ALEXANDRIA
SCIENCE EXCHANGE JOURNAL
VOL.38 JULY- SEPTEMBER 2017

Effect of Storage Duration and Package Materials on Viability and Grain Chemical Composition of Two Bread Wheat Cultivars

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ABSTRACT

This investigation was carried out at Plant Production Department Laboratories, Faculty of Agriculture (Saba-Basha), Alexandria University, Egypt to study the impact of storage period and package material on growth and some chemical contents of Giza 168 and Sids 12 grain wheat cultivars using split-split plot design. The studied traits, except infestation percent, were significantly decreased with increasing storage period till six months. The lowest germination (65.41%), shortest roots and shoots (5.45 and 3.39 cm), lightest shoot weight (0.030 g) and highest infestation percent (25.25%) resulted from stored grains for six months (at November). Stored grains till November, also showed the lowest 100-grain weight (2.33 g), protein, ash and moisture content (6.81, 1.03 and 8.82%), respectively. Giza 168 cultivar significantly surpassed Sids 12 in all the studied traits except root length. Sealed Sids 12 grains in black polyethylene bags decreased germination percent, shoot dry weight, 100-grain weight, protein and ash grain content, however it showed the highest insect infestation percent. Sids 12 bread wheat cultivar, generally, was more affected with increasing storage period than Giza 168 cultivar.

Keywords: Wheat cultivar, Storage period, Package material, Germination, Protein and Ash content.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the leading cereal crops and ranks first in cultivated area and production in the world (Ali et al.,2016). Wheat is a major source of dietary energy and protein for people whose daily diet is composed of cereal products. It is a staple food, consumed worldwide in the form of bread and bakery products.

Storage time and conditions have an influence on the technological quality of wheat and result in modifications of the flour parameters (Lukow and White, 1997). Time and temperature of storage and grain moisture content are the most important factors in terms of wheat quality. These factors have been reported to bring about significant changes in the functional characteristics of stored wheat (Mis, 2003). Storage of cereal crops is an important practice to preserve the grains for human consumption, animal feed or sowing. There are several factors that influence the quality of stored grains such as storage period, storage conditions (temperature, grain moisture content, relative humidity, etc…) and type of materials used for baking during storage. The present study aimed to investigate the effect of different packaging materials and storage duration on grain viability and chemical properties of Giza 168 and Sids 12 bread wheat cultivars.

MATERIALS AND METHODS

This lab experiment was carried out to study the effect of different packaging materials and storage duration on grain viability and chemical properties of Giza 168 and Sids 12 bread wheat cultivars in 2016.

Table 1. Monthly temperature and relative humidity for Alexandria governorate during the study

Month	Temperature °C		Relative humidity (%)
	Maximum	Minimum	
June	30	22	64.8
July	30	25	69.67
August	31	26	42.38
September	31	24	60.66
October	26	20	60.20
November	25	18	56.82

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Representative samples of wheat were packed using three different materials, i.e., burlap, white and black polyethylene bags of 3 kg size besides control (unbacked) treatment. The storage period was six months from June to November under normal room conditions. The studied traits were 100-grain weight, germination percentage after seven days of germination (according to ISTA, 1983), primary root and shoot length, fresh and dry weight of seedling at seven days after germination, grain moisture, protein and ash content (according A.O.A.C, 1990) and insect infestation percentage. Temperature and average relative

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Received May 2, 2017, Accepted July14, 2017.

humidity in Alexandria governorate during the studied are presented in Table (1).

The experiment was set up as a split-split plot arrangement in a randomized complete block design in three replicates. The main plots were assigned to six storage periods, the two studied wheat cultivars occupied the sub-plots, while the four packing treatments (burlap, white and black polyethylene bags besides control) were allocated to the sub-sub plots. Data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Results presented in Table (2) demonstrated that storage period, bread wheat cultivars and package materials had significant effect on the studied traits, i.e. germination percentage, root and shoot length, shoot dry weight and insect infestation percentage, except root and shoot length that was not significantly affected by package materials. On the other hand, storage period × wheat cultivar and storage period × package material interactions had significant effects on germination percent, root length and insect infestation percent.

