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Influence of Packaging Materials and Storage Methods on Some Cooking and Eating Quality Characteristics for Some Rice Varieties.

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ABSTRACT

The present investigation was carried out to study the effect of storage practices (Warehouse, open shed, and silo) and storage packages (jute sacks, paper packs, and plastic sacks) on cooking and eating characteristics, Kernel elongation (%),Gel consistency (mm), Amylose content (%) and cooking time (min) for three rice Egyptian varieties Sakha 102, Giza 179 as short grain varieties and Egyptian Yasmine as a long grain variety for two seasons 2014, 2015. The result show that warehouse storage place was the best among the other storage places since it caused the lowest degradation in cooking and eating quality characters. Sakha 102 was the less affected variety by different storage bags and the lowest deterioration in the cooking and eating quality characters occurred when jute sacks were used.

INTRODUCTION

Y early in Egypt more than 6 million tons of paddy are produced with a national yield average reaching to more than 4 ton/fad (USDA, 2016). This is one of the highest in the world. This production covers the national consumption and some more for exportation. This production is seasonal while consumption is continuous throughout the year. Suitable storage conditions must be provided for the paddy after harvest until it is needed for consumption. During storage, physico-chemical properties of rice keep changing and degree of changes vary depending on the applied practices and storage conditions.

Rice storage methods adopted in Egypt are variable, but they can be classified in two major types, packing storage and bulk storage. The first storage method include packing of dried rice in jute or plastic bags and storing it in warehouse or open shed and this method used for almost 90% of the total stored paddy. However the bulk storage means storing rice in silos which are available only in the major rice milling companies. The conventional storage facilities used in Egypt permit not only harmful organisms to penetrate easily into the rice from the outside, but also cause qualitative and quantitative losses by physiological process during storage of rice duration which can be prolonged. Furthermore, paddy is a biological product subject physical and chemical changes due to internal factors that include the condition of the product such as moisture content, cracks, fissures, chemical composition and impurities. Besides, external factors such as storage duration and storage practices. Numerous investigators studied the changes in the rice stored under different conditions El-Hissewy *et al*. (2002) recommended that rice grain, regardless of the variety, could be stored till six months without any significant changes in the chemical composition of the rice grain.

Nessrin Bassuony (2009). Reported that storage place had no significant effect on physical and cooking characteristics, except for head rice%, degree of milling and cracks. Moreover it was found that grain dimension and cooking characteristics were not significantly affected by storage period while, storage up to 12 months decreased significantly milling recovery, 1000 grain weight, degree of milling and cracks characteristics.

Aboukhadra *et al* (2013) in a study to compare pigmented "black rice" "aromatic rice" "El-yasmine" and E.hyprid rice for their agronomic and grain quality characteristics under different storage conditions (periods and places).They reported that no significant effect on milling, physical and cooking characteristics were determined due to storage places, except for head rice(%),degree of milling and cracks. In addition they found that grain dimension and cooking characteristics were not significantly affected by storage period, while storage up to 12 months caused significant decrease on milling recovery, 1000 grain weight, degree of milling and cracks characteristics.

Consequently, the present investigation aimed to study the effect of some storage conditions on grain quality characteristics of rice through two main topics:

1-The effect of storage places (Warehouse, Open shed and Silo) on cooking and eating characteristics of rice grain.
2-The effect of storage packing type on cooking and eating characteristics of rice grain.

MATERIALS AND METHODS

This study was carried out at the Rice Training Technology Center (RTTC), Field Crops Research Institute, Agricultural Research Center, Alexandria, during the successive seasons of 2014 and 2015. Three Egyptian rice varieties were selected, Sakha 102, Giza 179 as a short grain variety and Egyptian Yasmine as a long grain variety. Paddy rice varieties were obtained from the experimental farm of Rice Research Training Center (RRTC) at Sakha Kafr-El Sheikh Governorate at 14% moisture content wet bases.

The grain were cleaned and the foreign matter, as stones, straw were removed in the laboratories of Rice Technology Training Center (RTTC), Alexandria.

The study aimed to determine the effect of storage places on cooking and eating characteristics of rice. Warehouses, open shed and silo were the three places used to store the paddy for one year of study. Samples of newly harvested paddy was completely dried to 14 % moisture content and packed in jute sacks, each contains 25 kg and placed in the three storage places for one year. The warehouse was well ventilated and clean. Under the open shed the sacks were placed on wooden bases raised by 15 cm from the ground surface Metal mini silos were filled up by 25 kg paddy each and were placed at the back ground of RTTC during the experiment duration. After one year storage period, ten random samples from each treatment were used to determine all studied characteristics, kernel elongation (%), gel consistency (mm), amylose content (%) and cooking time (min).

