Influence of Milling Time on Physical Properties and Proximate Chemical Composition of Some Egyption Rice Cultivars

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ABSTRACT

The present study was conducted at Rice Technology Training Center (RTTC) to study the effect of milling time on physical properties and proximate chemical composition of some Egyption rice cultivars. Newly harvested certified seeds in 2014 and 2015 growing seasons of five rice cultivars namely, Sakha 103, Sakha 105, Giza 177, Giza 181 and Giza 182 were provided by Rice Research Training Center, Sakha, Kafr El-Sheikh, Field Crop Research Institute, Agriculture Research Center, Egypt. A split plot design with three replicates was used. The main plots were devoted to rice cultivars and the sub plots were occupied by different milling times (30, 50, 70 and 90 seconds). The results showed significant differences between cultivars for most studied characters. Comparison between means showed that rice cultivar Giza 177 gave the highest values for whiteness degree (37.72 and 38.26 %), grain width (2.92 and 2.88 mm) and grain thickness (2.16 and 2.12 mm) in 2014 and 2015 growing seasons, respectively. Moreover, the highest values for broken (13.97 and 14.86 %), grain length (6.4 and 6.27 mm) and grain shape (2.86 and 2.90 L/W) were noticed with Giza 181 rice cultivar in 2014 and 2015 growing seasons, respectively. Furthermore, Giza 182 rice cultivar gave the highest values for crude protein (8.07 and 8.25 %) and starch (75.38 and 75.65 %) in 2014 and 2015 growing seasons, respectively. Sakha 105 rice cultivar showed the highest values for rice bran (8.78 and 9.17 %) in 2014 and 2015 growing seasons, respectively. Increasing milling time from 30 to 90 seconds significantly increased rice bran %, broken rice %, whiteness degree %, grain shape and starch % while, significantly decreased milling %, grain length, grain width, grain thickness, crude protein %, crude fiber %, crude fat %, ash % and non starch polysaccharides %. Interaction between cultivars and different milling times indicated that the highest rice milling (75.31 and 75.62 %) was recognized with Sakha 105 rice cultivar and milling time 30 seconds.

Keywords: Rice, bran, milling time, milling degree, whiteness, grain quality, rice cultivars

INTRODUCTION

Rice is one of the most important cereals and the staple food of over half the world's population as the primary dietary source of carbohydrate and energy (Hu *et al.*, 2004 and Denardin *et al.*, 2007). Milling of rough rice (or paddy) is usually done at about 14% dry basis moisture content to produce white, polished edible grain, due to consumer preference. From the economic point of view, the quality of milled rice is of paramount importance since the grain size and shape, whiteness and cleanliness are strongly correlated with the transaction price of rice (Conway *et al.,* 1991). All these factors are closely related to the process of milling, in which rough rice is first subjected to dehusking or removal of hulls and then to the removal of brownish outer bran layer, known as whitening. Finally, polishing is carried out to remove the bran particles and provides surface gloss to the edible white portion. A high percentage of broken grains in the milled product or low head rice recovery represent a direct economic loss to the millers. Generally, rice is consumed as a whole kernel of white rice obtained by milling (dehulling and polishing) rough rice. The degree of milling (DOM) depends on purposes of milling required. Therefore, DOM is one of the key factors affecting several aspects of rice quality such as nutritional, chemical, physicochemical, cooking, and eating quality. DOM brought about variations in nutrient contents (Lamberts *et al.*, 2007 and Mohapatra and Bal 2007)

Varying the milling degrees not only affect the nutritional composition but also affected the appearance, yield, physico-chemical and functional properties as well. Low milled rice was found to have darker appearance and higher head rice yield. On the other hand, low milled rice is harder thus require more cooking time. Higher the degree of milling, greater is the losses in the lipids, protein, fiber and ash content but the carbohydrate content increases with increase in degree of milling. Milling is the combination of various unit operations in order to produce well milled rice from raw rice. On the removal of bran layers, the storage life of milled rice is improved. Milling yield affects the producer's profit as well as its eating quality when cooked. Quality of milled rice is depicted by two important parameters i.e whiteness of the kernel and yield of head rice (Payakapol *et al.,* 2011, Monks, *et al.,* 2013, Shruti *et al.,* 2014 and Marie 2016). The Present investigation aimed to determine the optimum milling time that affects head rice, physical properties and nutritional properties of some Egyptian rice cultivars.

