Evaluation of storability of some local onion cultivars (*Allium cepa* L)

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Abstract

Field experiments were conducted during the winter seasons of 2000 -2002 in the research farm of the National Institute for the Promotion of Horticultural Exports (NIPHE), University of Gezira, Wad Medani, Sudan, to evaluate storability of twelve local onion cultivars. The seeds of the cultivars were collected from the Agricultural Research Corporation (Genetic Resources Unit) and NIPHE. The crop was produced according to recommendation of culture practice, the bulb was harvested , cured and packed in jute sack with 50kg weight and placed in shade . At the beginning of the experiment the dry matter , total soluble solid and essential weigh were determinated . Monthly intervals, the rotten and sprouted blubs were sorted and weighted .The experiment was terminated after six months of storage from first May to first November. The data collected were the weight loss ,sprouting loss ,rotten loss and total loss. The results showed significant differences between the cultivars, The lowest percentage of weight loss was scored by the cultivars Abu Firewa, the lowest percentage of sprouting was recorded by The cultivar Saggai improved ,the lowest percentage of rotting was obtained by the cultivar Kamleen. The lowest total losses percentage was recorded by the cultivar Abu Firewa , while the cultivar Zalinge scored the highest percentage of total losses .The evaluation of the cultivars under this study showed variation in storability .The cultivars Abu Firewa , Kamleen and Saggai improved had a god storability.

المستخلص

أجريت هذه الدراسة بمزرعة المعهد القومي لتنمية الصادرات البستانية ، جامعة الجزيرة ،السودان خلال موسم 2000– 2002م ، هدفت الدراسة إلى تقييم المقدرة التخزينية لاثنا عشر صنف من البصل المحلى ، تم الحصول على بذور الاصناف من هيئة البحوث الزراعية (وحدة الموارد الوراثية) والمعهد القومي لتنمية الصادرات البستانية . أنتج المحصول وفقا للعمليات الفلاحية الموصى بها وحصدت الأبصال وأجريت لها عملية العلاج التجفيفى ثم عبئت في أكياس من الجوت بزنة 50 كيلو للوحدة ووضعت في الظل، في أول فترة التخزين تم قياس المادة الجافة ونسبة المواد الصلبة الذائبة الكلية واخذ الوزن الاساسى ، تم الفرز شهريا للأبصال المتعفنة والمزرعة و تم تقدير الوزن لكل منهما ، واستمرت فترة التخزين ستة أشهر من أول مايو إلى أول نوفمبر . القراءات التي أخذت شملت نسبة الفقد في الوزن ونسبة الفقد بالتعفن ونسب الفقد بالتزريع ونسبة الفقد الكلية . أوضحت النتائج فروقات معنوية بين الاصناف في مقدرتها التخزينية ، اقل نسبة فقد في الوزن سجلها الصنف أبو فريوة واقل نسبة فقد بالتزريع سجلت بواسطة الصنف سقاى محسن واقل نسبة فقد بالعفن سجلت بواسطة الصنف كاملين واقل نسبة في الفقد الكلى سجلت بواسطة الصنف أبو فريوة. أوضح تقييم المقدرة التخزينية تباين في المقدرة التخزينية للأصناف وكانت أفضل الاصناف الصنف أبو فريوة والصنف كاملين والصنف سقاى محسن.

Introduction

Onion (*Allium cepa* L.) in one of the most important horticultural crops in the world as far as production and consumption. It is very widely used as a vegetable by almost all classes of societies. The genus *Allium* is a diverse tax on of over 500 species including the cultivated bulb onion (*Allium cepa* L.), chive (*Allium shoenoprasum* L.), Japanese bunching onion (*Allium fistulosum* L.), Garlic (*Allium sativum* L.) and Leek (*Allium ampeloprasum* L.). All *Allium cepa* L. populations have 2n = 16 chromosomes (Van Der Meer and Davies ,1990). It is believed that onion was domesticated in central Asia about 6000 years ago. Onion growing areas have been expanding ever since, so that presently, it is grown in almost all parts of the world (Nova,2002).It has been introduced to the Sudan ,but no written records about the date of introduction are known (Bedri, 1984).Onion have played an important role in trade, human nutrition and medicine. It is very essential for the preparation of food and is eaten fresh or cooked with a mixture of other vegetables and meat. The bulb onion is the most economically important cultivated Allium species with a total world production of approximately 51 million tons in 2002.The leading producing countries are China, India, U.S.A and Turkey. The major exporting countries are U.S.A., China and Turkey, whereas the major importing countries are Germany, U.K. and France (FAO, 2002).

