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DIFFERENT PACKAGING TREATMENTS FOR AVOCADO SHELF LIFE PROLONGATION

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ABSTRACT

Avocado fruits " Nabal variety " were collected in mid November, from a farm in berkash (Giza) and packaged hermetically (3 fruits in a bag, 20 x 30 cm), using high density polyethylene film (30 µ), low density polyethylene film (30 µ), PVC film (10 µ), PELD + iron sachet inside the bag, and open bags for control. All avocado fruits were subjected to a usual ripening treatment (by calcium carbide), before being packaged. Half of the fruit packages was stored in ambient conditions (25-30°c), for 2 weeks. The other half was kept in cold store (10°c) for 4 weeks. After storage period, fruits were examined to evaluate their appearance and quality parameters. Packaged fruit retained generally their weight with a slight loss (2-3%) compared to control (3.5%). Quality of 2nd year fruit revealed to be superior to 1st year fruits. They have higher T.S.S. oil content, and better taste notes compared to 1st year fruits. High density Polyethylene fruit packages gave generally the best results. They have higher firmness values (8 lb/in^2 1st year and 8.5 lb/in^2 2nd year). They have also a higher T.S.S. content (5.5% 1st year and 8.5% 2nd year), and a higher oil content (12.3% 1st year and 13.2% 2nd year). Taste evaluation indicates also the superiority of these fruits packaged in PEHD. Other treatments yielded mixed results and addition of iron sachets was not very effective. Results indicate the importance of oil content as an indication to collect fruits at their highest level of this component, to have the highest quality avocado fruits.

INTRODUCTION

Avocado fruit is originated in America continent and now produced commercially in most subtropical areas. World production amount to 1.6 million metric ton , while Egypt ' s production is very limited, but there is actually a growing interest in this kind of fruit. Avocado is harvested when fruit reaches full maturity stage , with its characteristic form and color . All avocados are susceptible to chilling injury when kept in low temperatures, but varieties differ in their tolerance to low temperature. (Mans *et al*, 1995 & Nakasone *and paull*, 1998). Avocado as a chilling sensitive fruits, should be cold stored with care in a limited range of temperatures, above 7.5 ° c, to prolong its storage period, and to avoid chilling injury damage to fruits. (Lee *et al*, 1983). Controlled atmosphere has proved to be useful in extending shelf life of avocado. An atmosphere of 3% O_2 and 14% Co_2 proved effective in storing avocado 30 days at 10 °C, with acceptable organoleptic quality (Ryall *et al* 1974). Modified atmosphere packaging (MAP) is another useful means to prolong avocado life in cold store (Meir *et al*, 1998 &and Yahia , 1998 & Veloz *et al*, 1995) Iron powder is used in sachets to absorb oxygen

from the surrounding atmosphere, and helps in formation of a modified atmosphere inside fruit packages or any enclosed space (Nakamura *et al*, 1983). This research aims to investigate the utility and suitability of some local plastic films for avocado packaging and their contribution in maintaining quality of packaged fruits, in addition to testing the real usefulness of iron powder used MAP of avocado.

MATERIALS AND METHODS

Avocado fruit of Nabal variety were picked in middle of November, from Nemos farms in Giza, at 2001 and 2002 seasons. Fruits were transported to post harvest laboratory to be sorted and damaged fruits were eliminated. Fruits were kept in sealed packages; each three fruits in an individual package, and these treatments were carried out:

- Packaging in low density polyethylene (30 μ) bags (20 x 30 cm).
- Packaging in high density polyethylene (30 μ) bags (20 x 30 cm).
- Trays covered by P.V.C. (10 μ) films, each contained 3 fruits.
- Packaging in polyethylene low-density bags (20 x 30 cm) with a sachet of iron powder (1 gm) fixed inside
- Control treatment in open bags.

