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Study on Storage of Barhey Fruits (Consumer Package)

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ABSTRACT

This research has been carried out over two seasons (2005- 2006). Fruits of date palm cv. Barhey were obtained from private orchard at South Tahrir area in order to determine fruit quality, storage life and marketability and the effect of consumer polyethylene and mesh package on keeping quality of fruits during storage at 0°C and 20°C. Results revealed that there was an increase in fruit weight, length, diameter, TSS% and 'a value' of peel color with age advanced during maturation period. Storage life was 60 days at 0°C plus 7 days at ambient temperature (18-20°C), 28 days at (20-25°C). Fruits that stored in polyethylene bags showed lower values of weight loss and rutab percentage, higher texture than fruits in mesh bags, besides, delayed the development of peel and pulp color values. Therefore, shelf life was 28 days at 20°C without any symptoms of decay. However, no noticeable chilling injury was found in fruits of present study.

INTRODUCTION

Date palm (*Phoenix dactylifera*) is the major fruit tree in most Arabian countries and it is widely grown in Middle Eastern countries. North Africa and the Arab-Muslim world are the main production areas, according to a 2006 study for the years 2003 and 2004. Thus, 11 countries in these regions carry out 94% of world production; the 1st place was occupied by Egypt followed successively by Iran and Saudi Arabia, Abd Elkader, (2016). The date fruit takes about six months to ripen completely. Barhi dates can be eaten at Khalal stage, when they are free of astringency, sweet and crunchy. Fresh dates, such as Barhi cultivar, are popular and widely consumed at the Khalal stage of maturity (first edible stage, crunchy and sweet) during the date production season. In this respect Mortazavi *et al*. (2010) reported that 'Barhee' is mainly harvested at the Khalal stage. Growth of date fruits follows a sigmoid curve and is usually divided into five development stages known by the Arabic terms: 'hababouk', 'kimri', 'khalal', 'rutab' and 'tamr' (Yahia, 2004).

One of the primary technical challenges in marketing fresh Barhi fruits at the Khalal stage of maturity is the preservation of quality for the longest possible period after harvesting and during the marketing process. Abdullah M. Alhamdan *et al*. (2015).

Alhamdan & Al-Helal (2008) reported that there was no commercial method available to preserve fruit at the khalal stage of maturity beyond the few days provided by traditional refrigeration methods. Other postharvest preservation techniques that may be useful in commercially extending fruit shelf life include controlled atmosphere (CA), modified atmosphere packaging (MAP) (Sidhu, 2006; Omar, 2008 and Al-Redhaiman, 2005).

Storage at modified atmosphere (MA) conditions delays fruit senescence, and extends storage life of horticultural crops through reducing postharvest loss (Kader 2002).

Somboonkaew & Terry (2010a) reported that perforated polyethylene bags were used to extend the storability of litchi fruit cv. Mauritius through reducing abrasion damage, minimizing weight loss and delaying of ripening and senescence processes. They are also maintaining the organoleptic properties of the fruit (Ramin & Khashbakhat 2008).The improved method of high density polyethylene (HDPE) and low density polyethylene(LDPE) reduced respiration rate, weight loss, soluble solids content and titratable acidity; improved fruit firmness and ascorbic acid content; and extent fruit storability (Adamicki 2001; Aharoni et al., 2008).

It is necessary to find out a cheap and effective storage method to increase fruit shelf-life by means of retarding the natural physiological deterioration and preventing the activity of decay organisms. Different types of packaging can be used depending on requirements of the produce and the target market. These are polymer film bags, trays with ridged or sealed film lids, overwrapped trays, and clamshells, Rajkumar and Mitalid (2009) and (Forney, 2007).

The aim of this study is to determine the maturity stage of Barhey fruit, studying effect of pre-storage packaging with polyethylene and mesh bags on fruit characters during cold storage and evaluate fruit quality during shelf-life.