Prolonging storage periods led to a gradual and significant decrease in the aforementioned traits, except infestation percentage which was significantly increased with increasing storage period from 3.29 and 4.08% in June and July to 25.25% in November. These results are agreement with those obtained by Abass *et al.* (2014). Conversely, increasing storage period from June to November significantly decreased germination percent from (91.20 to 65.41%), root and shoot length by (19.50 and 30.39%), respectively, and shoot dry weight (42.31%). Similar results were reported by Paders *et al.* (1997) and Malaker *et al.* (2008) who reported decreasing of seed germination from 95% to about 75% at the end of ten months of storage.

Giza 168 wheat cultivar showed lower infestation percentage (10.48%) and shorter root length (7.62 cm), however it had significantly higher germination percentage (83.66%), taller shoot length (6.21 cm) and heavier shoot dry weight (0.043 g) than Sids 12 cultivar. These differences could be due to genetic structure of both cultivars, where Giza 168 had heavier grains that contained higher protein and ash content as shown in Table (3). Fahmey (1976) indicated that there were significant differences between super X and Giza 155 wheat cultivars in insect infestation.

Table 2. Means of germination percent, seedling root and shoot length and dry weight as influenced by storage period, cultivars and package materials

Treatment	Germination (%)	Root length (cm)	Shoot length (cm)	Shoot dry weight (g)	Insect infestation (%)
Periods (P)					
June	91.20	6.77	4.87	0.052	3.29
July	89.41	9.73	6.90	0.051	4.08
August	85.83	9.56	6.24	0.041	6.25
September	82.87	9.68	5.74	0.034	12.29
October	78.16	8.65	6.65	0.033	16.95
November	65.41	5.45	3.39	0.030	25.25
$L.S.D._{0.05}$	2.44	2.15	1.48	0.003	1.88
Cultivars (C)					
Giza 168	83.66	7.62	6.21	0.043	10.48
Sids 12	80.63	8.99	5.05	0.037	12.22
$L.S.D._{0.05}$	1.46	0.56	0.78	0.002	0.72
Package material (K)					
Unpacked	86.33	8.26	5.85	0.046	8.47
Burlap	84.16	7.80	5.72	0.042	10.08
White polyethylene	78.91	8.77	5.82	0.039	12.69
Black polyethylene	79.19	8.39	5.13	0.033	14.16
$L.S.D._{0.05}$	1.56	-	-	0.003	1.11
Interactions					
P× C	*	*	n.s.	n.s.	**
P× K	**	**	n.s.	n.s.	*
C× K	n.s.	n.s.	n.s.	n.s.	n.s.
P× C× K	n.s.	n.s.	n.s.	n.s.	n.s.

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

Table 3. Means of 100-grain weight, protein, ash and moisture content as influenced by storage period, cultivars and package materials

Treatment	100-grain weight (g)	Protein content (%)	Ash content (%)	Moisture content (%)
Periods (P)				
June	3.99	11.45	1.50	9.39
July	3.59	10.32	1.61	9.99
August	3.24	9.29	1.44	10.71
September	2.90	8.40	1.29	10.77
October	2.59	7.56	1.13	9.25
November	2.33	6.81	1.03	8.82
$L.S.D._{0.05}$	0.05	0.05	0.02	0.88
Cultivars (C)				
Giza 168	3.53	9.32	1.42	10.21
Sids 12	2.68	8.62	1.24	9.42
$L.S.D._{0.05}$	0.04	0.08	0.01	0.30
Package material (K)				
Unpacked	3.31	9.32	1.37	9.95
Burlap	3.17	9.15	1.34	9.20
White polyethylene	3.03	8.85	1.32	10.04
Black polyethylene	2.92	8.57	1.30	10.06
$L.S.D._{0.05}$	0.07	0.06	0.02	-
Interactions				
P× C	**	n.s.	**	*
P× K	n.s.	n.s.	**	n.s.
C× K	**	**	**	n.s.
P× C× K	n.s.	n.s.	n.s.	n.s.