Also studying the effect of storage bags on cooking and eating characteristics of rice was also considered. Three storage bagged types were used such as jute sacks with 113 cm x 70 cm dimensions, striped plastic sack with 100 cm x 57 cm dimensions and paper bag with 75 cm x 55 cm dimensions. An amount of 25 kg weight of each sample was filled in to the different storage bags. A total of 675 kg of paddy was divided to 27 treatments (3 replications / 3 varieties / 3 storage bag types) and stored in a warehouse and the treatments were protected and well ventilated during the storage time. After one year, 10 random samples were obtained from each treatment and they were used to test the grain quality characters. Throughout the study duration, all precautions were paid to protect the stored samples from rodents, birds and / or insects attack.

Cooking and eating characteristics:

Ten random samples were obtained from each replication for each treatment and they were used to test the cooking and eating quality characteristics:

1-Kernel elongation: Was determined according to Hayman (1955) .

2- Gel consistency : It was estimated, accordingly to Cagampang *et al*. (1973).

3- Amylose content% : Amylose content was determined by the method described by Williams *el al.,* 1958).

4- Cooking time (min)

RESULTS AND DISCUSSION

A brief information about their grain quality characteristics of the studied varieties presented in table (1).

Table 1. Cooking and Eating rice grain quality characteristics of used cultivars in the present study.

Statement	Varieties					
	Short grain				Long grain	
	Sahka 102		Giza 179		E.Yasmine	
	2014	2015	2014	2015	2014	2015
Kernel elongation %	68.39	67.87	67.68	68.88	66.93	71.99
Gel consistency(mm)	92.73	96.20	91.13	90.60	94.40	94.67
Amylose content %	18.84	18.43	18.51	18.43	21.00	21.07
Cooking time (min)	22.13	22.67	22.33	21.66	24.33	24.66
Origin	Egypt					

1- The effect of storage places on rice cooking and eating quality characteristics: Paddy rice of the three rice varieties, Sakha 102, Giza 179 and E. yasmine were stored in three different storage places namely; warehouse, open- shed and silo. The effect of these storage places on different grain quality characters could be discussed as follow:

The analysis of variance results indicated that there are significant differences between varieties in the two seasons of study during the course of this study; it was expected since these varieties are genetically differed in respect to all studied characters. Further, table (2) revealed that the rice variety E. Yasmine exhibited the highest mean values of all characters as affected by the different storage places in both seasons except in case of gel consistency in 2014 season only. From another point of view, it is worthy to note that in spite of the two varieties Sakha 104 and Giza 179 are short grains and Japonica, they were significantly differed in all characters except cooking time in the two seasons. In some cases such as elongation (%) in 2014 and 2015 seasons and gel consistency in 2015 season, no significant differences between the mean values of the two varieties Sakha 102 and E. Yasmine were estimated. These findings are confirmed with these reported earlier by El-Kady and El-Hissewy (1994), El-Kady and El-Hissewy (1999), Abd-El-Bary,Doaa (2006) and Mettananda (2006).

Additionally, the analysis of variance indicated that the differences between the three storage places concerning the cooking and eating quality characters were significant in 2014 and 2015 seasons. This may be logic because of the various conditions of each storage place that affects these characters differently. This was supported by the comparison between the mean values of these storage places tabulated in table (2). It is remarkable to observe that in both seasons, the lowest deterioration in all studied characters occurred when paddy was stored in ware-house followed by silo storage.

Consequently, the least mean values of the studied characters were detected for open-shed store since the lowest values of kernel elongation (%), beside the highest estimates of amylose content (%) and cooking time were obtained from the paddy stored in this storage place. This result indicated that cooking and eating quality characters were not deteriorated perceptibly when paddy stored in ware-house. However, they deteriorated respectively and grain was no longer acceptable to the consumer when paddy was stored in open-shed. This agree with Yang *et al*. (1995), while El-Kady and El-Hissewy (1999) reported that open- shed or closed room were the best among the studied storage places regarding their effect on grain cooking and eating quality characters.

