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EFFECT OF TEMPERATURE AND POLYETHYLENE WRAPS ON STORAGE LIFE OF LOQUAT

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Abstract

Lebanese 'Ahmar' loquat *Eriobotrya japonica* Lindl. for export is currently field packaged in one Kg units in wooden boxes, wrapped with Cellophane, and transported in refrigerated trucks (12°C). The condition of fruits upon arrival in foreign markets (2 weeks) is not known, nor is storage potential of 'Ahmar' variety. This study attempted to determine the storability of 'Ahmar' loquat in modified atmosphere packages at 5°C and 12°C, and to predict the status of fruits upon arrival in foreign markets. Samples were removed at 0, 2, 4, and 6 weeks of storage and evaluated for fruit and sensory qualities. Results indicated that packaging method and transport temperatures currently used are inadequate. After 2 weeks of storage at 12°C, Cellophane wrapped fruit boxes contained a large percentage of bruised, shrivelled, or decayed fruits. Storage at 5°C maintained sensory attributes and decreased decay. The use of polyethylene wraps delayed shrivelling of fruits and maintained their juiciness. Bruising was attributed to the wooden boxes and independent of the wrapping material.

1. INTRODUCTION

The loquat, *Eriobotrya japonica* Lindl, is well adapted to coastal areas of Lebanon, however, despite the fact that it is among the oldest fruit crops introduced , its cultivation has remained limited, and no efforts have been made to develop its marketing potentials. Loquat production is labor intensive requiring caging of trees to protect fruits, and harvesting is time consuming. In addition, the fruit is highly perishable. Substantial loss of marketability usually occurs within two weeks of harvesting, hindering export potentials. Limited attempts have been made in Lebanon to increase revenues from 'Ahmar' loquat, a leading local cultivar, by exporting it. Fruits for export are typically packaged in the field as one Kg units. The fruits are carefully placed in wooden rectangular boxes lined with thin purple paper, and covered with cellophane. Loquat is usually transported together with citrus fruits

in refrigerated trucks (12°C) reaching foreign markets within ten days. Limited information is available on the shelf life of 'Ahmar' or other loquat fruits, in addition the status of fruits upon arrival to foreign markets has not been documented. The objective of this study was to test minor modifications to the local packaging practices with the aim of extending the shelf life of fruits, while remaining feasible and acceptable to local growers. Accordingly we tested the efficacy of tightly wrapping fruit boxes with polyethylene films rather than merely covering boxes with Cellophane, and simulating shipment at 5°C rather than the currently used 12°C shipping temperature by storing fruit boxes at those temperatures.

2. MATERIALS AND METHODS

High quality mature fruits were carefully selected from a commercial orchard. Fruits were packed in the field, according to local practice, in wooden boxes, and either covered with Cellophane (C) or tightly wrapped with 40μm thick low density polyethylene film (LDPE), or 40μm thick high density polyethylene film (HDPE). The fruit boxes (1Kg each) were then stored at 5°C or 12°C depending on the treatment to which they were randomly assigned. At each 0, 2, 4, and 6 weeks of storage three boxes were randomly selected, removed from storage, and placed at room temperature for three days before being evaluated.

The following physico/chemical evaluations were made on fruits from each box: percentage bruised/decayed fruits, percentage shrivelled fruits, percent fruits with green stalk, pH, titratable acidity, and percent total soluble solids (TSS). Loquat fruits were peeled, decored, and 50g of flesh were blended with 8 ml of distilled water for ten seconds in a blender. A few drops of the puree were used to read the percent TSS in a refractormeter (Carl Zeiss, Germany). Titratable acidity was measured by diluting 10 ml of the puree to 100 ml with distilled water and titrating with 0.1N NaOH using 1% phenolphthalein as an indicator.

Organoleptic testing was performed to determine whether any difference was perceptible. Evaluation was by eight trained panelists trained for perceived intensities of sweetness, tartness, and juiciness using structured nine-point scales. Reference materials were used to describe sweetness, tartness, and juiciness (Table 1). Fruits selected for sensory analysis were those that were maintained in a marketable quality at the time of sampling. These were presented to panelists as two randomly ordered sets per treatment coded with three digit random numbers.