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

Concerning package material effects, results indicated that stored wheat grains in black polyethylene bags produced the highest insect infestation percentage (14.16%) and lightest shoot dry weight (0.033 g), while both white and black polyethylene bags produced the lowest germination percentages (78.91 and 79.19%), respectively. That might be due to higher moisture content of grains stored in polyethylene bags (Table 3). Similar results were reported by El-Kholy (1975) who indicated that under laboratory conditions, storage of wheat grains in cloth bags is highly recommended over storage in sealed polyethylene bags.

With respect to storage period × wheat variety interaction effects, obtained results (Table 4) demonstrated that Sids 12 cultivar had taller roots than Giza 168 across the six storage periods and it had the tallest roots (10.95 and 11.20 cm) at August and September, however Giza 168 cultivar produced significantly the shortest root (5.29 cm) at the end of storage period (November).

On the other hand, infestation percent was significantly increased for both cultivars with increasing storage period and the highest percent of infestation (28.58%) resulted from storage of Sids 12 grains for six months, and that might be due to lower protein and ash content in its grains (Table 3).

As for germination percentage, it was not significantly affected by storage for two and three months for Giza 168 and Sids 12 cultivars, respectively. However, the lowest germination percent (62.08%) resulted from storage of Sids grains for six months.

Storage period × package material interaction effects, Table (5), revealed that the highest germination percent (93.50%) was recorded from storage of wheat grains in burlap for one month and that was insignificantly different from other package materials and unpacked wheat for two months. However, sealed wheat grains in black and white polyethylene bags for six months showed the lowest germination percentages (58.66 and 60.66%), respectively.

On the other hand, stored wheat for three and four months in black polyethylene bags showed significantly tallest roots (11.66 cm) in both periods, however the shortest root length (4.08 and 4.50 cm) resulted from storing grains unpacked and in burlap bags, respectively, for six months.

Considering infestation effect, the highest value (30.0%) resulted from sealing wheat grains in black

polyethylene bags to six months. While, unpacked and sealed grains in burlap showed the lowest infestation percentages during June and July. Baskin *et al.* (1987) and Selvaraju and Krishna Samy (2005) studied the effect of bag types (gunny and cloth bags) on the percentage of seed germination and concluded that gunny bags recorded higher germination compared to those stored in cloth bags. They also pointed out a progressive decline in seed germination percentage with prolonged storage periods.

Table 4. Means of germination (%), root length, 100-grain weight, ash, moisture content and infestation percentages as influenced by storage period × wheat cultivars interaction

Storage period (month)	Cultivar	Germination (%)	Root length (cm)	100-grain weight (g)	Ash content (%)	Moisture content (%)	Infestation (%)
June	Giza 168	91.83	6.86	4.56	1.52	9.74	4.16
	Sids 12	90.58	6.68	3.42	1.48	9.04	2.41
July	Giza 168	90.0	9.30	4.08	1.75	9.96	3.58
	Sids 12	88.83	10.16	3.11	1.47	10.03	4.58
August	Giza 168	86.08	8.16	3.68	1.57	10.65	5.58
	Sids 12	85.58	10.95	2.80	1.32	10.68	6.91
September	Giza 168	83.75	8.16	3.29	1.40	10.59	11.25
	Sids 12	82.0	11.20	2.50	1.18	10.95	13.33
October	Giza 168	81.58	7.96	2.94	1.21	10.31	16.41
	Sids 12	74.75	9.33	2.24	1.05	8.19	17.50
November	Giza 168	68.75	5.29	2.64	1.10	9.99	21.91
	Sids 12	62.08	5.62	2.01	0.96	7.64	28.58
$L.S.D._{0.05}$		6.22	1.38	0.11	0.04	0.56	1.78

Table 5. Means of germination (%), root length, ash and infestation percentages as influenced by storage period × package materials interaction

