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Effects of Drying Temperature and Final Grain Moisture Content of Paddy On Grain Cracks

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Abstract: Paddy is one of the most important grains that need to be dried before storage and milling process**.** The most important factors that have a remarkable effect on rice quality losses are drying temperature and final moisture content. Thus in this research, two basic factors of cracking in the milling process were investigated using factorial experiment by randomized complete block design with three replications. The independent variables included: rice variety (Bahar1 and Tarom), drying temperature (40, 45, 50 and 55˚C) and final grain moisture content (10-11, 11-12 and 12-13% w.b.). Results showed that the Tarom variety was more sensitive to cracking. Also Tarom variety was sensitive to temperature of drying while Bahar1 variety was more sensitive to final grain moisture content. Drying temperature of 40 and 45˚C and final moisture content of (12-13)% is recommended to decrease amount of cracking for Tarom and Bahar1 varieties respectively.

Key words: Drying, paddy, crack percentage, final grain moisture content

INTRODUCTION

Among the cereals, rice (Oryza sativa L.) is one of the main products and the second most consumed food crop in the world. In Asia, 95% of the world's rice is produced and consumed. In Iran, rice is one of the most important cereal grains with the production of 3 million tons per 615000 hectares (Alizadeh et al., 2006; Farahmandfar et al., 2009). After harvesting of paddy, the thresher is used to separate the grain from the husk. At this stage, the first mechanical impact damages the paddy. After threshing, the grain for making to white rice is milled. Milling is one of the most important stages is in rice processing (Yadav and Jindal, 2008). In order to carry out milling, the grain moisture content must be reduced for milling. Moisture content of paddy before drying depends on climate harvesting time and ripe grain and is variable (13-18)% w.b. typically. In the drying stage, the rice grains were affected by high thermal stresses. Doing optimal conditions, percentage of broken rice will reduce (Khosh Zamir, 1993; Sabori, 2002; Hashemi Solimani, 1997).

Hedayatipoor et al. (2003) studied four varieties of rice at three temperature levels of 40, 45 and 50 ^{o}C and moisture content levels (10-11, 11-12 and 12-13)% w.b. They found that varieties had significant differences for broken percentage and milling index at 95% level. There was no significant temperature effect on the dependent variable.

Arefi (2000) studied two varieties of rice at four temperature levels of 35, 40, 45 and 50 ^{o}C and moisture content levels (10-11, 11-12 and 12-13)% w.b. He found that main effect of variety, misture content and temperature had significant differences for broken percentage at 99% level.

Minaee et al. (2005) carried out two varieties of rice at three temperature levels of 40, 50 and 60 ^{o}C and moisture content levels (10, 12 and 14)% w.b. They found that 40 ^{o}C and 14% moisture content, was the best conditions for reduction of broken rice and crack grain.

In a research, the effect of four levels of husked ratio (HR) of 0.6, 0.7, 0.8 and 0.9 on broken brown rice

(BBR), broken milled rice (BMR) and rice whiteness (RW) was examined. Three common Iranian rice varieties, namely Binam, Khazar and Sepidroud were used as raw materials. The results revealed that the BBR increased significantly (P<0.01) from 7.42 to 10.28%, 9.17 to 13.39% and 15.17 to 21.82% for Binam, Khazar and Sepidroud varieties, respectively as the HR increased from 0.6 to 0.9 (Alizadeh, 2011).

In other research, the effect of mesh size and rotor blades distance on performance of the rice milling were examined (Firouzi et al., 2010).

Cihan et al. (2007) investigated various mathematical models in describing the intermittent drying characteristics of thin layer rough rice. Experimental values for drying temperature 40 ^oC, drying velocity 1.5 ms^{-1} and tempering period ranging from 0 h to 1 h were fitted to the theoretical models to relate the parameters of the drying models with the drying conditions. The Midilli model was found to be the most adequate model in describing the intermittent drying of thin layer rough rice.

In a study, suitability of several drying models available in literature in defining thin layer drying behaviour of long-grain rough rice has been examined by using statistical analysis. For this purpose, drying models have been fitted to experimental data by means of the coefficients in the models for the drying air temperatures 40, 45, 50, 55 and 60 ^oC and at an airflow rate of 1.5 and 3.0 ms^{-1}. The results showed that the Midilli et al. is the most appropriate model for drying behaviour of thin layer rough rice (Hacihafizoglu et al., 2008).