In Sudan, onion is one of the most important vegetables. Variation in production seasons in the different regions of Sudan makes it available throughout the year. The main production areas are Gezira, Shendi , Kassala and Khartoum . Total production of onion in Sudan is around 59000 tons (FAO, 2003). In the Gezira State, onion was stored in open area, in jute sacks placed upside down on a cushion of cotton stalk.. Musa (1974) reported that storage of Wad Ramli cultivar in cottage for 6 months resulted in a total loss of 50%. About 30% of the loss was attributed to weight loss, 18% to rotting and the rest was attributed to sprouting . The major storage disease in Sudan was black mould which occurred in more than 80% of the rotting bulbs (Musa *et al.* 1973). High temperature coupled with high relative humidity at the beginning of the storage period under Sudan conditions encouraged rotting. . There is a great need to evaluate the onion cultivars for their storability to improve the onion storage life. The objectives of this study are: to evaluate storability of twelve indigenous onion cultivars under shad storage.

Materials and Methods

Field experiments were conducted during the seasons of 2000 - 2002 in the research farm of the National Institute for the Promotion of Horticultural Exports (NIPHE), University of Gezira, Wad Medani, Sudan. Local commercial cultivars of onion used in this study were Saggai improved (HSD 1408), Hilaliya (HSD 0100), Zalinge (HSD 1400), Shendi Red (HSD 0670), Abu Firewa (HSD 0445), Amara (HSD 1407), Shendi Yellow (HSD 0360), Dongola Yellow (HSD 1404), Dongola White (HSD 1405) and Fadasi (HSD 0775). Seeds of these cultivars were obtained from the Agricultural Research Corporation (Genetic Resources Unit). Other cultivars used in this study were Kamleen and El Hilo which obtained from the National Institute for the Promotion of Horticultural Exports. These cultivars were grown at research farm of NIPHE, They were subjected to standard cultural practices till harvested, cured and

placed into jute sacks 50 kg weight. Onion bulbs were stored under shade storage (open and rain proof shade covered with zinc roof). The experiment was terminated after six months of storage from first May to first November. Total soluble solids (TSS) and dry matter content (DM) were determined at the beginning of the experiment. Total soluble solids were determined using a hand refractometer. For the determination of dry matter content, 100 g of fresh onion slices were placed in an oven at 60°C and weighed every day till a constant weight was obtained(after three days). Percent dry matter was determined as follows:

$$\% \text{ dry matter (DM)} = \frac{\text{dry weight}}{\text{Fresh weight}} \times 100$$

The fresh weight of the sacks was determined at the beginning of the storage(Initial weight) and then at monthly intervals and were determined as follows:

$$\text{Weight loss (\%)} = \frac{\text{Initial weight – monthly weight}}{\text{Initial weight}} \times 100$$

Percentage of rotted and sprouted bulbs in each sack were determined at monthly intervals according to the flowing :

$$\text{Rotten bulbs (\%)} = \frac{\text{Weight of rotten bulbs (kg)}}{\text{Initial weight (kg)}} \times 100$$

$$\text{Sprouting bulbs (\%)} = \frac{\text{Weight of sprouted bulbs (kg)}}{\text{Initial weight (kg)}} \times 100$$

The total loss percentage were determined according to :
Total loss = weight loss (%) + rotten bulbs (%) + sprouting bulbs (%)

Statistical analysis

Data were subjected to analysis of variance procedure. Treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Result and Discussion