MATERIALS AND METHODS

This study was carried out during two successive season, 2005 and 2006 on Barhey date palm fruit trees grown at a private orchard at South Tahrir district, Behera Governorate. The study comprises the following:

1- Fruit characters at maturity stage:

Samples of Barhey fruits at maturity stage (color khalal) were taken at 220, 230, 240 days after full bloom to determine fruit properties (flesh 5 fruit weight "g", fruit texture "g/cm^2, peel and pulp color, TSS%, Acidity%, TSS/ acid%, Tannin%) according to (A.O.A.C. 1991).

2-Fruit characters during cold storage:

Fruit were picked at maturity, transferred immediately to laboratory, washed, divided into two groups, one

was packed in polyethylene bags (20 micron in thickness) and the other one was packed in mesh bags. Both of them stored at 0°C (85-90% RH) 60days and at ambient temperature (20-25° C) 28 days. Fruits were examined every 10 days to detect weight loss %, Rutab %, peel and pulp color, texture, TSS%, Acidity%, and TSS/acid ratio.

3- Fruit characters during shelf- life:

Fruits were weighted and put at ambient temperature (18-20°C) for 7 days to stimulate the marketing period, at the beginning 15 days, middle 40 days and the end 60 days of cold storage period at 0°C. Changes in fruit characters were recorded. Weight loss was measured using a digital balance according to A.O.A.C. (1991). Soluble solids content (SSC) was determined using a hand-held refractometer (Model K-0032, Cosmo, Japan) at room temperature according to A.O.A.C. (1991). Titratable acidity was calculated with the titrated volume of standard NaOH to pH 8.1 and expressed as mg of malic acid according to A.O.A.C. (1991).texture was estimated by measuring resistance of fruit flesh (at a middle position) for a penetrating needle of a texture analyzer instrument (Lfra texture analyzer) for a fixed distance of 2 millimeters inside fruit flesh and firmness is expressed in gram unit. Color measurements for the fruit were obtained using Hunter colormeter (DP9000), (a,value:green,red) (b,value:blue,yellow), (L,value: lightness), McGure, (1992).

Statistical analysis:

Data obtained were statistically analyzed using the L.S.D. value at 5% level (Scedecor and Cohran, 1972).

RESULTS

1- Fruit characters at maturity stage:

Data presented in Table (1) showed that, in Barhey fruits which picked at the color Khalal stage, the fruit weight; length and diameter were significantly increased till the age of 240 days. No statistical differences were detected regarding fruit shape index during maturation time Fruit firmness was decreased gradually toward the maturity stage. TSS percentage increased significantly and gradually during maturation period, meanwhile acid percentage and tannin content in date fruit, decreased significantly, these results indicate that tannins synthet sis is reduced in late stages of fruit development and at harvest, Nihad *et al*., (2013) came to the same findings.

Regarding fruit color, it is clear from Table (1) that Fruit became more yellowish, where "a" values were increased till the end of maturity stage while "b" values were decreased during maturity stage. These results are in agreement with the finding of Salah *et al*. (2012)

2- Fruit characters during cold storage:

2-1. Weight loss:

It can be concluded that weight loss % was increased with prolonged storage period in both seasons of the study. (Table 2 & 3)

Control treatments (mesh bags) lost 7.4%, 14. 2% and 20% of their total weight over the 20, 40 and 60 days of storage period in the first season, while polyethylene-treated dates lost 2.8%, 5.8% and 9.4%. At second season, packaging in polyethylene bags showed the least significant percentage of weight loss. The same trend was observed by Salah *et al*. (2012).

2-2. Rutab fruits percentage:

Rutab fruits (they are undesirable character), It means that the fruits begin to soften and acquiring a darker and less attractive color as reported by Saied *et al*. (2014). Rutab fruit% increased as the cold storage period increased, reached 24%, 22.0%in polyethylene treatment, while control gave the highest significant percentage 55%, 51% in 2005, 2006 respectively. (Table 2 & 3).

Even though consumers may find these softer fruit desirable at later date ripening stages such as in the rutab and tamr stages, they would not be considered 'crunchy' as expected from a khalal stage fruit and therefore would not be a suitable fruit quality, Salah *et al*. (2012).

