Properties of Some Egyptian Rice Hybrids as Affected by Parboiling Process

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ABSTRACT

This experiment was conducted at Rice Research Section, Field Crops Research Institute, Agriculture Research Center, Sakha, Kafr El-Sheikh and the Rice Technology Training Center (RTTC), Alexandria, Egypt during 2016 season to study the effect of parboiling process on characteristics of the three Egyptian rice hybrids i,.e. "Hybrid Rice 1, Hybrid Rice 2 and Hybrid Yasmine" and their grain quality. The results showed that the three hybrids of rice differed in their properties studied when treated by different temperatures and parboiling process improved rice eating and cooking quality by decreasing time to cook and decreasing sticky. The study showed that soaking rice on 70º C gave the best results especially hardness that decreases broken and insect infestation subsequently.

Key words: Rice- Hybrid-Parboiled- Properties-Process

INTRODUCTION

Due to the limited allowances of water sources in Egypt in the near future, the trends are to eliminate the rice cultivated area. To avoid the shortage of yield, it is strongly recommended to increase the yield in vertical expansion by replacing rice old varieties with high yielding ones. Among these high yield rice varieties are the hybrid rice that gives nearly (3.9 t/fed) according to FAOSTAT(2016). As hybrid rice enjoy a high yield it is also had some points of deficiency during its process which is high percentage of broken as well as special precautions during cooking.

Parboiled rice is done in three steps, Soaking, Steaming and drying. Soaking means paddy rice is penetrating into water then during heating the energy weakens the granules structure and more surfaces become available for water absorption. Now, parboiled paddy dried using modern method to take the minimum time for drying. Parboiling is a well-developed pre-milling treatment to achieve the highest recovery of head rice in rice milling and to decrease the breakage. Parboiling treatment was developed to reduce the milling losses and prevent the loss of nutrients during milling. It is affected the rice nutritional and cooking qualities. Parboiled rice takes longer time for cooking of needed softness. The parboiled rice contains less starch and more oil than raw rice bran (Elbert *et al*., 2000; Larsen, 2000; Bhattacharya, 2004; El- Dalil, 2017; kumar *et al*., 2018).

To avoid this deficiency this research tried to recommend the process of parboiling to this type of rice. Parboiled rice or converted rice is rice that has been partially boiled in the husk. Parboiling drives nutrients, especially thiamin, from the bran to the endosperm, hence parboiled white rice is 80% nutritionally similar to brown rice. Parboiled rice starches become gelatinized, then retrograded after cooling. By gelatinization, amylose molecules leach out of the granule of starch and diffuse into the encircling binary compound medium outside the granules that, once totally hydrous area unit at most body. Grains of the parboiled rice should be translucent when fully gelatinized. Cooling brings retrogression whereby amylose molecules re-associate with each other and form a tightly packed structure. This improvement the formation of starch which can have a role as a prebiotic and good for human's health. However, this also makes the kernels harder and glassier which gives the kernel more rigidity that leads to decrease in the percentage of broken during whitening process. Parboiled rice takes less time to cook and becomes firmer and less sticky which improves its eating and cooking quality (Adebowale and Lawal, 2003; Bello *et al.*, 2004; Lamberts *et al*., 2006; Thakur and Gupta, 2006; Ragaee and Abd El-Aal, 2006; Kadan *et al.*, 2008; Patindol *et al.*, 2008; Zhu *et al*., 2010; Chen *et al*., 2012; Dutta and Mahanta; 2012 and Shittu *et al*., 2012).

The hardness of rice was significantly increased after parboiling and varied among the cultivars with the highest Jehlum. Parboiling led to decrease the pasting parameters with increasing soaking temperature from 60˚C to 80˚C. The pasting characters of parboiled rice revealed the typical behavior giving high initial viscosity, but it gives lower peak viscosity in the raw rice. The water absorption and water solubility indices were subsequently increased with increasing soaking temperature (Mir and Bosco, 2013).

The aim of this study was to investigate the properties of parboiled rice hybrids cultivated in Egypt using different soaking water temperatures (65,70 and 75º C) and its effect on both broken and cooking quality of the final product.