Dry matter content(DM) and total soluble solids (TSS)

Dry matter content and total soluble solids are important characteristics to be considered in onion storage .The evaluation of DM and TSS of twelve local onion in table (1). . The cultivars Abu Firewa had the highest DM (24%) and TSS (21%),while the another cultivars had the medium to high DM and TSS. This result are in agreement to Mohamed Alai (1978), where showed the onion cultivars are classified according to dry matter content into high (more than 15%), medium (10-15%) and low (less than 10%) and the local cultivars had higher total soluble solids and dry matter contents as compared to introduced ones. McCollum and George (1968) reported a positive correlation between dry matter content and total soluble solids. Mahmoud and Babiker (1974) reported that dry matter content and T.S.S. of the local onion cultivars ranged from 8.0 to 21.0% and 6 to 18.5%, respectively.

Weight losses

Onion cultivars showed significant differences in weight loss after six months of storage under shade (Tables 2 and 3) . Generally in both seasons , weight loss increased

with increased storage period in all cultivars. The loss in bulb weight was mainly attributed to water loss. The lowest percentage of weight loss was scored by the cultivars Abu Firewa because they were characterized by high dry matter content and high total soluble solids (Tables 1) which are the main characters associated with good storage ability as indicated by Abdalla (1963). Ambient high temperatures and low relative humidity caused high losses in weight. This was in agreement with Aman (1996),who reported that high temperature significantly increased weight loss. According to Yamaguch (1975) and Zuzuki (1989), loss in weight was affected by temperature and relative humidity. Cultivars suitable for storage should produce a number of outer dry scales. These outer layers help to create an effective vapor barrier around the bulb, thereby minimizing moisture loss (Brice, 1995 and Atwa. *et al* 1974)

Sprouting losses

Onion cultivars showed significant differences in sprouting losses in both seasons (Tables 4 and 5). The cultivar Saggai improved showed the lowest percentage of sprouting ,while the cultivars Zalinge and Amara showed the highest percentage of sprouting .The increase in sprouting percentage at the end of the storage period was probably due to a decrease in temperature and an increase in relative humidity . Many workers indicated that if the duration of storage is extended into the winter season and the temperature dropped to intermediate levels , sprouting is rapidly encouraged (Abdalla, 1963 and Brewster 1990). These findings are in conformity with these reported by Bedford (1984), who reported that the characteristics which enhance superior storage quality of onion are high total soluble solids, high dry matter content of more than 15%, high pungency and globular shape to reduce bulb losses.. Khalil (1989) mentioned that sprouting losses were more in varieties with low percentage of dry matter and total soluble solids content. Komashi (1990) concluded that higher content of dry matter and TSS was associated with better keeping quality.

Rotting loss

Rotting of onion bulbs is another limitation of onion storage. Onion cultivars showed significant differences in rotting losses (Tables 6 and 7). Rotting losses increased with duration of storage period in both seasons .The lowest percentage of rotting was obtained by the cultivar Abu Firewa and Kamleen and the highest values were recorded by the cultivars Zalinge , Dongola White and Amara . The low rotting percentage showed by the Abu Firewa and the cultivar Kamleen was probably due to its high dry matter content and total soluble solid. These results are in agreement with those reported by Patil *et al*.(1988), who found that onion bulbs with higher levels of dry matter, total soluble solids and non reducing sugars contents exhibited a longer storage life. Tanaka (1985) stated that the poor keeping quality of onion cultivars had been attributed to the low dry matter content, low total soluble solids, low level of non-reducing sugars and high rate of water.