2-3. Peel and pulp color

Both external color of peel and pulp were increased during storage period, generally, polyethylene bags de-

Table (1): Fruit characters at maturity

season	Days from full bloom	Weight 5 fruit	Length	Diam-eter	shape index	firm-ness	Tex-ture%	TSS%	Acid%	TSS/ acid	Tan-nins%	Peel color a	Peel color b	Pulp color a	Pulp color b
2005	220	83.2^{C}	3.6^{C}	2.5^{C}	1.44^{A}	26.0^{A}	116^{A}	30.1^{B}	0.5^{A}	60.2^{C}	0.44^{A}	0.60^{C}	22.9^{A}	-2.4^{A}	17.5^{A}
	230	95.4^{B}	4.0^{B}	2.7^{B}	1.48^{A}	24.0^{B}	110^{B}	32.9^{A}	0.5^{A}	65.8^{B}	0.43^{A}	0.71^{B}	21.5^{C}	-2.1^{B}	17.3^{A}
	240	106.1^{A}	4.4^{A}	3.0^{A}	1.46^{A}	22.0^{C}	112^{B}	33.2^{A}	0.4^{B}	83.0^{A}	0.29^{C}	0.75^{A}	22.0^{B}	-1.7^{C}	16.5^{B}
2006	220	87.1^{C}	3.6^{C}	2.5^{C}	1.44^{A}	24.0^{A}	120^{A}	31.0^{C}	0.5^{A}	62.0^{C}	0.45^{A}	0.66^{C}	21.4^{B}	-1.8^{B}	19.5^{A}
	230	93.9^{B}	4.2^{B}	3.0^{B}	1.40^{A}	20.0^{B}	116^{B}	33.2^{B}	0.4^{B}	83.0^{A}	0.40^{B}	0.72^{B}	21.3^{B}	-5.1^{A}	17.4^{B}
	240	105.6^{A}	4.5^{A}	3.1^{A}	1.45^{A}	20.0^{B}	110^{B}	33.7^{A}	0.4^{B}	84.2^{A}	0.27^{C}	0.75^{A}	21.7^{A}	-2.1^{B}	16.7^{C}

Mean separation by L.S.D at 0.05.
Means followed by the same letters are not significantly different.

Table (2): Fruit physical characters at cold storage at (0°C) first season

Days of storage	Weight loss			Rutab %			Peel color						Pulp color					
							a			b			a			b		
	mesh	P.E*	mean	mesh	P.E	mean	mesh	P.E	mean	mesh	P.E	mean	mesh	P.E	mean	mesh	P.E	mean
Start	0	0	0	0	0	0	0.6	0.72	0.66^{G}	22.9	22.2	22.5^{B}	-3.8	-2.5	-3.15^{G}	16.2	16.3	16.25^{A}
10	2.2	1.6	1.9 ^{F}	5.5	0	2.75 ^{F}	1.9	0.76	1.33^{F}	21.6	26.4	24.0^{A}	-2.5	-1.2	-1.85^{F}	16.5	15.8	16.15^{A}
20	7.4	2.8	5.1 ^{E}	9	2	5.5^{E}	3.52	3.01	3.26^{E}	22.3	22.7	22.5^{B}	-0.5	-0.2	-0.35^{E}	14.4	14.9	14.65^{C}
30	10	4.2	7.1 ^{D}	15	5.1	10.05^{D}	4.48	3.77	4.12^{D}	19.3	24.4	21.8^{C}	-0.4	-0.14	-0.27^{D}	16.2	15.3	15.75^{B}
40	14.2	5.8	10.0 ^{C}	30	9.9	19.95^{C}	7.37	6.74	7.05^{C}	19.5	23.7	21.6^{C}	-0.4	0.63	0.11^{C}	14.6	14.3	14.45^{C}
50	17.3	7.2	12.2 ^{B}	40	20	30.0 ^{B}	7.64	8.05	7.84^{B}	20.4	23.1	21.7^{C}	0.3	0.92	0.61^{B}	17.1	14.9	16.00^{A}
60	20	9.4	14.7 ^{A}	55	24.4	39.7 ^{A}	9.99	10.84	10.41^{A}	20.1	22.4	21.2^{C}	0.5	0.9	0.70^{A}	16.8	15.2	16.00^{A}
M	10.1^{A}	4.4 ^{B}		22.0^{A}	8.7^{B}		5.1^{A}	4.8^{B}		20.8^{B}	23.5^{A}		-0.9^{B}	-0.22^{A}		15.9^{A}	15.2^{B}	

Mean separation by L.S.D at 0.05. P.E*: Polyethylene.
Means followed by the same letters are not significantly different.