From another point of view, it was clear in table (2) that the interaction between varieties and storage places was not significant in general. This result indicated that both factors were react separately under the conditions of this experiment. However, in 2014 season the interaction between varieties and storage places were highly significant in case of gel consistency character. As shown from table (2), the highest values of this character were detected from the three varieties Sakha 102, E. Yasmine and Giza 179 when stored in ware- house. Their respective values were 90.67 mm, 86.60 mm and 84.43 mm. Meanwhile the lowest estimates from the same varieties were 82.67 mm, 76.50 mm and 70.60 mm when stored under open-shed. Similar trend was observed for kernel elongation (%) character in 2015 season. The three cultivars were affected variously by different storage places. In general, Sakha 102 had the best storability since it resulted the highest kernel elongation (%) under all storage places in spite-of it decreased from 76.13 % to 72.80% when changing the storage place from ware-house to open-shed while, the variety Giza 179 had the lowest storability when its, mean values of characters were compared to the other varieties under the same condition. This type of interaction between cultivars and storage place for these characters could be attributed to the differences in the prevailing environments during these two seasons. These findings were confirmed by those reported by Nessrin Bassuony (2009) and Aboukhadra *et al*. (2013).

Table 2. The effect of grain storage places on cooking and eating quality Characters of three rice varieties in 2014 and 2015 seasons.

A- Kernel elongation (%)

Storage places	2014 Season				2015 Season			
	Short grain		Long grain		Short grain		Long grain	
	Sakha 102	Giza 179	E. yasmine	Mean	Sakha 102	Giza 179	E. yasmine	Mean
Warehouse	76.13	75.20	76.05	75.79	72.13	75.20	76.05	74.46
Open shed	76.13	65.17	69.08	70.13	76.80	65.17	69.08	70.35
Silo	73.80	71.97	72.96	72.91	73.80	71.96	72.96	72.91
Mean	75.35	70.78	72.70	72.94	74.24	70.78	72.70	72.57
L.S.D at 5% level for:								
Varieties (V)			2.09			1.89		
Storage places (P)			2.41			2.18		
V x P			N.S			3.77		

B- Gel consistency (mm)

Warehouse	90.67	84.43	86.60	87.23	86.00	81.50	86.00	84.50
Open shed	90.67	70.60	76.50	79.26	75.67	67.27	76.00	72.98
Silo	87.53	78.59	84.60	83.57	83.33	78.49	82.33	81.38
Mean	89.62	77.87	82.57	83.35	81.67	75.75	81.44	79.62
L.S.D at 5% level for:								
Varieties (V)			1.39			1.68		
Storage places (P)			1.61			1.94		
V x P			2.79			N.S		

C- Amylose content (%)

Warehouse	20.09	19.77	24.11	21.32	21.32	20.11	22.75	21.39
Open shed	26.17	24.86	28.28	26.44	24.55	24.37	25.97	24.96
Silo	21.20	20.59	25.23	22.34	22.32	20.89	23.57	22.26
Mean	22.49	21.74	25.87	23.37	22.73	21.79	24.11	22.87
L.S.D at 5% level for:								
Varieties (V)			0.82			0.64		
Storage places (P)			0.95			0.74		
V x P			N.S			N.S		

D- Cooking time (min)

Warehouse	25.50	18.55	28.70	24.25	25.00	25.33	25.67	25.33
Open shed	29.80	31.00	33.00	31.27	28.67	30.00	30.33	29.67
Silo	27.20	27.33	29.90	28.14	26.67	27.00	27.00	26.89
Mean	27.50	25.63	30.53	27.89	26.78	27.44	27.67	27.30
L.S.D at 5% level for:								
Varieties (V)			0.54			0.74		
Storage places (P)			0.62			0.85		
V x P			N.S			N.S		

As a conclusion, the results obtained in the two seasons of study that there were significant differences between cultivars and between storage places regarding all cooking and eating characters. Further, the cultivar of Sakha 102 was having the best storability with regard to the effect of different storage places on its mean values of these characters compared with the other two varieties. In addition, warehouse storage place was the best among the other storage places since it caused the lowest degradation in cooking and eating quality characters. The interaction between varieties and storage places was not significant for all characters except for gel consistency in 2014 season and kernel elongation (%) in 2015 season.