Total loss

Table (8 and 9) shows the total loss percentage of onion cultivars during storage in two seasons. There were significant differences in the total losses percentage between the different onion cultivars. The least total loss percentage was recorded by the cultivar Abu Firewa , while the cultivar Zalinge scored the highest percentage of total loss and the other cultivars ranged between mid to high total losses. The cultivar Abu Firewa had the

highest dry matter and total soluble solids contents and higher pungency , while the cultivar Zalinge had the lowest contents of dry matter and total soluble solids (Table 1). These results are in line with those reported by. Ryall and Lipton (1983), who mentioned that the characteristics which enhanced superior storage quality of onion were high total soluble solids, high dry matter content of more than 15% and high pungency. Hurst *et al.* (1985) reported that varieties of low dry matter content and less pungent are grown for the fresh market for raw consumption and generally do not store very well. Good storage potential of onion cultivars varies considerably with their physical and physiological characteristics (Woodman and Barnell, 1937;) Foskett and Peterson (1950) reported that the poor keeping cultivars generally have low dry matter content and a high rate of water loss especially in the period immediately following harvest which results in softening, shriveling and weight loss. Magruder *et al.* (1941) found that cultivars differed in the duration of dormancy and in their potential for long-term storage .

Conclusion

Evaluation of twelve local onion cultivars for storage ability showed that the cultivars Abu Firewa Kamleen , Saggai improved and El Hilo had the highest storability and the mid storability were scored by the another cultivar.

Table 1. The percentage of dry matter content and total soluble solids in twelve local onion.

Cultivar	DM (%)	TSS (%)
Abu Firewa	24a	21a
Amara	18c	15d
Dongola (white)	19b	15d
Dongola (yellow)	17d	15d
El Hilo	18c	16c
Fadasi	17d	15d
Hilaliya	17d	15d
Kamleen	19b	17b
Saggai Imp.	19b	17b
Shendi (yellow)	18c	16b
Shendi (red)	17d	15d
Zalinge	16e	14e
Mean	18.3	15.9
Significance level	*	*
S.E.+_	0.38	0.45
C.V.	6.07	7.2

***Indicates significance at P≤0.05**

Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 2 .Mean Weight loss of twelve local onion cultivars after 6 months store (season 2000-2001)

Cultivar	Weight loss (%)					
	Months					
	1	2	3	4	5	6
Abu Firewa	1.89	3.13	4.56	6.48	8.17	10.48 d
Amara	2.51	5.15	8.69	10.21	12.35	16.31 b
Dongola (white)	3.94	6.78	9.53	11.72	13.94	15.80 b
Dongola (yellow)	3.12	7.01	10.26	12.12	14.95	16.48 b
El Hilo	1.10	3.20	6.21	9.16	11.78	13.14 c
Fadasi	3.03	7.81	10.15	13.12	15.15	17.36ab
Hilaliya	2.76	5.25	8.34	11.38	14.28	18.92 a
Kamleen	1.78	3.16	5.56	8.58	10.64	12.74 c
Saggai Improved	2.47	4.36	6.24	9.13	10.52	12.61 c
Shendi (yellow)	1.15	3.12	7.76	10.94	13.31	16.31 b
Shendi (red)	1.78	4.39	7.48	9.36	11.14	14.21bc

Zalinge	5.83	9.38	13.93	15.23	17.18	19.61 a
Mean			15.41			
Significance level			*			
SE+_			0.42			
CV			3.17			

***Indicates significance at P≤ 0.05.**
Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 3 . Mean Weight loss of twelve local onion cultivars after 6 months store (season 2001-2002).

Cultivar	Weight loss (%)					
	Months					
	1	2	3	4	5	6
Abu Firewa	0.89	1.93	2.35	4.37	6.34	8.19 d
Amara	2.98	6.15	7.89	9.01	11.64	13.46 b
Dongola (white)	3.54	5.88	7.73	9.12	10.34	12.78b c
Dongola (yellow)	3.54	6.31	8.36	10.42	12.35	14.73 b
El Hilo	1.78	3.94	5.89	7.26	9.18	11.43 c
Fadasi	3.03	5.81	7.15	10.32	13.25	15.65a b
Hilaliya	3.46	6.27	8.96	11.58	13.78	16.18 a
Kamleen	2.78	4.76	5.84	7.88	9.53	10.37 c
Saggai Improved	2.97	5.06	6.54	8.23	9.86	10.54 c
Shendi (yellow)	2.30	5.82	7.96	10.21	12.54	14.46 b
Shendi (red)	1.89	4.98	7.64	9.21	11.00	12.19bc
Zalinge	6.83	9.10	12.13	14.53	16.10	17.62 a
Mean			13.14			
Significance level			*			
S.E+			0.38			
C.V .			3.01			