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Received November 29, 2018, Accepted December 20, 2018

MATERIALS AND METHODS

This experiment was conducted at the Rice Research Section, Field Crops Research Institute, Agriculture Research Center, Sakha, Kafr El-Sheikh and the Rice Technology Training Center (RTTC) Alexandria Egypt during 2016 rice growing seasons to study the effect of parboiling process on characteristics of the three rice hybrids i.e. "Hybrid Rice 1 , Hybrid Rice 2 and Hybrid Yasmine" and their grain quality.

Rice samples (150 g for each) were taken randomly; samples were cleaned and dehulled with an experimental Satake huller machine and polished in Satake miller and estimated according to standerd evaluation system of IRRI (1996).

The paddy rice was mechanically cleaned and impurities were removed based on shape, size and specific weight and then placed into a pressure tank and soaked for about 150 minutes in water of temperature; 65, 70 and 75º C kept in circulation. When the rice has reached the temperature of the soaking water the water supply was turned off and hydrostatic pressure of 4 to 6 kg/cm is applied by admitting compressed air. The second heating or cooking period started by lowering and readmitting water heated to a very high temperature to ensure that the starch gelatinizes completely. The water was then drained away and the paddy with a moisture content of about 30 – 35 percent (wb) (Kimura *et al*., 1995 and Bhattacharya, 1985) then drying is continued until a moisture content of 13 percent is reached at room temperature.

Hulling %, milling %, broken (%), 1000- grain weight (g), grain length(mm), grain width (mm), grain thickness (mm), grain shape, protein, hardness and cooking time were recorded.

Hardness of grain was measured using grain hardness tester on a sample of 10 grains. (Islam *et al.*, 2004).

Protein content was determined for brown rice, according to the standard Micro – Kjeldahl method. Then, the estimated nitrogen content was multiplied by a factor of 5.95 to estimate the crude protein content. Amylose content was estimated by the simplified procedure reported by Juliano and Bechtel (1971).

All collected data were subjected to analysis of variance in a Completely Randonized Design (C.R.D) using five samples in each treatment according to Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique by means of CoStat computer software package (CoStat, Ver. 6.311., 2005). The least significant differences (LSD at 0.05) were used to compare the treatment means.

RESULTS AND DISCUSSION

Table (1) shows mean squares of studied grain characters for the three Egyptian hybrids using three temperature degree and their interactions. The obtained results indicated that all studied characters were significantly affected by the hybrids of rice and soaking temperature, except protein and cooking time. The interaction between the two studied factors significantly influenced all studied characters, hulling % except protein, grain hardness and cooking time.

The results in Table (2) revealed that rice hybrids varied in their superiority for the different characteristics, where Hybrid 1 was significantly superior in hulling % along with Hybrid 2, milling %, 1000- grain weight and grain width along with Hybrid Yasmine and hardness. Furthermore, Hybrid Yasmine was significantly superior in broken%, length, shape, protein and cooking time.

Data presented in Table (3) indicated that 70 º C gave significantly higher values for hulling (along with 75 ºC), milling %, 1000- grain weight, grain length, grain width, thickness and hardness. Soaking at 65 ºC on the other hand, gave significantly higher values for broken (1.91%).

The pervious obtained results are in agreement with those results obtained by Kadan *et al. (*2008); Patindol *et al.* (2008), Zhu *et al*. (2010), Chen *et al*. (2012), Dutta and Mahanta (2012), Shittu *et al*. (2012) and Mir and Bosco (2013) who reported that grain characters of rice like milling, hardness and cooking time can be improved by parboiling process (high temperature up to 70^0 C).

The results presented in Table (4) for interaction between rice hybrids and soaking temperatures indicated that the highest for milling values (70.38 and 70.31%) obtained when soaking Hybrid 1 variety at 70 and 75º C respectively, whereas the lowest value (68.53%) was obtained when Hybrid Yasmine was soaked at 65º C. Concerning broken %, the highest values (2.41 and 2.37%) obtained when Hybrid Yasmine was soaked at 65, 70º C whereas the lowest value was recorded for Hybrid 1 soaked at 70,75º C. The highest values for 1000- grain weight was obtained for Hybrid 1 soaked at 65º C while the lowest values were recorded for Hybrid 1 at 65 ºC, Hybrid 2 at 65 and 70º C and Hybrid Yasmine at 65 and 75º C. Concerning grain length, the significantly highest value was recorded for Hybrid Yasmine at 70 C while the lowest value was obtained when Hybrid 1 was soaked at 65º C. Similarly, Yasmine hybrid at 70 º C gave the highest value for grain width (along with Hybrid 1 at 70 ºC) whereas the lowest values were recorded for the three Hybrid varsities at