2- The effect of storage bags on rice cooking and eating quality characters: As indicated previously the effect of three types of packing material namely ; jute sacks, paper packs and striped plastic sacks, on grain quality characters of the three rice varieties was investigated in 2014 and 2015 seasons. The results could be discussed as follow:

It is clear from the analysis of variance of the cooking and eating quality character as affected by varieties and storage bags in 2014 and 2015 seasons that there were significant variations. Furthermore, table (3) illustrated the mean values of the cooking quality characters. It is worthy to note that the E. Yasmine showed the highest estimates of most of cooking and eating quality characters in the two seasons of study, while the lowest values were found in case of the variety Giza 179 regardless the storage bags. Meantime, the differences between the mean values of Sakha 102 and E. Yasmine and between Sakha 102 and Giza 179 were significant. Consequently, these results led to the conclusion that this difference between cultivars might be attributed to genetic constitution of these varieties. The differences between cultivars were also reported by Anonymous (1978), El-Kady and El-Hissewy (1994), El-Hissewy *et al.* (2002) and Mettanand (2006).

In addition means presented in table (3) indicated that the differences between types of storage bags were significant in the two seasons with respect to the studied characters. Furthermore, the highest mean values in kernel elongation (%) and gel consistency were determined for the Jute sacks. In contrast, amylose content and cooking time were maximized in the samples tested from the plastic sacks and minimized in case of jute sacks. In most cases, intermediate values of all cooking and eating quality characters were evaluated for the paper packs. These

results are in close agreement with those reported by Agrawal (1985), El-Hissewy *et al*. (2002) Liaquat *et al*. (2004) Abd-El-Bary (2006) and Butt *et al* (2008). However, Holcomb *et al*. (1997) and El-Kady El-Hissewy (1999) Nessrin Bassuony (2009) and Aboukhadra *et al*. (2013) found that package type had no significant impact on virtually all cooking and eating quality characters.

Table 3. The of grain storage bags on cooking and eating quality characters of three rice varieties in 2014 and 2015 seasons.

A- Kernel elongation (%)

Storage bags	2014 Season				2015 Season			
	Short grain		Long grain	Mean	Short grain		Long grain	Mean
	Sakha 102	Giza 179	E. yasmine		Sakha 102	Giza 179	E. yasmine	
Jute sacks	74.42	72.97	75.19	74.19	72.93	74.63	78.49	75.35
Paper packs	71.05	68.84	72.12	70.67	70.50	73.17	78.49	73.01
Plastic sacks	69.22	57.69	69.56	65.49	66.87	65.27	78.49	66.88
Mean	71.56	66.50	72.29	70.12	70.10	71.02	78.49	71.75
L.S.D at 5% level for:								
Varieties (V)			1.91			2.14		
Storage bags (B)			2.2			2.48		
V x B			3.8			N.S		
B- Gel consistency (mm)								
Jute sacks	91.20	83.49	89.07	87.92	88.00	83.93	87.23	86.39
Paper packs	87.40	79.14	84.80	83.78	84.33	80.40	84.90	83.21
Plastic sacks	70.40	62.08	63.40	65.29	75.00	63.23	74.53	70.92
Mean	83.00	74.90	79.09	79.00	82.44	75.85	82.22	80.17
L.S.D at 5% level for:								
Varieties (V)			4.47			1.37		
Storage bags (B)			5.16			1.58		
V x B			N.S			2.72		
C- Amylose content (%)								
Jute sacks	20.06	20.81	23.32	21.40	21.30	21.03	22.65	21.66
Paper packs	22.66	23.36	25.23	23.75	23.30	23.31	23.97	23.19
Plastic sacks	27.79	25.67	27.98	27.14	27.13	24.30	26.66	26.03
Mean	23.50	23.28	25.51	24.10	23.91	22.55	24.43	23.63
L.S.D at 5% level for:								
Varieties (V)			4.47			1.37		
Storage bags (B)			5.16			1.58		
V x B			N.S			2.72		
D- Cooking time (min)								
Jute sacks	23.87	25.33	27.10	25.43	25.00	25.33	25.67	25.33
Paper packs	25.90	27.33	29.07	27.43	26.67	27.00	27.00	26.89
Plastic sacks	30.17	30.00	31.60	30.59	30.00	29.67	29.67	29.78
Mean	26.65	27.55	29.26	27.82	27.22	27.33	27.45	27.33
L.S.D at 5% level for:								
Varieties (V)			1.07			0.07		
Storage bags (B)			1.24			0.80		
V x B			N.S			1.38		