***Indicates significance at P≤ 0.05.**
Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 4. Mean Percentage sprouting of twelve local onion cultivars after 6 months store (season 2000-2001)

Cultivar	**Sprouting losses (%)**					
	Months					
	1	**2**	**3**	**4**	**5**	**6**
Abu Firewa	0	0.67	1.12	1.54	1.98	2.31 c
Amara	0	1.23	1.76	2.14	2.83	4.61 a b
Dongola (white)	0	1.12	1.58	2.11	2.63	4.15 a b
Dongola (yellow)	0	0.98	1.32	1.74	2.48	3.41 b
El Hilo	0	0.58	1.11	1.38	1.86	2.34 c
Fadasi	0	0.11	0.47	1.93	2.12	2.54 c
Hilaliya	0	0.31	0.68	1.84	3.28	4.68 a b
Kamleen	0	0.74	1.12	1.43	1.88	2.12 c
Saggai Imp.	0	0.02	0.41	0.73	1.02	1.59 d
Shendi (yellow)	0	0.17	0.23	0.86	1.94	2.32 c
Shendi (red)	0	0.12	0.42	0.93	1.39	2.22 c
Zalinge	0	1.79	1.68	2.72	4.83	5.22 a
Mean				3.13		
Significance level				*		
S.E+				0.15		
C.V.				3.42		

***Indicates significance at P≤ 0.05.**
Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 5. Mean Percentage sprouting of twelve local onion cultivars after 6 months store (season 2001-2002)

Cultivar	Sprouting losses (%)					
	Months					
	1	2	3	4	5	6
Abu Firewa	0	0.18	0.87	1.25	1.87	2.03 d
Amara	0	1.03	1.36	2.14	2.79	3.58 b
Dongola (white)	0	1.02	1.18	2.01	2.72	3.34 c
Dongola (yellow)	0	0.48	1.82	2.14	2.71	3.72 c
El Hilo	0	0.68	1.01	1.68	2.06	2.34 d
Fadasi	0	0.31	0.97	1.93	2.82	3.54 c
Hilaliya	0	1.31	2.18	2.84	4.26	5.28 a
Kamleen	0	0.82	1.32	1.89	2.18	2.84 c
Saggai Imp.	0	0.94	1.11	1.83	2.32	2.97 c
Shendi (yellow)	0	0.97	1.83	2.26	3.24	4.12 b
Shendi (red)	0	0.72	1.82	2.53	3.29	4.35 b
Zalinge	0	1.79	2.68	3.39	4.23	5.45 a
Mean				3.66		
Significance level				*		
S.E+				0.42		
C.V.				4.76		

***Indicates significance at P≤0.05.**
Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 6. Mean percentage rotting of twelve local onion cultivars after 6months store (season 2000-2001).

Cultivar	Rotting losses (%)					
	Months					
	1	2	3	4	5	6
Abu Firewa	0.01	0.86	1.48	2.16	2.78	3.30 e
Amara	0.53	1.13	1.48	2.98	3.63	7.22 b
Dongola (white)	0.98	2.38	3.61	4.74	5.13	7.28 b
Dongola (yellow)	0.28	1.87	2.23	3.81	4.45	5.11 c
El Hilo	0.16	0.73	1.84	2.41	3.73	4.32 d
Fadasi	0.51	1.63	2.72	3.26	3.96	5.56 c
Hilaliya	0.28	1.98	2.28	3.97	4.48	5.13 c
Kamleen	0.18	0.60	0.82	1.01	1.18	3.35 e
Saggai Imp.	0.48	1.13	1.74	2.11	2.67	3.33 e
Shendi (yellow)	0.25	1.87	2.12	3.56	4.96	5.53 c
Shendi (red)	0.63	1.51	2.53	3.14	4.71	5.39 c
Zalinge	0.48	1.24	2.31	3.41	5.67	8.52 a
Mean				5.42		
Significance level				*		
S.E+				0.26		
C.V.				5.15		

***Indicates significance at P≤0.05.**
Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 7. Mean percentage rotting of twelve local onion cultivars after 6months store (season 2000 -2001) .