MATERIALS and METHOD

In this research, The effect of drying temperature at four levels (40, 45, 50 and 55 °C) and final moisture content of paddy on three levels (10-11, 11-12 and 12-13)% w.b. for both varieties, Bahar 1 and Tarom on increasing 0f crack percentage (ICP) of rough rice were investigated. The data were analized by factorial experiment in randomized complete block design with three replications. Samples were selected from experimental fields with same management and irragation. Digital grain moisture meter (Kia Seisakusho, SP-1D model, accuracy ±0.5%) used for measuring of moisture grain paddy which was about (14-16)% w.b. After threshing and before drying, the cracks of sampels were counted by crack viewer instrument which were 12% and 14% for Bahare 1 and Tarom varieties respectively. The fixed-bed dryer was used for drying. Dryer construction was consist of: blower, electrical heater, product holding tray and chamber. After the desired temperature was set, the dryer worked 30 minutes to obtain uniform conditions. Then sampels were put in the dryer. The sampels were dried until the moisture content of them reach to desired level. Then, a 250 g dried sampel was selected randomly and 100 numbers of intact and without fractures grains were randomly selected and peeled by hand. Then, the cracks of sampels were counted again. The differences between primary and secondary cracks were used for analysis of variance by SPSS 21 software. Averages were compared by Duncan's multiple range test.

RESULTS and DISCUSSION

The results showed main effects of the all factors on the ICP of grains were significant at 95% level.

Main effect of variety factor

The main effect of variety on ICP was significant, so they were in two different groups, with averages 22.6% and 16% for Tarom and Bahar 1 varieties respectively. It may that Tarom variety has less resistance against temperature and final miosture content than Bahare 1. This can relate to genetic characteristics of each variety. Minaee et al. (2005) and Arefi (2000) pointed to that different varieties showed different sensivitivity against causes cracks.

Main effect of temperature factor

As seen from Figure 1, 50 and 55 °C temperatures are more effective on ICP and there are difference between 40 and 45 ^oC levels and 50 and 55 ^oC levels. It may increase in temperature accelerates desorption of water and transfer it to the surface of grain. This may cause tensile stress at the surface of the grain and compressive stress at the center of the grain. If this stress was been more than strength of the grain, caused it is cracked and broken. This result conformity with Minaee et al. (2005) and Arefi (2000) results and disagreement with Hedayatipoor et al. (2003) results.

Main effect of final moisture content factor

As seen from Figure 2, the lowest ICP in (12-13)% moisture content is observed. By reducing the moisture content of (12-13)% to (11-12)%, the amount of ICP increased. Reducing the moisture content of paddy is caused internal tensions in milling processing and cracked grains increased and gradient moisture caused fine cracks at surface of the grains. This result conformity with Minaee et al. (2005) results and disagreement with Hedayatipoor et al. (2003) results.

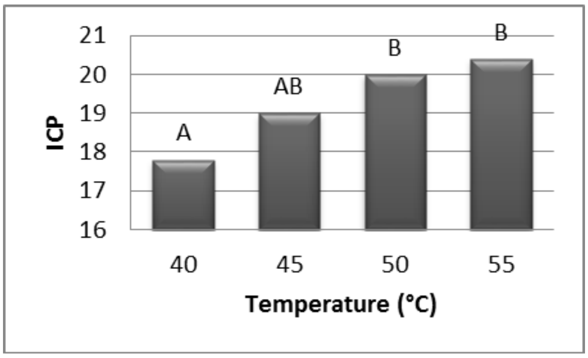

Figure 1. Mean comparison of main temperature effect on ICP of grains

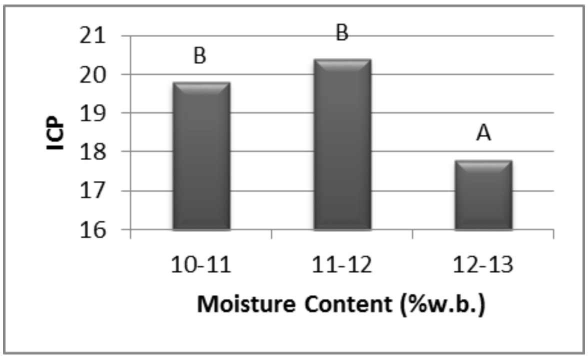

Figure 2. Mean comparison of main moisture content effect on ICP of grains

Interaction effects of factors

Analysis of variance showed interaction between temperature and variety is not significant. It means varieties at different temperatures showed the same reaction for increasing of cracks. As seen from figure 3, created cracks at all levels of temperature for Tarom variety is more than Bahar 1 variety. Amount of cracks has increased during increasing of drying air temperature.