Table (3) revealed, also, that the interaction between varieties and different types of storage bags were significant for kernel elongation (%) only in 2014 season. Meanwhile, it was significant for gel consistency, amylose content (%), and cooking time in 2015 season. These differences in the interaction effects from season to another could be attributed to the differences in the prevailing environmental conditions during these seasons. Moreover, it is obvious that kernel elongation (%) was maximized when Sakha 102 variety was stored in jute sacks and minimized in case if Giza 179 when it was packed in plastic sacks. Same trend was observed for gel consistency character in 2015 season. Further, the highest estimates of amylose content (%) were 27.13 and 26.66% for the two varieties Sakha 102 and E.Yasmine, respectively, when they were stored in plastic sacks, while the lowest value (21.03%) was found for Giza 179 packed in jute sacks. Additionally, the lowest cooking time was measured for Sakha 102 when stored in jute sacks; however the highest time was observed for the same variety when the plastic sacks were used in storage. These findings led to the conclusion that the best storage bags must be determined for each variety individually. El-Hissewy *et al*. (2002), reported that the interaction between varieties and storage bags was not significant.

Accordingly, it could be concluded that the three rice varieties differed significantly with regard to all cooking and eating quality characters.

Besides, the differences between storage bags were also significant in the two seasons of study. The variety Sakha 102 was less affected by different storage bags and the lowest deterioration in the cooking and eating quality characters occurred when jute sacks were used. In addition, the interaction between varieties and storage bags differed from season to another and from character to character.

CONCLUSION

The results obtained in the two seasons of study indicated that there were significant differences between

varieties and between storage places regarding all cooking and eating characters. Further, the variety of Sakha 102 had the best storability with regard to the effect of different storage places on its mean values of these characters compared with the other used varieties. In addition, warehouse storage place was the best among the other storage places since it caused the lowest degradation in cooking and eating quality characters. From another point of view, the interaction between cultivars and storage places was not significant for all characters except for gel consistency in 2014 season and kernel elongation (%) in 2015 season.

The three rice cultivars differed significantly with regard to all cooking and eating quality characters. Besides, the differences between storage bags were also significant in the two seasons of study. The variety Sakha 102 was the less affected variety by different storage bags and with the lowest deterioration in the cooking and eating quality characters. In addition, the interaction between varieties and storage bags was differed from season to another and from character to character.

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تأثيرنوع العبوة وطرق التخزين على بعض صفات الطبخ والاكل وجودة الحبوب فى بعض اصناف الأرز

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تمت دراسة تأثير بعض ظروف التخزين على بعض صفات الطبخ والاكل وجودة حبوب الأرز. أستخدمت مجموعة متنوعة من الأصناف المحلية من الأرز المصرى سخا 102، جيزة 179من الأصناف قصيرة الحبة، وياسمين المصرى من الأصناف العطرية طويلة الحبة موسمى 2014، 2015 لمناقشة تاثير كل من اماكن التخزين (مخزن مغلق جيد التهوية، التخزين فى العراء، الصوامع المعدنية)، وكذا نوع العبوة (اجولة جوت، اجولة بلاستيك، عبوات ورقية) بعد فترة تخزين 12 شهرا على جودة صفات الطبخ والأكل (نسبة الاستطالة ، طول الجل، محتوى الاميلوز %، وقت الطبخ). أظهرت النتائج التى تم النوصل اليها فى موسمى الدراسة ان هناك فروق معنوية بين الاصناف وبين اماكن التخزين فيما يتعلق بجميع صفات الطبخ والاكل، وكان المخزن المغلق جيد التهوية هو افضل اماكن التخزين حيث اظهر ادنى قيم للتدهور فى صفات الطبخ والأكل، وكان التأ ثير بين الأصناف واماكن التخزين غير معنوى لجميع الصفات باستثناء صفة طول الجل موسم 2014 ونسبة الاستطالة موسم 2015. كانت الاختلافات بين نوع العبوات معنوية وكان الصنف سخا 102 اقل الأصناف تأثرا بأنواع عبوات التخزين واقلها تدهورا فى صفات الطبخ والاكل، واعطت العبوات الجوت اقل قيم تدهور فى صفات الطبخ والاكل. وكان تأثيرالتفاعل بين الاصناف والعبوات معنويا اختلف من موسم لآخر ومن صفة لأخرى. ويوصى البحث أن أفضل ظروف تخزين للأرز الشعير تحت الدراسة هو التخزين على محتوى رطوبى 14% لمدة 6 شهور فى المخزن المغلق جيد التهوية بأستخدام العبوات الجوت يليها العبوات الورقية وحيث ان هذا المستوى من المحتوى الرطوبى هو الأمثل لعمليات الضرب والتبييض.