EFFECT OF RICE MOISTURE AT HARVEST AND ROUGH RICE STORAGE TIME ON MILLING YIELD AND GRAIN BREAKAGE

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Abstract

In this paper was examined the milling yield and the percentage of head rice yield and grain breakage in San Andrea rice variety, depending on paddy moisture content at harvest and time of storage of paddy after harvest. The influence of moisture content in paddy in the time of harvest was analyzed through representative samples of paddy harvested in three different terms in production in 2013 (24.09.2013, 04.10.2013 and 14.10.2013). In paddy harvested in the first term was measured average moisture content of 22.8 %. Moisture content in paddy harvested in the second and third terms was 19.6 % and 16.3 % respectively. The highest milling yield (74.81 %) and head rice yield (64.64 %) was obtained from paddy with the highest average moisture content at harvest time. From the same variant was received the lowest percentage of grain breakage (10.17 %). To determine the influence of paddy time of storage, paddy was processed and kept one, two and three months after harvest. The milling yield and head rice yield from all three terms of harvest was the largest in the processing of paddy one month after harvest. From this variant was obtained the lowest percentage of grain breakage. The best results from variants of factor time of storage again were associated with variant with the highest percentage of moisture at harvest.

Keywords: rice, milling yield, head rice yield, grain breakage.

Introduction

The yield and quality of white rice obtained by paddy processing determine the income of rice producers. They directly depend of yield and paddy quality. The variety, soil, climate conditions, applied technology in production and paddy processing are the main factors that affect on yield and quality of paddy and white rice. For maximum yield of paddy and white rice essential is the time of sowing and harvest, as well as post harvest paddy management. In Macedonia usually the rice is sown from late April to late May. The rice harvest is usually done in the end of September to late October. At the end of rice vegetation, the environmental conditions in rice production regions in Macedonia are characterized with sunshine and relatively high temperature during the day and high relatively humidity at night. In such conditions the grains during the day dried relatively quickly and in the night reabsorbed significant amount of moisture. The changes create cracks in the grains resulting in increased violations of the grains during their processing. Different rice varieties react differently of the appearance of cracks in the grains because water absorption.

Generally, the harvest is conducted when the average moisture content in grain is below 18 %. Ilieva et al. (2009) reported that the optimum time for harvest is when the moisture content in grain is between 18 and 20 %. In all examined varieties they received significantly lower milling yield when paddy was harvested with moisture content above 20 % and below 18 %.

In research of Bautista et al., 2009, the optimal harvest moisture content for long-grain cultivars generally is ranged from 18 to 22 % and 19 to 20 % for medium-grain cultivars. Similar results of these reported Bautista and Siebenmorgen, 2008. Siebenmorgen et al. (2007) reported that head rice yield is a quadratic function of harvest moisture content, which implies that there exists an

optimal harvest moisture content to maximize head rice yield. The optimal harvest moisture content differs depending on cultivar and growing location. They recommend optimal harvest moisture content 18.7 to 23.5 % for long-grains varieties and 21.5 to 24.0 % for medium-grains varieties.

Moisture content in paddy in the moment of harvest, paddy post harvest processing and other factors that influence on yield and quality of white rice are studied by many authors (Saeed and Mohammad, 2013, Akowuah, et al., 2012, Saeed and Mohammad, 2011, Thompson and Mutters, 2006, Thompson et al., 1990). Mainly, the variability of milling yield increases and its amount is reduced when the rice is harvest with lower moisture content. Harvest below 20 % moisture content of grain increases the percentage of grain breakage of all varieties with short and medium grain.

Paddy is harvested at optimum grain maturity at which the grains have an average moisture content of 20 −25 %. Higher moisture content results in more losses from poor grain quality. Lower moisture content results in more losses from shattering. For safe storage grains need to be dried to below 14 %, and seeds should be dried to below 12 %. Ideal moisture content for milling is between 12 – 14 %. (IRRI).

Hashemi et al. 2008 (according Akowuah et al., 2012), reports that fissuring can occur in the field prior to harvest, harvesting, processing and storage. Knowledge about the influence of moisture content in paddy in the moment of harvest and time of paddy storage after harvest, on yield and quality of white rice is extremely important, especially in defining the specific recommendations before and after harvest management with yield and quality of white rice in different rice varieties.

The propose of this research was to investigate the influence of moisture content in paddy in the moment of harvest and time of paddy storage after harvest on milling yield and on grain breakage at San Andrea variety. In Macedonia, more than 90 % in rice production is based on this variety.

Materials and methods

The researches were conducted with Italian rice variety San Andrea. San Andrea variety is medium early variety, with medium long grain and in the recent years has dominant role in rice production in Macedonia. The experimental material is produced in Kocani region, on the experimental area of Faculty of Agriculture, "Goce Delchev" University - Shtip. The sowing was done on 10.05.2013. Standard technology was applied in production. At the end of rice vegetation in three terms (24.09.2013, 04.10.2013 and 14.10.2013) were taken representative samples in four repetitions. The size of each experimental plot was 5 m^2 and manual harvest was applied for the samples from each repetition. Immediately after harvest the grain was separated from the straw and on each sample, in laboratory with standard oven method was determined the average moisture content (the moment of harvest for commercial proposes is determined based on the average moisture content in representative sample. The harvest usually begins when the moisture content drops below 18 %). Then the samples were dried at room temperature to 14 % moisture content in the grain. After drying each sample was divided into three parts for testing the influence of storage time (one month after harvest, two months after harvest and three months after harvest). Paddy samples from the three terms of harvest and three terms of storage, in four repetitions, were processed into white rice with laboratory paddy quality test machine – CRM 125 2T (1,5 minutes). In percentage, from the obtained white rice was calculated the average milling yield, average percentage of head rice yield and average percentage of grain breakage. The received results were statistically calculated according analysis of variance and tested by LSD test.