65º C. Concerning grain thickness, results presented in Table (4) showed that soaking grains of both hybrid 2 and yasmine at 70 º C produced the highest values (2.04 and 2.06 mm), respectively .However, the lowest thickness values (1.70 and 1.75 mm) resulted from soaking hybrid 1 and yasmine grains on 65 º C .Finally, the highest value for shape (L/W) was recorded for Hybrid Yasmine at 65 ºC and the lowest values were found when Hybrid 1 was soaked at any temperature degree.

Table 1. Mean Squares (MS) of some grain characters for the three Egyptian hybrids under three degree of temperatures and their interactions

Sources of variations (SOV)	Degree of freedom (df)	Hulling %	Milling %	Broken %	1000- grain weight	Grain length	Grain width	Grain thickness	Grain shape	Grain protein %	Hardness	Cooking time
Replicates	4	--	--	--	--	--	--	--	--	--	--	--
Hybrid (H)	2	7.283**	3.593**	3.631**	3.884**	9.049**	0.009**	0.036**	1.401**	0.046*	6.513**	3.417**
Temperature (T)	2	2.987**	2.382**	0.153**	4.611**	0.163**	0.118**	0.235**	0.030**	0.007n.s.	1.078**	0.050n.s.
H xT	4	0.047n.s.	0.425**	0.023*	3.038**	0.006**	0.006**	0.007*	0.014**	0.009n.s.	0.028n.s.	0.017n.s.
Error	32	0.067	0.056	0.007	0.259	0.001	0.002	0.002	0.002	0.009	0.043	0.016

*,** Significant at 0.05 and 0.01 probability levels . n.s. Not significant

Table 2. Means of grain characters of the three rice hybrids overall by soaking temperature

Hybrid	Hulling %	Milling %	Broken %	1000- grain weight (g)	Grain length (mm)	Grain width (mm)	Grain thickness (mm)	Grain shape	Grain protein %	Hardness %	Cooking time (M)
H1	79.44a	70.24a	1.36c	26.40a	5.37c	2.47a	1.81b	2.18c	8.56b	9.68b	25.25b
H2	79.54a	69.52b	1.74b	25.52b	5.69b	2.43b	1.88a	2.34b	8.57b	9.91a	25.31b
H3 (Yasmine)	78.29b	69.30c	2.33a	25.51b	6.84a	2.48a	1.89a	2.77a	8.66a	8.67c	26.11a
LSD at 0.05	0.19	0.18	0.06	0.38	0.03	0.03	0.04	0.03	0.07	0.15	0.09

*Means in the same column followed by the same letter(s) are statistically equaled according to L.S.D 0.05 values .

Table 3. Means of grain characters as affected by the three degree of soaking temperature overall rice hybrids

Soaking temperature	Hulling %	Milling %	Broken %	1000- grain weight (g)	Grain length (mm)	Grain width (mm)	Grain thickness (mm)	Grain shape	Grain protein %	Hardness %	Cooking time (M)
65	78.59b	69.27c	1.91a	25.26c	5.86c	2.37c	1.75c	2.48a	8.57a	9.20b	25.49a
70	79.44a	70.06a	1.71c	26.37a	6.06a	2.54a	1.99a	2.38c	8.62a	9.72a	25.60a
75	79.25a	60.73b	1.81b	25.80b	5.98b	2.47b	1.85b	2.42b	8.60a	9.35b	25.57a
LSD0.05	0.19	0.18	0.06	0.39	0.03	0.03	0.04	0.03	-	0.15	-

*Means in the same column followed by the same letter(s) are statistically equaled according to L.S.D 0.05 values .