Storage period (month)	Package material	Germination (%)	Root length (cm)	Ash content (%)	Infestation (%)
June	Unpacked	91.66	7.20	1.59	2.0
	Burlap	93.50	7.50	1.54	2.83
	White polyethylene	89.16	6.0	1.37	4.50
	Black polyethylene	90.50	6.40	1.51	3.83
July	Unpacked	92.50	10.83	1.60	2.33
	Burlap	90.50	9.95	1.58	2.83
	White polyethylene	87.83	10.50	1.63	4.83
	Black polyethylene	86.83	7.66	1.61	6.33
August	Unpacked	88.50	8.58	1.44	3.66
	Burlap	89.0	7.91	1.41	5.0
	White polyethylene	82.83	10.08	1.46	7.16
	Black polyethylene	83.0	11.66	1.45	9.16
September	Unpacked	86.33	9.08	1.31	10.16
	Burlap	86.50	7.91	1.26	11.0
	White polyethylene	79.16	10.08	1.30	13.83
	Black polyethylene	79.50	11.66	1.28	14.16
October	Unpacked	83.16	9.83	1.18	12.50
	Burlap	79.0	9.05	1.19	14.66
	White polyethylene	73.83	8.66	1.12	19.16
	Black polyethylene	76.66	7.05	1.04	21.50
November	Unpacked	75.83	4.08	1.09	20.16
	Burlap	66.50	4.50	1.07	24.16
	White polyethylene	60.66	7.33	1.02	26.66
	Black polyethylene	58.66	5.91	0.94	30.0
$L.S.D._{0.05}$		6.60	1.83	0.06	2.72

Table 6. Means of 100-grain weight, protein and ash content as affected by wheat cultivars × package materials interaction

Cultivars	Package material	100-grain weight (g)	Protein content (%)	Ash content (%)
Giza 168	Unpacked	3.60	9.75	1.49
	Burlap	3.65	9.47	1.47
	White polyethylene	3.50	9.13	1.37
	Black polyethylene	3.38	8.94	1.37
Sids 12	Unpacked	3.01	8.88	1.25
	Burlap	2.69	8.84	1.21
	White polyethylene	2.56	8.57	1.26
	Black polyethylene	2.46	8.20	1.24
$L.S.D._{0.05}$		0.10	0.09	0.03

With respect to storage period, wheat cultivar and package material and their interactions effect on 100-grain weight, grain protein, ash and moisture content, means presented in Table (3) pointed out that increasing storage period gradually and significantly decreased 100-grain weight, grain protein and ash content till November. However, the highest moisture percentages in stored wheat grains (10.71 and 10.77%) resulted during August and September. That might be due to higher air relative humidity during this period (Table 1).

Data, also, showed that Giza 168 cultivar significantly surpassed Sids 12 for 100-grain weight, grain protein, ash and moisture contents (9.32, 1.42 and 10.21%), respectively.

On the other hand, unpacked wheat grains had significantly highest values for 100- grain weight (3.31 g), protein content (9.32%) and ash content (1.37%). Conversely, sealed wheat grains in black polyethylene bags showed the lowest values (2.92 g, 8.57% and 1.30%) for 100-grain weight, grain protein and ash contents, respectively. These findings agreed with those reported by Ahmedani *et al.* (2009).

Concerning the two factor interaction effects storage period × wheat cultivar, means presented in Table (4) revealed that increasing storage period, generally, significantly decreased 100-grain weight and ash content in both studied cultivars. However, Giza 168 cultivar had the highest 100-grain weight (4.56 g) and ash content (1.75%) after storage for one and two months, respectively. On the other hand, after storage for the three and four months, the two studied cultivars had the highest moisture content. That might be due to high air relative humidity during August and September (Table 1). Sijbring (1973) stated that the moisture content of seeds stored will eventually reach a value which is in equilibrium with the atmospheric relative humidity in the store. Al-Borai *et al.* (1993), also studied the changes in viability and chemical composition of three soybean seed lots stored for different storage periods (6-30 month) and reported that seed moisture content was increased from (12.45 to 13.53%) during storage.