MATERIALS AND METHODS

Newly harvested certified seeds in 2014 and 2015 growing seasons of five rice cultivars namely, Sakha

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103, Sakha 105, Giza 177, Giza 181 and Giza 182 were provided by Rice Research Program, Field Crop Research Institute, Agriculture Research Center, Sakha, Kafr El-Sheikh, Egypt. A split plot design with three replicates was used. The main plots were devoted to rice cultivars and the sub plots were occupied by different milling times (30, 50, 70 and 90 seconds).

The studied characters were: rice bran %, milling rice %, broken rice %, whiteness degree %, grain length, grain width, grain thickness, grain shape, crude protein %, crude fiber, starch %, crude fat %, ash % and non starch polysaccharides %. The paddy rice samples were cleaned by Dockage Tester Machine (Carter Day CO, style number XT3, USA) to remove the dust foreign matter, mud balls, and immature green automatically. Rice samples (200 g for each) were taken randomly; samples were dehulled with an experimental Satake huller machine and polished in Satake miller and estimated according to IRRI (1996). Moisture content was adjusted at 14 % by drying by hot air using rotary dryer Schule, Germany. The percent of whiteness degree as assessed by whiteness meter (Kett Electric Laboratory C-300-3, Tokyo, Japan), with calibration plate made from calcium chloride (85.4+0.1), as described by (USDA.1990), U.S. standard for milled rice. Length, width and thickness of milled rice kernel were measured using a micrometer and size and shape was classified according to the method described by Khush *et al* (1979). Proximate chemical composition of milled rice including crude protein, crude fiber, crude fat, ash % was carried out according to the AOAC (1990). Starch content was determined according to Egan *et al*., (1981**)** and non starch polysaccharides % was calculated by difference. Analysis of variance was carried out according to Gomez and Gomez (1984) using SAS program, version 8 Means were compared using least significant differences (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

1- Effect of rice cultivars:

Performance of the studied rice cultivars is presented in Tables (1, 2 and 3). Data revealed that there were significant differences between rice cultivars for all studied characters except for rice bran %. Comparison between means showed that rice cultivar Giza 177 gave the highest values for whiteness degree (37.72 and 38.26 %), grain width (2.92 and 2.88 mm) and grain thickness (2.16 and 2.12 mm) while, lowest values for crude protein (7.45 and 7.18 %) and ash (0.954 and 0.902 %) in 2014 and 2015 growing seasons, respectively. Moreover, the highest values for broken (13.97 and 14.86 %), grain length (6.4 and 6.27 mm) and grain shape (2.86 and 2.90 L/W) were noticed with Giza 181 rice cultivar in 2014 and 2015 growing seasons, respectively. Furthermore, Giza 182 rice cultivar gave the highest values for crude protein (8.07 and 8.25 %) and starch (75.38 and 75.65 %) while, lowest value for non starch polysaccharides (14.34 and 13.93 %) in 2014 and 2015 growing seasons, respectively. Sakha 105 rice cultivar showed the highest values for rice bran (8.78 and 9.17 %) while, lowest values for whiteness degree (36.57 and 36.80 %), crude fiber (0.273 and 0.265 %) and starch (74.20 and 74.46 %) in 2014 and 2015 growing seasons, respectively.

Table 1. Influence of milling time on some physical properties of some Egyption rice cultivars during 2014 and 2015 growing seasons