Table (3): Fruit physical characters at cold storage at (0°C) second season

Days of storage	Weight loss			Rutab %			Peel color						Pulp color					
							a			b			a			b		
	mesh	P.E*	mean	mesh	P.E	mean	mesh	P.E	mean	mesh	P.E	mean	mesh	P.E	mean	mesh	P.E	mean
Start	0	0	0	0	0	0	0.66	0.9	0.78	21.1	23.4	22.25^{A}	-1.22	-2.1	-1.66^{G}	19.1	19.1	19.1^{A}
10	3	2	2.5^{F}	4.2	0	2.1^{F}	0.95	1.2	1.07^{F}	21.2	22.3	21.75^{B}	-2.11	-1.7	-1.90^{F}	17.5	17.3	17.4^{C}
20	5.8	3.1	4.45^{E}	8.3	2.3	5.3^{E}	2.2	3.4	2.8^{E}	19.5	21.1	20.3^{D}	-0.68	-0.3	-0.49^{E}	17.8	18.2	18.0^{B}
30	8.4	4.6	6.5^{D}	12	4.8	8.4^{D}	5.35	5.2	5.27^{D}	20.3	21.5	20.9^{C}	-0.33	-0.22	-0.27^{D}	14.4	16.6	15.5^{E}
40	11.5	6	8.75^{C}	28	8.6	18.3^{C}	6.45	7.6	7.02^{C}	20.6	21.4	21.0^{B}	1.03	0.32	0.67^{C}	16.2	13	14.6^{F}
50	15.4	8	11.7^{B}	37	17	27.0^{B}	8.33	6.8	7.56^{B}	19.9	20.9	20.4^{D}	1.62	0.63	1.12^{A}	17.1	15.5	16.3^{D}
60	17.7	9.3	13.5^{A}	51	22	36.5^{A}	8.14	9.8	8.97^{A}	20.1	21.1	20.6^{C}	0.96	0.55	0.75^{B}	14.3	14.7	14.5^{F}
M	8.8^{A}	4.7^{B}		20.0^{A}	7.81^{B}		4.58^{B}	4.9^{A}		20.3^{B}	21.6^{A}		-0.1^{A}	-0.4^{B}		16.6^{A}	16.3^{B}	

Mean separation by L.S.D at 0.05 P.E*: Polyethylene
Means followed by the same letters are not significantly different

layed the development of peel and pulp color in comparison with mesh bags, it is evident from Table (2) that treated dates had significantly higher "b" values (23.5) of peel color, higher "a" values (-0.22) of pulp color than control dates in the first season, while in the second season, fruits treated with polyethylene bags had higher «a» and "b" values of peel color, suggesting that by this time MAP dates were notably more yellow in appearance than control dates.

The results of two seasons were confirmed with Salah *et al*. (2012) who indicate that the use of MAP had some potential to reduce rate of color change of Khalas dates packed at the khalal stage of maturity and stored at 0°C.

Texture:

It is evident from Tables (4 & 5) that fruit texture was decreased gradually during storage period; moreover, polyethylene bags kept fruit texture higher than mesh bags (102.8, 10.4.4%) in the two studies seasons, respectively. Storage control-packaged dates continued to record low penetration measurements, but this was most likely due to that the fruit being firmer through dehydration and weight loss.

Total Soluble Solids (TSS):

Soluble solids content(SSC)was gradually increased till 60 days in the two seasons (Tables 4 & 5), polyethylene bags significantly reduced the degradation of TSS% the highest total soluble solids was obtained from fruits in mesh bags (34.2%) in the two seasons.

Slow increases in control date fruit TSS may be due to that the fresh dates being stored at their optimum storage temperature of 0°C (Kader & Hussein, 2009).

