulation device of satake type,will operating time which is adjusted for 2 minutes and the angle of inclination is 25 degree isolate the broken and full grain for all size. The following indicators are calculated:

Fig. I. The machine (type Satake) which is used for hulling paddy

Fig. II. The machine (type Yanmar) which is used for hulling paddy

Percentage of cracked grain

Overexposure of mature paddy 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 results in reduces milled rice recovery and head rice yields. Equation (1) (Ali et al., 2006)

$$P_{cg} = \frac{W_{cg}}{W_S} \times 100, \quad (1)$$

where: P_{cg} is proportion of cracked grain (%), W_{cg} is weight cracked grain (g) and W_S is weight sample used (g).

Percentage of brown rice

The Equation (2) represents the amount of grain produced by the process of husking which included percentage of breakage and percentage of cracked grain (Alwakel 1999):

$$P_{obr} = \frac{W_{br}}{W_S} \times 100, \quad (2)$$

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

The husking efficiency

The husking efficiency is determined by using Equation (3) (Minaei et al., 2007):

$$P_E = \frac{W_S - W_{RU}}{W_S} \times 100, \quad (3)$$

where; P_E is the husking efficiency (%), W_{RU} is weight of paddy unhuskinged (g) and W_S is weight of paddy sample used (g).

Precentage of head rice

Equation (4) represents the amount of head rice resulting from the husking process and is free of broken grains (Ali et al., 2007).

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

where: P_{Fg} is the proportion of whole grain (%), W_{Fg} is weight head rice (g) and W_S is weight of rice sample used (g).

Proportion of breakage rice:

The Equation (5) is used to calculate the percentage of the head rices and brokens in the separation process of the broken rice from the whole grains (Gbabo et al., 2014)

$$P_{br} = \frac{W_{br}}{W_S} \times 100, \quad (5)$$

where P_{br} is the proportion of breakage rice (%), W_{br} is the weight of breakage grain (g) and W_S is the weight of rice sample used (g).

Then by repeating the same method and measurements of the previous using of the Satake type machine, grain moisture content 12–14%, 14–16% and clearances 0.6, 0.4 mm and three replications for paddy cultivar (TH). Then by repeating the same steps and all accounts using of the Yammer type machine and each moisture content of grain and each clearance . Results are analyzed statistically using the design C R D and tested the difference among treatment each factor according to the test LSD less significant difference 0.05 (Alsahoeke et al., 1990) .

Results and Discussion

Cracked grain

Table 1 shows the influence of the type of machine, clearance, and grain moisture on the percentage of cracked grain %. The results indicate that increasing the clearance between

Table 1

The effect of machines types, clearance and grain moisture on percentage of cracked grain %

	The overlap between Machines , Grain Moisture and Clearance				
Machines	Grain Moisture	Clearance between cylinder			The overlap between Machines and Moisture
		0.4	0.6	0.8	
Yanmar	10-12%	5.569	4.312	3.693	4.525
	12-14%	6.585	5.930	4.910	5.833
	14-16%	6.924	5.600	4.867	5.797
Satake	10-12%	4.768	4.079	3.007	3.951
	12-14%	6.180	5.473	4.083	5.245
	14-16%	6.544	5.937	4.468	5.650
L.S.D=0.05			0.274		0.158
Average of Clearance		6.107	5.222	4.171	
L.S.D=0.05			0.112		
Machines	The overlap between Machines and Clearance				Average of Machines
Yanmar	6.384		5.281	4.490	5.385
Satake	5.830		5.163	3.853	4.949
L.S.D=0.05		0.158			0.091
Grain Moisture	The overlap between Grain moisture and Clearance				Average of Grain moisture
10-12%	5.168		4.196	3.350	4.238
12-14%	6.419		5.702	4.496	5.539
14-16%	6.734		5.769	4.668	5.723
L.S.D=0.05			0.194		0.112