Treatments	Rice bran%		Milling rice%		Broken rice%		Whiteness degree %	
	2014	2015	2014	2015	2014	2015	2014	2015
C- (Cultivars)								
Sakha 103	8.47	8.23	72.47	72.71	3.69	4.29	37.38	37.85
Sakha 105	8.78	9.17	72.12	72.57	4.88	5.38	36.57	36.80
Giza 177	8.67	8.90	72.03	71.82	9.18	8.98	37.72	38.26
Giza 181	8.35	8.53	69.23	69.45	13.97	14.86	37.14	37.40
Giza 182	8.54	8.72	69.56	67.99	11.31	12.12	37.22	37.59
L.S.D.$_{0.05}$	0.075	0.163	0.327	0.135	0.701	0.981	0.261	0.235
M- (Milling time)								
30 seconds	6.06	5.76	74.14	73.49	6.42	6.73	33.66	33.90
50 seconds	7.81	8.53	71.95	71.70	7.6	8.18	35.74	36.65
70 seconds	9.26	9.74	70.05	69.82	9.2	9.90	38.3	37.94
90 seconds	11.11	10.82	68.19	68.03	11.2	11.69	41.13	41.85
L.S.D.$_{0.05}$	0.267	0.877	0.322	0.987	0.436	1.213	0.539	0.955
Interaction								
C x M	n.s	n.s	**	**	**	**	n.s	n.s

Table 2. Influence of milling time on grain dimension properties of milled rice for some Egyption cultivars during 2014 and 2015 growing seasons

Treatments	Grain length (mm)		Grain width (mm)		Grain thickness (mm)		Grain shape (L/W)	
	2014	2015	2014	2015	2014	2015	2014	2015
C- (Cultivars)								
Sakha 103	5.25	5.09	2.82	2.65	2.05	1.98	1.86	1.92
Sakha 105	5.71	5.50	2.89	2.82	2.08	2.02	1.98	1.95
Giza 177	5.48	5.34	2.92	2.88	2.16	2.12	1.87	1.85
Giza 181	6.4	6.27	2.24	2.16	2	1.95	2.86	2.90
Giza 182	6.28	6.20	2.37	2.26	1.97	1.92	2.66	2.74
L.S.D.$_{0.05}$	0.084	0.055	0.029	0.048	0.055	0.028	0.037	0.022
M- (Milling time)								
30 seconds	6.06	5.92	2.80	2.73	2.21	2.15	2.2	2.17
50 seconds	5.92	5.80	2.69	2.63	2.11	2.08	2.24	2.21
70 seconds	5.77	5.63	2.63	2.48	2.01	1.95	2.24	2.27
90 seconds	5.55	5.38	2.47	2.36	1.87	1.81	2.3	2.28
L.S.D.$_{0.05}$	0.082	0.105	0.068	0.085	0.061	0.045	0.035	0.027
Interaction								
C x M	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

Table 3. Influence of milling time on proximate chemical composition of milled rice for some Egyption cultivars during 2014 growing season. (On dry weight basis)

Treatments	crude protein %	crude fiber %	Starch %	Crude fat %	Ash %	Non starch polysaccharides %
C- (Cultivars)						
Sakha 103	7.64	0.286	75.02	0.828	1.043	15.19
Sakha 105	7.86	0.273	74.2	0.859	1.055	15.75
Giza 177	7.45	0.305	74.82	0.813	0.954	15.66
Giza 181	7.97	0.320	74.95	0.836	1.052	14.87
Giza 182	8.07	0.319	75.38	0.857	1.028	14.34
L.S.D.$_{0.05}$	0.094	0.012	0.312	0.013	0.015	0.088
M- (Milling time)						
30 seconds	8.25	0.384	72.56	0.941	1.070	16.66
50 seconds	8.07	0.321	73.62	0.880	1.020	16.04
70 seconds	7.83	0.278	75.2	0.826	0.956	14.92
90 seconds	7.04	0.219	78.12	0.706	0.877	13.03
L.S.D.$_{0.05}$	0.152	0.031	0.369	0.028	0.035	0.382
Interaction						
C x M	n.s	n.s	n.s	n.s	n.s	n.s

The lowest values for broken (3.69 and 4.29 %) and grain length (5.25 and 5.09 mm) were noticed with Sakha 103 rice cultivar in 2014 and 2015 growing seasons, respectively. Variation between rice cultivars might be due to genetic factors. These results were in harmony with (Chuchuan *et al*., 2006 and Abou El-Soud, 2015).