Analysis of variance showed interaction between moisture content and variety is not significant at 95% level too. It means varieties showed the same response to different levels of final moisture content. As seen from figure 4, increased cracks rate from 17.3% decrease to 14.9% with increasing final moisture content levels. In Tarom variety, ICP increased from (10-11)% to (11-12)% moisture content levels and decreased from (11-12)% to (12-13)% moisture content levels. This may Tarom variety is sensitive to moisture content of (11-12)%.

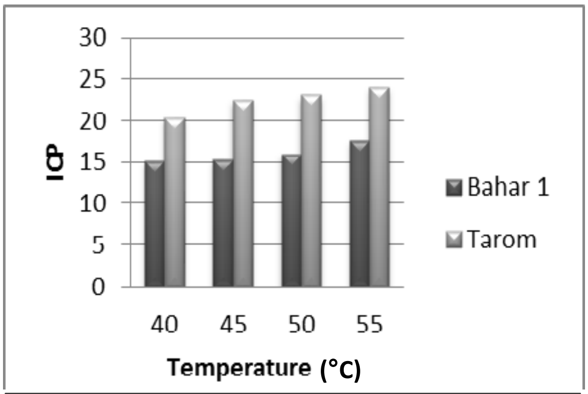

Figure 3. Mean comparison of interaction effect between temperature and variety

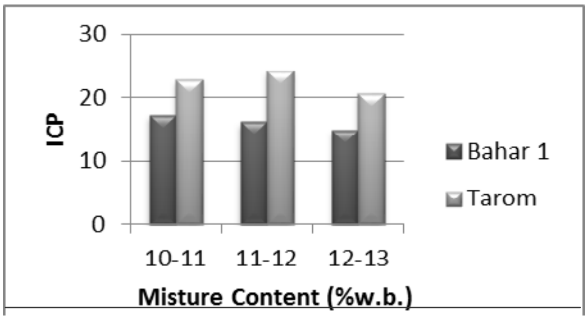

Figure 4. Mean comparison of interaction effect between moisture content and variety

Analysis of variance showed interaction between moisture content and temperature is significant at 95% level for ICP. İt means moisture content and temperature were not the same performance at levels of each other. Figure 5, show the interaction effects between moisture content and temperature for ICP.

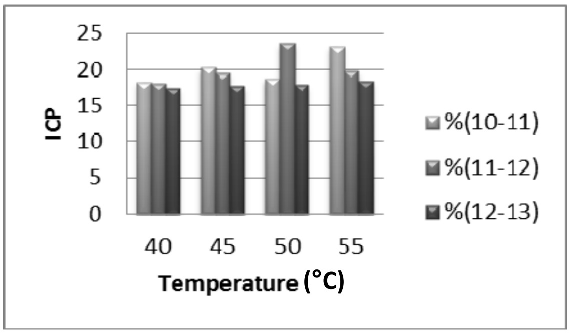

Figure 5. Mean comparison of interaction effect between moisture content and temperature

Also results show triple interaction effect between temperature and moisture content and variety is not significant.

CONCLUSIONS

The followings were concluded from the study:

- Bahar 1 variety is sensetive to air drying tempereture and Tarom variety is sensetive to final moisture content.
- Bahar 1 variety is more resistance than Tarom variety for causes cracks factors.
- The lowest ICP for Bahar 1 variety was 14.3% at 45 °C and (12-13)% w.b. final moisture content.
- The lowest ICP for Tarom variety was 19.7% at 40 °C and (12-13)% w.b. final moisture content.
- Interactions effects between temperature and variety, final moisture content and variety on ICP were not significant and between temperature and final moisture content was significant at 95% level.

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