cylinders leads to decrease the cracked grain percentage, and the results are 6.107, 5.222 and 4.171% respectively. Because the low pressure on the grain in the husking chamber hence decrease cracked grain percentage with increased clearance between cylinders. These results are consistent with the results that gained by (Lee, 2015). As for the increasing the grain moisture leads to increasing of the cracked grain percentage, and the results are 4.238, 5.539 and 5.723% respectively. This is due to the fragility of the rice grains and increasing the pressure, this leads to increase the percentage of cracked grain with grain moisture increase. This is consistent with (Ali et al., 2006). However the Satake type machine is significantly better than the Yanmar type machine and the results are 5.385 and 4.949% respectively. This is due to the efficiency and engineering design of the machine and finishing the works with less time as compared the Yanmar type machine. The levels of the brown rice percentage at different conditions is shown in Figure 1 for two machines, moisture content and clearance.

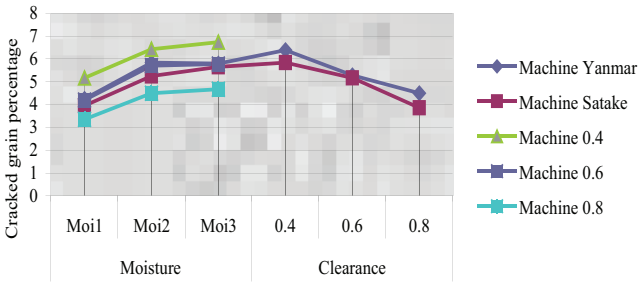

Fig. 1. The effect of grain moisture and clearance on the percentage of cracked grain for two machines

Percentage of brown rice

The influence of the type machine,clearance and moisture content on the brown rice percentage. At moisture content of 10 to 12% has the highest brown rice percentage of 82.158%, and moisture content of 14 to 16% has the lowest brown rice percentage of 80.889. from Table 2 it is indicated that the Satake type machine is significantly better than the Yanmar type machine. The results which get to are 81.307 and 81.723% respectively. This is due to there is positive relationship between percentage of raw rice and percentage of Palea and Lemma. when used the Satake type machine as compared the Yanmar type machine. These findings are consistent with the findings of Jia et al. (2005). Increasing the clearance between cylinders leads to increase the percentage of brown rice , and the results are 80.937 , 81.552 and 82.080 % respectively. This is due to

Table 2
The effect of machines types, clearance and grain moisture on percentage of brown rice %

	The overlap between Machines, Grain Moisture and Clearance				
Machines	Grain Moisture	Clearance between cylinder			The overlap between Machines and Moisture
		0.4	0.6	0.8	
Yanmar	10-12%	81.087	81.976	82.525	81.863
	12-14%	80.988	81.507	81.911	81.469
	14-16%	80.125	80.630	81.014	80.590
Satake	10-12%	81.997	82.387	82.976	82.453
	12-14%	81.035	81.501	81.992	81.509
	14-16%	80.953	81.309	81.819	81.206
L.S.D=0.05			0.176		0.102
Average of Clearance		80.937	81.552	82.040	
L.S.D=0.05			0.072		
Machines	The overlap between Machines and Clearance				Average of Machines
Yanmar	80.733		81.371	81.817	81.307
Satake	81.174		81.732	82.262	81.723
L.S.D=0.05			0.102		0.058
Grain Moisture	The overlap between Grain moisture and Clearance				Average of Grain moisture
10-12%	81.542		82.182	82.750	82.158
12-14%	81.012		81.504	81.952	81.489
14-16%	80.281		80.969	81.417	80.889
L.S.D=0.05			0.125		0.072

milling process quality with increasing clearance among cylinders hence decreased percentage of raw rice .These results are consistent with the results that gained by (Shoughy, 2008) . The best results 82.976% have come from the triple overlap among Satake type machine, grain moisture 10-12%, and clearance 0.8 mm. The levels of the brown rice percentage at different conditions is shown in Figure 2 for two machines, moisture content and clearance.