2- Effect of milling time:

Increasing milling time from 30 to 90 seconds significantly increased rice bran %, broken rice %, whiteness degree %, grain shape and starch % while, significantly decreased milling %, grain length, grain width, grain thickness, crude protein %, crude fiber %, crude fat %, ash and non starch polysaccharides. This might be due to that thickness of layer removed by milling increased by increasing the milling time that separates pericarp, tegmma, aleurone layer, embryo and part of the endosperm. These results were in harmony with those reported by (Kasturi, 2010, Monks, *et al.,* 2013 and Marie, 2016).

3- Interaction between rice cultivars and different milling time:

Data in Table (4) showed significant differences for interaction between rice cultivars and different milling time for rice milling % and rice broken % in 2014 and 2015 seasons. The highest rice milling (75.31 and

75.62 %) was noticed with Sakha 105 rice cultivar at 30 seconds milling time while, the lowest value (65.93 and 64.74 %) for such character was recognized with Giza 182 rice cultivar and milling time 90 seconds in 2014 and 2015 growing seasons, respectively. Furthermore, the highest broken (18.17 and 18.63 %) was noticed with Giza 181 rice cultivar and milling time 90 seconds while, the lowest value (2.7 and 3.25 %) was recognized with Sakha 103 rice cultivar and milling time 30 seconds in 2014 and 2015 growing seasons, respectively.

Table 4. Influence of milling time on proximate chemical composition of milled rice for some Egyption rice cultivars during 2015 growing season. (On dry weight basis)

Treatments	crude protein %	crude fiber %	Starch %	Crude fat %	Ash %	Non starch polysaccharides %
			C- (Cultivars)			
Sakha 103	7.37	0.278	75.46	0.811	1.078	15.00
Sakha 105	7.60	0.265	74.46	0.885	1.120	15.67
Giza 177	7.18	0.290	74.59	0.827	0.902	16.21
Giza 181	7.74	0.311	74.75	0.850	1.021	15.33
Giza 182	8.25	0.301	75.65	0.872	0.993	13.93
$L.S.D._{0.05}$	0.126	0.011	0.122	0.015	0.022	0.295
			M- (Milling time)			
30 seconds	8.41	0.355	72.38	0.918	1.155	16.78
50 seconds	7.85	0.304	73.34	0.868	1.110	16.52
70 seconds	7.39	0.259	75.65	0.849	0.980	14.87
90 seconds	6.85	0.237	78.55	0.760	0.846	12.76
$L.S.D._{0.05}$	0.338	0.045	0.752	0.017	0.043	0.571
			Interaction			
C x M	n.s	n.s	n.s	n.s	n.s	n.s

Table 5. Mean values for milling % and broken % as affected by the interaction between rice cultivars and milling time during 2014 and 2015 growing seasons

Cultivars	Milling time	Rice milling %		Rice broken %	
		2014	2015	2014	2015
Sakha 103	30 seconds	74.73	75.15	2.70	3.25
	50 seconds	73.42	73.83	3.08	3.71
	70 seconds	71.62	72.10	3.86	4.55
	90 seconds	70.11	69.86	5.11	5.66
Sakha 105	30 seconds	75.31	75.62	3.29	3.88
	50 seconds	73.27	73.84	4.20	4.76
	70 seconds	70.9	71.25	5.30	5.62
	90 seconds	69.0	69.55	6.72	7.26
Giza 177	30 seconds	74.77	75.03	6.32	5.87
	50 seconds	72.9	72.61	8.25	7.90
	70 seconds	70.88	70.45	10.34	10.72
	90 seconds	69.58	69.17	11.83	11.41
Giza 181	30 seconds	73.03	72.52	10.28	10.74
	50 seconds	69.62	70.15	12.54	13.89
	70 seconds	67.97	68.30	14.87	16.16
	90 seconds	66.30	66.83	18.17	18.63
Giza 182	30 seconds	72.83	72.13	9.53	6.73
	50 seconds	70.56	68.10	9.90	8.18
	70 seconds	68.89	67.00	11.63	9.90
	90 seconds	65.93	64.74	14.17	11.69
$L.S.D._{0.05}$		0.719	0.522	0.975	0.613