For statistical evaluation, each storage temperature (5°C and 12°C) was analyzed separately where, the type of wrapping (C, LDPE, and HDPE) and storage period (0, 2, 4, and 6 weeks) were considered as factors. Each treatment was replicated four times in the analytical tests, while duplicates were assessed by the eight panelists for the sensory tests. Experimental units consisted of wooden boxes containing one kg of loquat fruits. All data were analyzed statistically by the analysis of variance using MstatC computer program. Mean separation was done using Duncan's multiple range test ($p<0.05$).

3. RESULTS

Limited reports suggest that the keeping quality of loquat is increased by cold storage, and post-harvest treatment of fruits with fungicides (Morton,1987). Cold storage is reported to increase shelf life of loquat fruits to 60 days, while treatment with fungicide is reported to maintain loquats for one month at 15°C (Morton, 1987). The use of polyethylene bags was found to alter the flavor. (Morton, 1987).

Percent TSS of fruits stored at either 5°C or 12°C was affected by wrapping material (Table 2). In Cellophane covered fruits there was no significant change in %TSS throughout the experimental storage period (4 and 6 weeks at 12°C and 15°C respectively). In LDPE wrapped fruits, %TSS was lower after 4 weeks of storage, and after 2 weeks of storage in HDPE wrapped fruits , at both 5°C and 12°C (Table 2).

In contrast, the wrapping material had no effect on titratable acidity which, during 6 weeks of storage at 5°C, had declined for all wrapping treatments to approximately 43% of the initial value (Table 2). The rate of decrease in titratable acidity was more rapid in fruits stored at 12°C than at 5°C. A comparable decline to 47% of the initial value was detected 4 weeks earlier than those stored at 5°C (Table 2).

Panelists detected an increase in the sweetness of Cellophane wrapped fruits after 2 weeks of storage at 12°C . There was a trend of decreased sweetness in fruits wrapped with LDPE and HDPE and stored at 12°C. As a result, Cellophane wrapped fruits were significantly sweeter than those wrapped with LDPE after 4 weeks of storage, and from those wrapped in HDPE after 2 weeks of storage. No perceived difference in sweetness was reported by panelists for fruits stored at 5°C, regardless of storage time or wrapping material. Similarly, while panelists detected a difference in juiciness between control fruits strored at 12°C and those wrapped with either HDPE or LDPE, no difference was recorded when fruits were stored at 5°C regardless of storage time or wrapping material.

The decrease in fruit acidity during storage was not perceived by panelists regardless of storage time, temperature, or wrapping material (Table 3).

Boxes covered with Cellophane had a significant percentage of shrivelled fruits after 2 and 4 weeks of storage at 12°C and 5°C respectively (Table 4). Polyethylene wrapping of fruit boxes delayed shrivelling of fruits by at least two weeks under both storage temperatures.

The color of the fruit stalk pedicel affects the quality, and therefore the marketability, of the fruit. At 12°C, a significant number of fruits had lost the green stalk color after 2 weeks of storage (Table 4). In contrast, fruits stored at 5°C maintained their stalk color for at least 4 weeks. The kind of wrapping material had no significant effect on stalk color.

Fruits from each treatment sampled soon after harvest (0 weeks in storage) contained a large number of fruits with bruises regardless of wrapping material (Table 4). Surface bruising of fruits was apparently caused by the wooden boxes. In fact, after 2 weeks of storage, all fruits in contact with the wood were clearly bruised,

and this value remained unchanged in subsequent sampling dates in the 5°C storage treatment where little or no fungal decay developed. When fruits were stored at 12°C, in addition to fruit bruising, surface decay had also contributed to significant losses within 2 weeks of storage in all wrapping treatments. These results show the inadequacy of both the wooden boxes as the packaging container, as well as of the transport temperature used. Despite the selection of high quality fruits and careful hand-packing, a poor quality product probably reaches foreign markets because of the high percentage of bruised and/or decayed fruits. Accordingly, a change in the packing material is essential to improve export potential. In addition, storing and exporting 'Ahmar' loquat at 5°C would maintain quality and extend storage by at least two weeks.