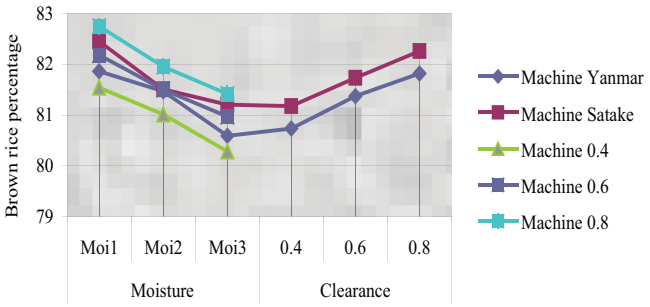

Fig. 2 The effect of grain moisture and clearance on the percentage of brown rice for two machines

The husking efficiency

The influence of the type machine,clearance and moisture content on the husking efficiency. At clearance between cylinders 0.4 mm has the highest husking efficiecy of 84.490%, and clearance between cylinders 0.8 mm has the lowest husking efficiency of 81.764%. From Table 3 it is indicated that the Satake type machine is significantly better than the Yanmar type machine. The results which get to are 84.589 and 82.494% respectively .This is due that of the machine fit required volume of work hence increasing the husking efficiency as for Satake type machine and decrease the cylinders. These results are consistent with the results that gained by (Mineai et al., 2007). As for the increasing the grain moisture leads to decreasing of the husking efficiency, and the results are 85.336, 83.578 and 81.711% respectively, with the increase percentage 2.1 and 2.3% respectively. This is due to the non-use of energy available to the entire machine , due to blockage of the cavities of the machine when increasing the moisture content of grain hence decreasing the husking efficiency. This is consistent with (Chung et al., 2003). The best results 87.936% have come from the triple overlap among Satake type machine, grain moisture 10-12%, and clearance 0.8 mm. The levels of the brown rice percentage at different conditions is shown in Figure 3 for two machines, moisture content and clearance.

Table 3
The effect of machines types, clearance and grain moisture on husking efficiency %

	The overlap between Machines ,Grain Moisture and Clearance				
Machines	Grain Moisture	Clearance between cylinder			The overlap between Machines and Moisture
		0.4	0.6	0.8	
Yanmar	10-12%	86.822	84.045	82.237	84.368
	12-14%	84.175	82.092	80.134	82.134
	14-16%	82.972	80.420	79.551	80.981
Satake	10-12%	87.936	86.680	84.297	86.304
	12-14%	86.884	84.526	83.653	85.021
	14-16%	84.148	82.462	80.716	82.442
L.S.D=0.05			0.142		0.082
Average of Clearance		85.490	83.371	81.764	
L.S.D=0.05			0.058		
Machines	The overlap between Machines and Clearance				Average of Machines
Yanmar	84.656		82.186	80.641	82.494
Satake	86.323		84.556	82.888	84.589
L.S.D=0.05			0.082		0.047
Grain Moisture	The overlap between Grain moisture and Clearance				Average of Grain moisture
10-12%	87.379		85.363	83.267	85.336
12-14%	85.530		83.309	81.894	83.578
14-16%	83.560		81.441	80.133	81.711
L.S.D=0.05			0.101		0.058

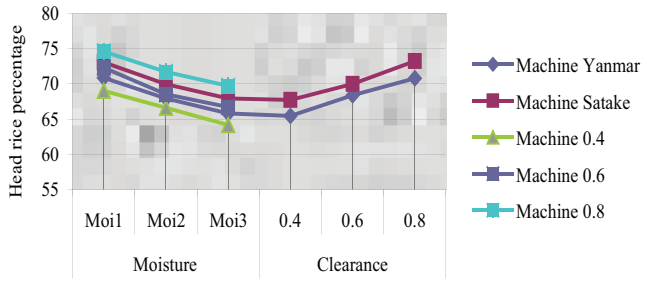

Fig. 3 The effect of grain moisture and clearance on the husking efficiency for two machines