CONCLUSION

The present study indicated that increasing milling time from 30 to 90 seconds significantly increased rice bran %, broken rice %, whiteness degree %, grain shape and starch % while, significantly decreased milling %, grain length, grain width, grain thickness, crude protein %, crude fiber %, crude fat %, ash % and non starch polysaccharides %. Moreover, the highest rice milling (75.31 and 75.62 %) was noticed with Sakha 105 rice cultivar at 30 seconds milling time while, the lowest value (65.93 and 64.74 %) for such character was recognized with Giza 182 rice cultivar at milling time 90 seconds in 2014 and 2015 growing seasons, respectively. Furthermore, the highest broken (18.17 and 18.63 %) was noticed with Giza 181 rice cultivar at milling time 90 seconds while, the lowest value (2.7 and 3.25 %) was recognized with Sakha 103 rice cultivar at milling time 30 seconds in 2014 and 2015 growing seasons, respectively. This study referred that a lower milling time could lead to more nutritious rice for better life quality by creating health.

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الملخص العربي

تاثير زمن التبييض علي الصفات الطبيعية والتركيب الكيماوي لبعض أصناف الأرز المصرية

خالد مصطفى حمدى عبدالسلام

اجريت هذه الدراسة بمركز تدريب تكنولوجيا الارز لدراسة تاثير زمن التبييض علي الصفات الطبيعية والتركيب الكيماوي لبعض أصناف الأرز المصرية. تم حصاد التقاوى المعتمدة في موسمي زراعة ٢٠١٤ و٢٠١٥ لخمسة أصناف أرز شعير وهي سخا ١٠٣، سخا ١٠٥، جيزة ١٧٧، جيزة ١٨١، وجيزة ١٨٢من مركز تدريب و بحوث الأرز، سخا، كفرالشيخ، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، مصر. وقد تم إستخدام تصميم القطع المنشقة بثلاث مكررات حيث وزعت أصناف الأرز في القطع الرئيسية وشغلت قطع الأرض الفرعية بأوقات تبيض مختلفة (٣٠ و ٥٠ و ٧٠ و ٩٠ ثانية). أظهرت النتائج وجود فروق معنوية بين الأصناف بالنسبة لمعظم الصفات المدروسة. وأظهرت المقارنات أن صنف الأرز جيزة ١٧٧ أعطى أعلى القيم لنسبة درجة التبييض (٣٧,٧٢ و٣٨,٢٦٪) وعرض الحبوب (٢,٩٢ و٢,٨٨مم) وسمك الحبوب (٢,١٦ و٢,١٢مم) في موسمي ٢٠١٤ و٢٠١٥ علي التوالي. كما لوحظ ان أعلى القيم للكسر (١٣,٩٧ و١٤,٨٦٪) وطول الحبوب (٦,٤ و٦,٢٧ملم) وشكل الحبوب (٢,٨٦ و ٢,٩٠) مع صنف الأرزجيزة ١٨١ في موسمي ٢٠١٤ و٢٠١٥ علي التوالي. وعلاوة على ذلك، أعطى صنف الأرز جيزة ١٨٢ أعلى القيم للبروتين الخام (٨,٠٧ و ٨,٢٥٪) والنشا (٧٥,٣٨ و٧٥,٦٥٪) في موسمي ٢٠١٤ و٢٠١٥ علي التوالي. أعطى صنف الأرز سخا ١٠٥ أعلى القيم لنسبة الرجيعة (٨,٧٨ و٩,١٧ %) في موسمي ٢٠١٤ و٢٠١٥ علي التوالي. وزيادة وقت التبيض من ٣٠ إلى ٩٠ ثانية ادي الي زيادة معنوية في نسبة رجيعة الأرز، وكسر الأرز٪، ودرجة التبييض ٪، وشكل الحبوب ونسبة النشا بينما انخفضت نسبة التبيض بشكل كبير، وطول الحبوب، وعرض الحبوب، وسمك الحبوب، والبروتين الخام٪، والألياف الخام٪، الدهون الخام٪، الرماد٪ و السكريات غيرالنشوية ٪. وأظهر التفاعل بين الأصناف وأوقات التبيض المختلفة أن أعلى نسبة تبيض للأرز (٧٥,٣١ و٧٥,٦٢٪) تم الحصول عليه مع صنف سخا ١٠٥ مع زمن ٣٠ ثانية.