Acidity

It is evident from tables (4 & 5) that fruit acidity percentage decreased with the advancing of storage period. The highest acidity was obtained from fruits in polyethylene bags.

TSS: acid ratio

Significantly increased till the end of storage pe-

Table (4): Fruit characters at cold storage at (0°C) first season

Days of storage	Texture%		mean	TSS%		mean	Acid%		mean	TSS :acid%		mean
	mesh	P.E*		mesh	P.E*		mesh	P.E*		mesh	P.E*	
Start	110	120	115^{A}	33.1	33	33.05^{C}	0.4	0.4	0.4^{A}	82.75	85.5	
10	106	116	111^{A}	32.4	33.4	32.9^{D}	0.4	0.4	0.4^{A}	81	83.5	85.6^{D}
20	100	114	107^{B}	33	34	33.5^{C}	0.3	0.4	0.35^{B}	110	85	82.25^{E}
30	88	95	91.5^{C}	34.1	34.7	34.4^{B}	0.3	0.3	0.3^{C}	113.6	115.6	97.5^{C}
40	79	90	84.5^{D}	35.2	34.5	34.8^{B}	0.3	0.3	0.3^{C}	117.3	115	114.6^{B}
50	77	88	82.5^{D}	35.6	34.3	34.9^{B}	0.3	0.3	0.3^{C}	118.6	114.3	116.1^{B}
60	56	79	67.5^{E}	36	34.8	35.4^{A}	0.2	0.3	0.25^{D}	180	116	116.4^{B}
M	88^{B}	102.8^{A}		34.2^{A}	34.1^{B}		0.3^{A}	0.3^{A}		114.7^{A}	102.1^{B}	148.0^{A}

Mean separation by L.S.D at 0.05 P.E*: Polyethylene

Table (5): Fruit characters at cold storage at (0°C) second season

Days of storage	Texture%		mean	TSS%		mean	Acid%		mean	TSS :acid%		mean
	mesh	P.E*		mesh	P.E*		mesh	P.E*		mesh	P.E*	
Start	112	122	122^{A}	34	33.5	33.7^{D}	0.4	0.4	0.4^{A}	85	83.75	84.35^{D}
10	100	120	110^{B}	33.4	33.4	33.4^{E}	0.4	0.4	0.4^{A}	83.5	83.5	83.5^{D}
20	98	115	106.5^{C}	33.4	33.6	33.5^{DE}	0.3	0.4	0.35^{B}	111.3	84	97.65^{C}
30	94	107	100.5^{D}	33.6	34	33.8^{D}	0.3	0.4	0.35^{B}	112	85	98.5^{C}
40	80	99	89.5^{E}	34.4	34.1	34.2^{C}	0.2	0.3	0.25^{C}	172	113.6	142.8^{B}
50	69	90	79.5^{F}	35	34.4	34.7^{B}	0.2	0.3	0.25^{C}	175	114.6	144.8^{B}
60	54	88	71^{G}	35.6	35	35.0^{A}	0.2	0.2	0.2^{C}	178	175	176.5^{A}
M	86.7^{B}	104.4^{A}		34.2^{A}	33.9^{B}		0.2^{B}	0.3^{A}		130.9^{A}	105.6^{B}	

Mean separation by L.S.D at 0.05 P.E*: Polyethylene

riod, polyethylene bags treatment had scored the lowest values (102.1, 105.6%) in both seasons, respectively (Tables 4 & 5).

3- Fruit characters during shelf- life:

Data from table (6) showed that weight loss %, TSS%, TSS: acidity ratio and Rutab % were increased during shelf-life at ambient temperature (18-20^{0}C) at the beginning, middle and the end of storage period, while texture % and acidity % were decreased with prolonged storage. The lowest weight loss, TSS % and rutab % were found of fruits in polyethylene bags, Moreover, there was no incidence of physiological disorder during storage and shelf-life.

It is clear from table (7) that fruits were stored for a period of 28 days at 20-25^{0}C with good appearance, whereas, fruits treated with polyethylene had the lowest weight loss(7.5,7.4%),the lowest Rutab% (7.1,9.2%) , the highest texture% (77.6,80.0%) compared with control treatment (mesh bags) in the two season respectively.