Percentage of head rice

Table 4 shows the influence of the type of machine, clearance, and grain moisture on the head rice percentage. The results indicate that the Satake type machine is significantly better than the Yanmar type machine. The results that gained it are 70.341 and 68.224 % respectively. This is due to decrease broken rice when using of Satake type machine as compared with Yanmar type machine which gives highest percentage of breakage hence decrease head rice percentage. These results are consistent with the results that gained by (Ali et al., 2007). Increasing the clearance between cylinders leads to increase the percentage of head rice, the results are 66.620, 69.361 and 72.332% respectively. Because increasing the percentage of breakage with the decreasing clearance between cylinders and reflected negatively on the ratio of head rice. These results are consistent with the results that gained by (Alsharifi, 2010). As for the increasing the grain moisture leads to the decreasing of the percentage of head rice,and the results are 71.992, 68.959 and 66.896% respectively. This is due to the increasing of broken grains, bran as well as ratio of cracked grain leads to decrease the percentage of head rice. This is consistent with (Ali et al., 2007). The best results 75.770% have come from the triple overlap among Satake type machine, grain moisture 10-12%, and clearance 0.8 mm. The levels of the head rice percentage at different conditions is shown in Figure 4 for two machines, moisture content and clearance.

Percentage of breakage grain

Table 5 shows the percentage of the broken rice of two machine types at different levels of moisture and clearance between cylinders. The results showed significant effects of difference in moisture content on breakage percentage. Increasing the moisture content achieved increase in breakage percentage which is 5.928% .Where as the highest break-

Table 4
Effect of machines types, clearance and grain moisture on percentage of head rice %

	The overlap between Machines, Grain Moisture and Clearance				
Machines	Grain Moisture	Clearance between cylinder			The overlap between Machines and Moisture
		0.4	0.6	0.8	
Yanmar	10-12%	67.785	71.463	73.432	70.900
	12-14%	65.390	67.675	70.787	67.951
	14-16%	63.265	66.034	68.164	65.821
Satake	10-12%	70.312	73.171	75.770	73.084
	12-14%	67.834	69.396	72.673	69.968
	14-16%	65.133	67.448	71.332	67.971
L.S.D=0.05			0.361		0.208
Average of Clearance		66.620	69.198	72.029	
L.S.D=0.05			0.147		
Machines	The overlap between Machines and Clearance				Average of Machines
Yanmar	65.480		68.391	70.801	68.224
Satake	67.760		70.005	73.258	70.341
L.S.D=0.05			0.208		0.120
Grain Moisture	The overlap between Grain moisture and Clearance				Average of Grain moisture
10-12%	69.049		72.317	74.611	71.992
12-14%	66.612		68.536	71.730	68.959
14-16%	64.199		66.741	69.748	66.896
L.S.D=0.05			0.255		0.147

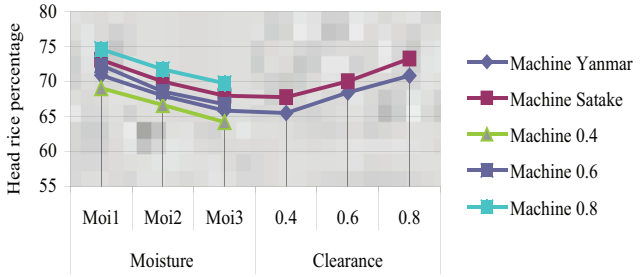

Fig. 4 The effect of grain moisture and clearance on the head rice percentage for two machines