In contrast, Sids 12 cultivar showed the lowest 100-grain weight (2.01 g), ash content (0.96%) and moisture content (7.64%) at the end of storage period (six months).

Considering storage periods × package materials interaction effect, obtained results presented in Table (5) demonstrated that wheat grains packed or unpacked for two months showed the highest ash content, however sealed wheat grains in black polyethylene bags and stored for six months showed the lowest ash content in grains (0.94%).

As for wheat cultivar × package material interactions effect, results in Table (6) revealed that unpacked Giza 168 cultivar grains or sealed in burlap package showed the heaviest 100-grain weight (3.60 and 3.65 g), highest protein (9.75 and 9.47%), and ash content (1.49 and 1.47%). Conversely, stored Sids 12 grains in black polyethylene bags produced the significantly lowest 100-grain weight (2.46 g), protein (8.20%) and ash content (1.24%).

CONCLUSION

It could be concluded that sealing bread wheat grains in burlap packages for six months , generally caused lower hazard effects than other packing materials, however there were significant differences for wheat cultivars response for storage.

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الملخص العربي

تأثير فترات التخزين ونوع العبوات على الحيوية والمحتوى الكيماوى لحبوب صنفين من قمح الخبز

محمود أبو عجيله على رحومه

أجرت الدراسة فى معامل قسم الإنتاج النباتى- كلية الزراعة (سابا باشا) جامعة الإسكندرية، خلال الموسم الصيفى ٢٠١٦ وذلك بهدف دراسة تأثير ست فترات شهرية بدءاً من شهر يونيو حتى نهاية نوفمبر على الحيوية والمحتويات الكيماوية لحبوب قمح الخبز صنفى Giza 168، Sids 12 التى خزنت فى (أكياس من الخيش، أكياس بلاستيكية بيضاء، أكياس بلاستيكية سوداء بالإضافة إلى معاملة المقارنة بدون تعبئة)- وقد نفذت التجربة فى تصميم قطع منشقة مرتين Split-split plot فى ثلاث مكررات وكانت فترات التخزين ممثلة للقطع الرئيسية، الأصناف ممثلة للقطع الفرعية، نوع العبوات ممثلة للقطع تحت الفرعية.

وقد أظهرت النتائج أن جميع الصفات التى تم دراستها تناقصت معنوياً بزيادة فترة التخزين ماعدا نسبة الإصابة التى ازدادت معنوياً بزيادة فترة التخزين وقد أدى التخزين حتى شهر نوفمبر إلى أقل نسبة من الإنبات (٦٥,٤١%)- أقصر الجذور والمجموع الخضرى طولاً (٥,٤٥ سم، ٣,٣٩جم) وأخف وزن جاف للمجموع الخضرى (٠,٠٣ جم)- فى حين كانت نسبة الإصابة (٢٥,٢٥%).

كذلك سجل أقل وزن للمائة حبة (٢,٣٣ جم) وأقل نسبة من البروتين والرماد والرطوبة (٦,٨١، ١,٠٣، ٨,٨٢%) على الترتيب فى شهر نوفمبر- من ناحية أخرى تفوق الصنف جيزة ١٦٨ على الصنف سدس ١٢ فى جميع الصفات عدا طول الجذر.

وأدى التخزين فى أكياس البوليثلين السوداء إلى انخفاض نسبة الإنبات، الوزن الجاف للمجموع الخضرى، وزن المائة حبة ومحتوى الحبوب من البروتين والرماد وإلى زيادة نسبة الإصابة فى الحبوب خاصة فى الصنف سدس ١٢.

وعموماً كانت حبوب الصنف سدس ١٢ أكثر تأثراً بطول فترة التخزين مقارنة بالصنف جيزة ١٦٨.

الخلاصة.

نخلص من ذلك إلى أن تخزين حبوب قمح الخبز فى العبوات المصنوعة من الخيش أدت إلى حدوث أضراراً طفيفة مقارنة بالعبوات الأخرى- كذلك فإن درجة تأثر أصناف القمح بفترة التخزين تختلف من صنف لآخر.