The use of polyethylene instead of Cellophane had the major advantage of delaying shrivelling of fruits and of maintaining their juiciness. No difference was detected, however, between low density and high density polyethylene films which differ significantly in their permeability to gases and water vapor (Paine and Paine, 1983).

REFERENCES

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Table 1. Sensory Attributes and Referendce Material for Panel Training

Attributes	Scal	Verbal Description	Reference Material
Sweetness	1	Slightly sweet	5 % sucrose solution
	5	Moderately sweet	7.5 % sucrose solution
	9	very sweet	10 % sucrose solution
Tartness	1	Slightly tart	0.01 % citric acid solution
	5	Moderately tart	0.03 % citric acid solution
	9	Very tart	0.05 % citric acid solution
Juiciness	1	Moderately juicy	Apple slices z
	5	Very juicy	Whole canned mushrooms

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Table 2. Effect of storage time and wrapping film on the sensory attributes of "Ahmar" loquat.

	pH				Solid soluble content (%)				Titratable acidity ml .01 NaOH			
Source of Variation	0	14	30	45	0	14	30	45	0	14	30	45
5°C												
	f	cd	ab	bc	a	a	a	a	a	bc	cd	d
Conventional z	3.15	4.09	4.63	4.37	12.25.	212.75	12.88	12.38	1.2	0.89	0.62	0.45
	f	e	ab	a	ab	a	bc	bc	a	ab	cd	d
LDPE y	3.09	3.73	4.43	4.7	11.63	12.13	10.633	10.63	1.17	1.15	0.71	0.49
	f	de	ab	bc	a	c	c	c	ab	ab	cd	d
HDP x	3.36	3.88	4.46	4.37	12.38	10.12	10	10.25	1.14	1	0.66	0.56
Significant effects w		T				T , W				T		
12°C												
	cd	b	a	v	a	abc	a		a	b	b	
Conventional	3.15	4.55	5.07	-	12.25	11.38	12.25	-	1.2	0.59	0.43	-
	d	b	a		ab	abc	c		a	b	b	
LDPE y	3.09	4.52	5.03	-	11.63	11.25	9.87	-	1.17	0.56	0.4	-
	c	b	a		a	bc	c		a	b	b	
HDPE	3.36	44.63	4.99	-	12.38	10.38	9.75	-	1.14	0.52	0.39	-
Significant effects		T , W										

z
Conventional wrapping film = cellophane (see materials and methods for more details).

y
Low density polyethylene wrapping film (see materials and methods for more details).

x
High density polyethylene wrapping film (see materials and methods for more details).

w
Factors significant at $P < 0.05$, whereT=storage time, and W=wrapping film.Mean seperation within and across columns for eacn measured parameter.

v
Unavailable fruits because of bruising/ decaying.

Table 3 Effect of storage time and wrapping film on the sensory attributes of "Ahmar" loquat.

	% Shrivel-ing				% Bruised / decayed fruits				% Fruits with green stalk			
Source of Variation	0	14	30	45	0	14	30	45	0	14	30	45
5°C												
	d	d	b	a	d	bc	ab	b	a	a	a	bc
Conventional z	0	1.92	12.15	20.73	9.42	27.85	36.5	32.65	100	94.75	93.6	78
	d	d	cd	b	cd	b	ab	a	a	a	a	c
LDPE y	0	1.37	4.92	10.68	13.88	32.98	38.5	50.93	100	93.15	98.08	64.38
	d	d	d	bc	d	b	bc	b	a	a	ab	c
HDP x	0	0	4.97	10.15	8.77	33.15	25.15	32.23	100	98.03	91.13	69.13
Significant effects w		T , W				T , W				T		
12°C												
	d	b	a	v	d	c	b		a	b	b	
Conventional	0	36.87	75.9	-	9.42	37.23	56.53	-	100	85.47	82.1	-
	d	cd	c		d	bc	ab		a	b	b	
LDPE y	0	5.4	15.03	-	13.88	42.2	60.53	-	100	87.93	88.7	-
	d	d	cd		d	bc	a		a	b	c	
HDPE	0	1,27	10.2	-	8.77	45.15	77	-	100	86.65	64.38	-
Significant effects		T , W										

z
Conventional wrapping film = cellophane (see materials and methods for more details).