Table (6): Fruit characters at shelf-life ambient temperature (18- 20o C)

Season	Period/ treatment	Weight loss		Texture		TSS%		Acidity		TSS/acid ratio		Rutab %	
		M	P.E*	M	P.E*	M	P.E*	M	P.E*	M	P.E*	M	P.E*
2005	After 15 days	12.4	3.9	87	116	36	35	0.4	0.4	90	87.5	20	9
	After 40 days	15.1	6.2	75	92	36.4	36	0.3	0.3	121.3	120	25	12
	After 60 days	22	9.8	55	75	37	36.5	0.2	0.3	185	121.6	30	20
2006	After 15 days	9.9	3.4	93	111	37	35.6	0.3	0.4	123.3	89	15	5
	After 40 days	13.8	5.8	71	90	38	36.2	0.3	0.3	126.6	120.6	20	10
	After 60 days	20.3	9.5	56	77	37.5	36.5	0.2	0.3	187.5	121.6	25	15

Mean separation by L.S.D at 0.05 P.E*: Polyethylene

Table (7): Fruit characters at shelf life 28 days at (20-25°C)

Season	Treatment	Weight Loss%	Texture%	TSS%	Acid%	TSS:Acid%	Rutab%
2005	Mesh (control)	11.6^{A}	61.6^{B}	37.9^{A}	0.23^{B}	164.7^{A}	16.3^{A}
	polyethylene	7.5^{B}	77.6^{A}	36.1^{B}	0.26^{A}	138.8^{B}	7.1^{B}
2006	Mesh (control)	11.2^{A}	61.2^{B}	37.8^{A}	0.20^{B}	189.0^{A}	22.1^{A}
	polyethylene	7.4^{B}	80.0^{A}	36.9^{B}	0.30^{A}	123.0^{B}	9.2^{B}

Mean separation by L.S.D at 0.05.

CONCLUSIONS

Perforated polyethylene bags are useful in the storability of Barhey date palm fruit, as they delay fruit ripening, maintain quality and extend cold storage period. Fruit could be stored for 60 days at 0°C and 28 days at 20°C in high density polyethylene bags (HDPE 20) with the optimal quality parameters than perforated with mesh bags treatments as control. However, no noticeable chilling injury or decay was found in fruits of present study.

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دراسه عن تخزين ثمار البلح البارحى (عبوات مستهلك)

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أجرى البحث على ثمار البلح صنف البارحى المأخوذه من مزرعه خاصه بمنطقه جنوب التحرير – محافظه البحيرة خلال موسمى ٢٠٠٥– ٢٠٠٦ وهو من الاصناف العالية الجودة المرتفعة الثمن حيث تم دراسه التغيرات فى الصفات الطبيعية والكيمائيه وصولا لمرحله اكتمال النمو وجمع الثمار وكذلك دراسه تأثير التعبئة فى مواد مغلفه (البولى ايثيلين والشباك) على جوده الثمار خلال التخزين على درجه الصفر المئوى ودرجه حراره الغرفة.

وأظهرت نتائج البحث ان وزن الثمار وابعادها ونسبه المواد الصلبة الذائبة ولون القشرة يزداد مع تطور عمر الثمار بينما تقل نسبه الحموضة والصلابة والتانينات. تغليف ثمار البلح البارحى بالبولى ايثيلين كان اكثر ثاثيرا فى تقليل كل من نسبه الفقد فى الوزن ونسبه الترطيب الى جانب تأخر تطور لون قشره الثمار ولون اللب الداخلى والمحافظه على صفات الجودة التخزينية والتسويقية لاكثر من ٦٠ يوما على درجه الصفر المئوى ورطوبة نسبيه ٨٥–٩٠٪ بالاضافة الى اسبوع على درجه حراره ١٨ – ٢٠ درجه مئوى للتسويق .كما امكن تخزين الثمار٢٨ يوم بجوده عاليه على درجه ٢٠ درجه مئوى .