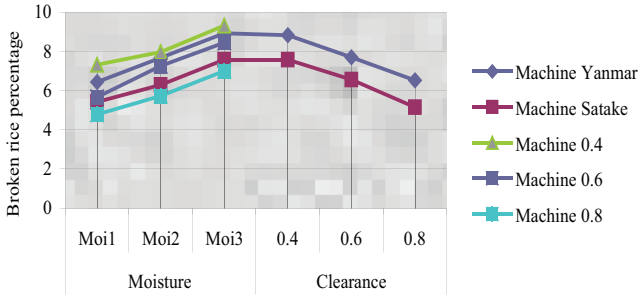

Fig. 5 The effect of grain moisture and clearance on the broken rice percentage for two machines

age percentage accompanied 8.261%. This is due to low the effort damocles on grains when using Satake type machine as compared with Yanmar type machine. with high increase because the ease grain flow, lead to increase the proportion of breakage grain , with increased moisture content. This is consistent with (Almaamouri et al., 2008). Increasing the clearance between cylinders leads to decrease the breakage percentage of the machine, and the results are 8.210, 7.132 and 5.839%respectively. However the Satake type machine is significantly better than the Yanmar type machine. The results that gained it are 6.433 and 7.687% respectively. The percentage of breakage increased 19.4% .The reason for this is efficiency and type of machine as well as their ability to perform the requested operation. These findings are consistent with the findings of (Gbabo et al., 2014). The best results 4.199% have come from the triple overlap among Satake type machine, grain moisture 10-12%, and clearance 0.8 mm. The levels of the broken rice percentage at different conditions is show in Figure 5 for two machines, moisture content and clearance.

Table 5
The effect of machines types, Clearance and Grain moisture on proportion of breakage rice %

	The overlap between Machines ,Grain Moisture and Clearance			
Machines	Grain Moisture	Clearance between cylinder		
		0.4	0.6	0.8	The overlap between Machines and Moisture
Yanmar	10-12%	7.733	6.201	5.380	6.438
	12-14%	8.939	7.902	6.214	7.685
	14-16%	9.836	8.996	7.983	8.938
Satake	10-12%	6.917	5.137	4.199	5.418
	12-14%	7.022	6.631	5.237	6.297
	14-16%	8.811	7.924	6.019	7.585
L.S.D=0.05		0.203			0.117
Average of Clearance		8.210	7.132	5.839	
L.S.D=0.05		0.083			

Machines	The overlap between Machines and Clearance			Average of Machines
Yanmar	8.836	7.700	6.526	7.687
Satake	7.583	6.564	5.152	6.433
L.S.D=0.05		0.117		0.086

Grain Moisture	The overlap between Grain moisture and Clearance			Average of Grain moisture
10-12%	7.325	5.669	4.789	5.928
12-14%	7.981	7.267	5.726	6.991
14-16%	9.324	8.460	7.001	8.261
L.S.D=0.05		0.143		0.083

Conclusions

The Satake type machine is significantly better than the Yanmar type machine ,the grain moisture content 10-12% superior significantly on the two levels 12-14%, 14-16% and the clearance between cylinders 0.8 mm superior significantly on two clearance 0.4 , 0.6 mm in all studied properties. The overlap between the Satake type machine and moisture content 10-12% superior significantly. And also overlap between the Satake type machine and clearance is 0.8 mm, as compared the overlap of the Yanmar type machine with moisture content and clearance between cylinders in all studied properties. The best results have come from the triple overlap between Satake type machine, grain moisture (10-12%), and clearance 0.8 mm.

Recommendations

The present recommends to carry out future studies using other of machinery types and other varieties of paddy.

Conduct other organizations on machine and the moisture content of grain to know their effect on the qualitative characteristics of paddy.

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The research unsheathed from ph.D. thesis for the first researcher

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(b) The first page should include the title, author's names and their affiliations

(c) The text should include Introduction, Materials and Methods, Results, Discussion, Conclusion, Acknowledgements (if any) and References

References

(a) The references in the text should be cited as the name of the first author plus "et al.", followed by the year of publication

(b) The reference list should be in alphabetical order

Tables

(a) The tables should be as simple and as few as feasible for the presentation of the essential data. They should be in Word or Excel program and in separate files, not in the text

(b) Explanations essential to the understanding of the table should be given at the bottom marked in an appropriate way

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Your disk should be submitted to the editorial secretariat or the article should be send by e-mail

The preferred word-processing packages are Word, WINDOWS

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