Cultivar	Rotting losses (%)					
	Months					
	1	2	3	4	5	6
Abu Firewa	0.00	0.36	0.98	1.86	2.58	3.25 d
Amara	0.53	1.73	2.58	3.18	4.63	5.82 b
Dongola (white)	0.28	1.98	3.11	4.24	5.23	6.34 b
Dongola (yellow)	0.18	1.37	2.03	3.51	4.75	5.32 b c
El Hilo	0.12	0.63	1.74	2.51	3.13	3.52 d
Fadasi	0.47	1.23	2.762	3.26	3.86	4.76 b c
Hilaliya	0.28	1.58	2.48	3.57	4.18	4.83 b c
Kamleen	0.18	0.92	1.52	1.94	2.38	3.25 d
Saggai Imp.	0.48	0.93	1.64	2.01	2.57	3.63 d
Shendi (yellow)	0.25	1.97	2.42	3.36	4.86	5.53 b c
Shendi (red)	0.83	1.87	2.43	2.94	4.69	5.29 b c
Zalinge	1.48	2.14	4.52	5.21	6.17	7.64 a
Mean			4.95			
Significance level			*			
S.E+			0.26			
C.V.			4.68			

***Indicates significance at P≤0.05.**

Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 8. Mean total losses of twelve local onion cultivars after 6 months store (season 2000-2001).

Cultivar	Weight losses (%)	Sprouting losses (%)	Rotting losses (%)	Total Losses (%)
Abu Firewa	10.48	2.31	4.30	19.09 d
Amara	16.31	4.61	7.22	28.14 b
Dongola (wh.)	15.8	4.15	7.28	31.23 a
Dongola(yell.)	17.48	3.41	5.11	27.00 b
El Hilo	13.14	2.34	4.32	22.80 cd
Fadasi	17.36	2.54	5.56	28.46 b
Hilaliya	18.92	4.68	5.13	29.72 ab
Kamleen	12.74	2.12	3.35	20.21 d
Saggai Imp.	12.61	1.59	3.33	21.53 cd
Shendi (yell.)	16.31	2.32	5.53	25.16 c
Shendi (red)	14.21	2.22	5.39	24.82 c
Zalinge	19.61	5.22	8.52	34.38 a
Mean	15.41	3.12	5.42	26.03
Significance level			*	
S.E +			0.74	
C.V.			6.28	

***Indicates significance at P≤0.05.**

Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Table 9. Mean total losses of twelve local onion cultivars after 6 months store (season 2001-2002).

Cultivar	Weight losses (%)	Sprouting losses (%)	Rotting losses (%)	Total Losses (%)
Abu Firewa	8.19	2.03	3.25	13.50e
Amara	13.46	3.58	5.82	22.86c
Dongola (wh.)	12.78	3.34	6.34	22.70c
Dongola(yell.)	14.73	3.72	5.32	23.77bc
El Hilo	11.43	2.34	3.52	17.29
Fadasi	15.65	3.54	4.76	23.95bc
Hilaliya	16.18	5.28	4.83	26.29b
Kamleen	10.37	2.84	3.25	16.46d
Saggai Imp.	10.54	2.97	3.63	17.14d
Shendi (yell.)	14.46	4.12	5.53	24.11bc
Shendi (red)	12.1	4.35	5.29	21.83c
Zalinge	17.62	5.45	7.64	30.71a
Mean	13.13	3.63	4.93	21.72
Significance level				*
S.E +				0.37
C.V.				5.87

*** Indicates significance at $P \leq 0.05$.**
Means within columns followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

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