Results and discussion

Table 1 shows the results obtained from the average values of milling yield, head rice yield and grain breakage in San Andrea variety depending on time of harvest. In paddy obtained from the first term of harvest was measured average moisture content of 22.8 %. Paddy from the second

terms of harvest contains average 19.6 % moisture and from the third term 16.3 %. The highest average milling yield (74.81 %) was obtained from paddy which had the highest average moisture content (22.8 %) at time of harvest. At least white rice (69.86 %) was produced in the paddy processing with the average moisture content of 19.6 %. The difference between the obtained values was statistically highly significant.

The milling yield is determined from the quantity of whole kernels (head rice) and broken kernels produced during the milling of rough rice. Therefore, head, broken and total milled rice are usually expressed as a percentage of the total quantity of the rough rice subjected to the milling procedure. As a common rule, milled rice kernel longer than 75 % of a whole kernel is known as head rice; otherwise identified as broken kernel (Thakur and Gupta, 2006). Head rice yield is the most commonly used indicator of rice milling quality Broken grain has normally only half of the value of head rice (USDA, 2009, Bautista and Siebenmorgen, 2008).

The analysis of the results for percentage of whole grain in white rice shows that the reduction of moisture content at paddy harvest decreases the percentage of whole grains in white rice. Processing of paddy harvested with 22.8 % moisture resulting with white rice with 64.64 % whole grains. The lowest percentage of whole grains (55.18 %) was obtained during the processing of paddy with 16.3 % moisture. From paddy with 19.6 % moisture in harvest was produced white rice with 57.33 % of whole grains. The obtained differences were significantly for both levels of significance. The percentage of grain breakage was higher in white rice obtained from paddy harvested with less moisture content. The percentage of grain breakage in white rice obtained from paddy harvested with 22.8 % moisture was smallest (10.17 %) and from paddy harvested with 16.3 % moisture the percentage of grain breakage was the highest (17.02 %).

Table 1. Average milling yield (head rice yield and grain breakage) of variety San Andrea depending on the moisture content at harvesting (2013)

Date of harvesting	Average moisture content at harvesting (%)	Average milling yield (%)	Head rice yield (%)	Grain breakage (%)
24.09. 2013	22.8	74.81	64.64	10.17
04.10.2013	19.6	69.86	57.33	12.53
14.10.2013	16.3	72.40	55.18	17.02
		LSD ($p \leq 0.05$) 4.04	0.44	
		($p \leq 0.01$) 6.12	0.67	

Tables 2, 3 and 4 show the results obtained from the average values for milling rice and percentage of head rice yield and grain breakage in San Andrea variety depending of time of paddy storage after harvest. The highest average milling yield from all terms of harvest was obtained by paddy processing one month after harvest. The differences were statistically significant compared to the values obtained by paddy processing for two and three months after harvest. Again, mostly milling yield (74.81 %) was produced from paddy with 22.8 % moisture. From the same sample was obtained white rice with the highest percentage of whole grains (4.64 %). The lowest milling yield one month after harvest (57.33 %) was obtained from paddy with 19.6 % moisture, while at least head rice yield (55.18 %) was received from paddy with 16.3 % moisture at harvest. The processing of paddy from all three terms of harvest, after two and three months of harvest result with reduce of milling yield, reduce the head rice yield and increase of grain breakage. The differences were more pronounced among the results from paddy processing after first and second month of harvest, than between the results of paddy processing after second and third month of harvest.

Table 2. Average milling yield (head rice yield and grain breakage) of variety San Andrea depending on the time of storage of paddy after harvesting (2013) - Moisture content at harvesting – 22.8 %

Time of storage of paddy after harvesting (months)	Average milling yield (%)	Head rice yield (%)	Grain breakage (%)
I	74.81	64.64	10.17
II	73.25	62.15	11.10
III	72.30	61.22	11.08
	LSD ($p \leq 0.05$) 0.54	0.62	
	($p \leq 0.01$) 0.76	0.76	

Table 3. Average milling yield (head rice yield and grain breakage) of variety San Andrea depending on the time of storage of paddy after harvesting (2013) - Moisture content at harvesting – 19.6 %

Time of storage of paddy after harvesting (months)	Average milling yield (%)	Head rice yield (%)	Grain breakage (%)
I	69.86	57.33	12.53
II	68.68	56.28	12.40
III	69.42	56.62	12.80
	LSD ($p \leq 0.05$) 0.34	0.44	
	($p \leq 0.01$) 0.52	0.67	

Table 4. Average milling yield (head rice yield and grain breakage) of variety San Andrea depending on the time of storage of paddy after harvesting (2013) - Moisture content at harvesting – 16.3 %

Time of storage of paddy after harvesting (months)	Average milling yield (%)	Head rice yield (%)	Grain breakage (%)
I	72.40	55.18	17.02
II	70.55	56.20	14.35
III	70.51	56.14	14.37
	LSD ($p \leq 0.05$) 0.58	0.68	
	($p \leq 0.01$) 0.70	0.71	

Conclusions

Based on the obtained results for the influence of moisture content in paddy at the moment of harvest and the time of paddy storage after harvest, on yield and quality of white rice, can be made the following conclusions:

- Milling quality of San Andrea rice variety was found to be affected by moisture content of harvesting and time of storage of paddy after harvesting;
- From examined levels of moisture content at harvest with the highest head rice yield resulting the level around 22 %;
- Moisture content of about 16% induced maximum breaking of the grain;
- For post harvesting storage duration of 1, 2 and 3 months, paddy storage 1 month gave highest head rice yield.

Literature

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