Table 4. Interaction effect between rice hybrids and soaking temperatures on grain characters

Rice hybrids	Soaking temperature	Milling %	Broken %	1000- grain weight (g)	Grain length (mm)	Grain width (mm)	Grain thickness (mm)	Grain shape
	65° C	70.03b	1.54d	24.99d	5.23i	2.37c	1.70d	2.21e
H1	70 ° C	70.38a	1.22e	27.89a	5.51g	2.56a	1.89b	2.16e
	75 ° C	70.31ab	1.32e	26.31b	5.36h	2.48b	1.82c	2.16e
	65 ° C	69.25c	1.78c	25.39d	5.57f	2.37c	1.79cd	2.34d
H2	70 ° C	69.90b	1.69c	25.61c	5.78d	2.48b	2.04a	2.33d
	75 ° C	69.42c	1.74c	25.55d	5.71e	2.44b	1.84bc	2.35d
	65 ° C	68.53d	2.41a	25.40d	6.76c	2.35c	1.75d	2.88a
H3 (Yasmine)	70 ° C	69.92b	2.22b	25.61c	6.91a	2.59b	2.06a	2.67c
	75 ° C	69.45c	2.37a	25.53d	6.86b	2.49b	1.87bc	2.75b
LSD at 0.05		0.31	0.11	0.66	0.04	0.06	0.06	0.06

*Means in the same column followed by the same letter(s) are statistically equaled according to L.S.D 0.05 values .

CONCLUSION

The study explored the effect of different soaking temperatures on physical and functional properties of some Egyptian rice hybrids. These changes significantly affected by hybrids and subsequent parboiled conditions. Higher soaking temperatures increased the hardness value which will help to increase the milling yield of rice and protect them from damage and insect infestation. Cooking property of rice samples were substantially decreased by parboiling with soaking at 70°C.

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الملخص العربي

تأثير الغليان على خصائص بعض هجن الأرز المصرية

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أجريت هذه الدراسة بمركز تدريب تكنولوجيا الأرز لدراسة تأثير عملية الغليان على ثلاثة هجن من الأرز المصري ناتج من مركز بحوث الزراعية سخا كفر الشيخ – خلال موسم ٢٠١٦. وذلك من خلال دراسة بعض خصائص هذه الهجن (الهجين ١، الهجين ٢، هجين ياسمين) باستخدام درجات حرارة مختلفة لمياه النقع : ٦٥، ٧٠و ٧٥ درجة مئوية وتأثيرها على جودة المنتج النهائي.

ويمكن تلخيص أهم النتائج فيما يلى:

- إختلفت هجن الأرز الثلاثة فيما بينها اختلافاً معنوياً نتيجة نقعها في المياه ذات درجات الحرارة المختلفة. حيث أظهر الهجين ١ أعلى قيم لصفات التقشير والتبيض واقل نسب في الصفات الأخري خاصة نسبة الكسر ووقت الطبخ. بينما أعطى الهجين ٢ أعلى قيم للتقشير وسمك الحبوب والصلابة. أما هجين الياسمين فقد أعطى أعلى القيم في نسب الكسر وطول الحبوب وعرضها وسمكها ونسبة البروتين ووقت للطبخ.
- تأثرت الصفات تحت الدراسة بالنقع بدرجات الحرارة المختلفة (ظروف الغلي)، حيث أدى النقع في درجة الحرارة ٧٠ درجة مئوية عملت على زيادة نسبة التقشير والتبيض ووزن الألف حبة وطول الحبوب وعرضها ونسبة البروتين والصلابة ولم توثر في وقت الطبخ لحبوب الأرز.
- و أدى نقع حبوب هجين ١ على درجة ٧٠ درجة مئوية حقق أعلى القيم في صفات وزن الألف حبة ، وعرض الحبوب، في حين أدت نفس الدرجة مع الهجين المصري (هجين٢) الى الحصول على أعلى سمك للحبوب، في حين أدت مع الهجين ياسمين الى الحصول على أعلى طول وسمك للحبوب.
- عموماً أوضحت النتائج أن نقع حبوب الأرز في درجات حرارة عالية حتى ٧٠ درجة مئوية (الأرز المغلي) عمل على تحسين صفات والخصائص الفيزيائية والتكنولوجية لها.