y
Low density polyethylene wrapping film (see materials and methods for more details).

x
High density polyethylene wrapping film (see materials and methods for more details).

w
Factors significant at $P < 0.05$, whereT=storage time, and W=wrapping film.Mean seperation within and across columns for eacn measured parameter.

v
Unavailable fruits because of bruising/ decaying.

Table 4. Effect of storage time and wrapping film on the sensory attributes of "Ahmar" loquat.

	Brown spots				Firmness			
Source of Variation	0	14	30	45	0	14	30	45
5°C								
	e	bc	ab	a	bc	bc	ab	abc
Conventional z	2.75	4.75	5.19	5.87	4.12	3.94	5.06	4.75
	Cde	cd	cde	bcd	abc	abc	ab	a
LDPE y	3.75	3.87	3.69	4.25	4.56	4.25	5.12	5.5
	Bcd	de	ab	ab	c	bc	ab	a
HDP x	4.56	3.62	5.12	5.06	3.56	4	5.12	5.5
Significant effects w		T , W				T		
12°C								
	d	b	a	v	ab	ab	b	
Conventional	2.75	5.06	8.19	-	4.12	4.81	5.69	-
	cd	bc	d		ab	b	ab	
LDPE y	3.75	4.87	3.37	-	4.56	3.75	5	-
	bc	bc	bc		b	b	b	
HDPE	4.56	4.69	4.75	-	3.56	3.87	3.75	-
Significant effects		T , W						

z
Conventional wrapping film = cellophane (see materials and methods for more details).

y
Low density polyethylene wrapping film (see materials and methods for more details).

x
High density polyethylene wrapping film (see materials and methods for more details).

w
Factors significant at $P < 0.05$, whereT=storage time, and W=wrapping film.Mean seperation within and across columns for eacn measured parameter.

v
Unavailable fruits because of bruising/ decaying.

Table 5. Effect of storage time and wrapping film on the sensory attributes of "Ahmar" loquat.

	Sweetness				Tartness				Juiciness			
Source of Variation	0	14	30	45	0	14	30	45	0	14	30	45
5°C												
	cd	ab	abc	abc	a	a	a	a	a	ab	ab	ab
Conventional z	4.31	5.94	5.56	5.81	3.5	3.31	3.25	2.81	5.87	5.06	4.56	4.69
	abcd	d	abc	a	a	a	a	a	ab	ab	ab	a
LDPE y	5.12	3.75	5.56	6.5	3.62	3.75	3.62	2.62	5.12	5.44	5.37	4.19
	bcd	bcd	abcd	ab	a	a	a	a	ab	ab	ab	ab
HDP x	4 69	4.56	5.19	6.12	4	3.12	3.87	2.87	5.44	5.52	5.37	5.06
Significant effects w		T										
12°C												
	bc	a	a	v	ab	ab	ab		a	ab	c	
Conventional	4.31	6.44	6.56	-	3.5	2.56	2.69	-	5.87	4.75	3.12	-
	abc	ab	c		ab	ab	ab		a	ab	a	
LDPE y	5.12	5.62	3.62	-	3.62	2.69	3.12	-	5.12	5.06	5.94	-
	bc	c	c		a	b	ab		ab	ab	a	
HDPE	4.69	3.81	3.62	-	4	2.25	2.62	-	5.44	5.37	5.94	-
Significant effects		T , W										

z
Conventional wrapping film = cellophane (see materials and methods for more details).

y
Low density polyethylene wrapping film (see materials and methods for more details).

x
High density polyethylene wrapping film (see materials and methods for more details).

w
Factors significant at $P < 0.05$, whereT=storage time, and W=wrapping film.Mean seperation within and across columns for eacn measured parameter.

v
Unavailable fruits because of bruising/ decaying.