All fruits were subjected to the usual ripening treatment (by calcium carbide, to generate ripening gases) for one day, immediately after delivered in the laboratory and then packaged as above. Each treatment composed of ten replicates (bags) half of them were kept in ambient conditions (temperature of 25°- 30 °C) for 2 weeks, while the other half was kept in cold store at (10°C)and 90 % R.H for a period of 4 weeks.
At the end of storage, these quality parameters were evaluated:

1– General appearance: based on the exemption of defects, like flesh softening and brown batches, or spots on skin, and decay absence or presence, this parameter was judged by a scale of 4 grades; excellent (totally sound fruit); good; just acceptable (slight softening); and unacceptable (very soft with presence of brown or black spots). All acceptable fruits had a note exceeding 4.5, while less than that is considered unacceptable.

2 – Firmness: fruit flesh was evaluated by a hand fruit pressure tester (with penetrating tip of 6 mm) Penetrometer, and results expressed in lb/inch^2.

3 – Weight loss: fruit weight loss, evaluated by the end of storage.

4 – Total soluble solids (T.S.S.): this was estimated by a digital refractometer (Abbe).

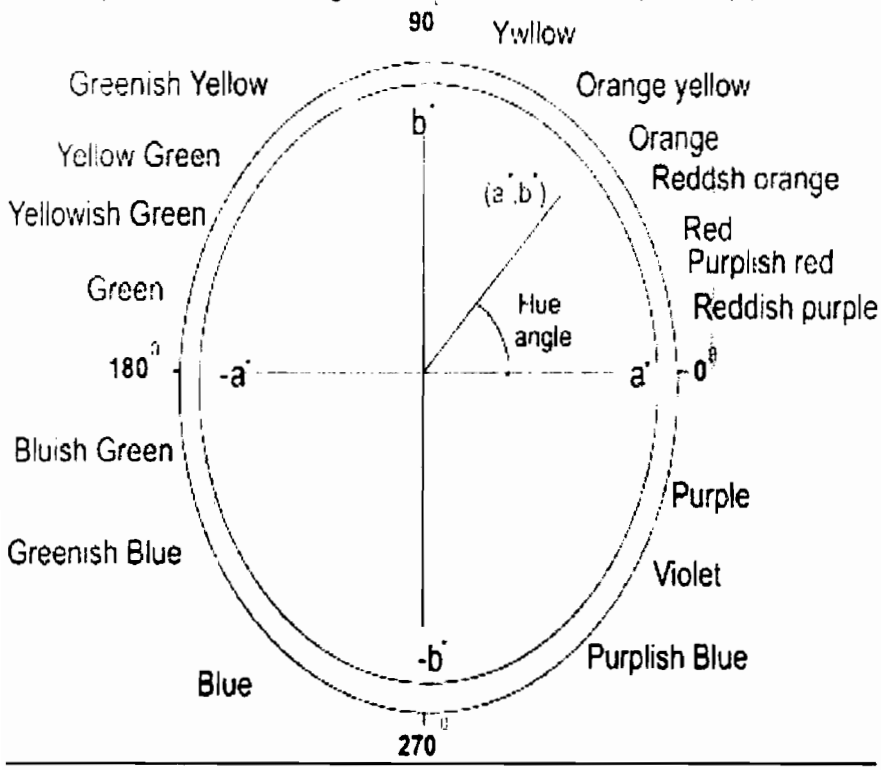
5 – Oil percentage: oil extraction method used (for flesh samples of 5 gm each) was based on Soxhelt instrument, as it was defined by Sweet (1955) and Saung (1981).

6 – **Taste judgement**: a panel test was held to evaluate organoleptic parameter. Taste was judged, taking in consideration; flesh softness, platability acceptance (oil, moisture ---- etc) and flesh consistence, according to four grads; excellent {10 – 8}; good {7.9 – 6}; acceptable {5.9 – 4.5}; and unacceptable, less than 4.5.

7 – **PH value:** - This value was estimated by a PH meter instrument (Schott gerate).

Flesh color:

Values of l, a, b, defining characteristics of any color (lightness, and color intensity) were estimated for avocado flesh using a Hunter colorimeter (Hunter lab D 25 L). Hue angle was calculated as follows: - arctangent b/a Hue sequence, and hue angle orientation are clear in picture (1).



Picture (1): Hue sequence and hue-angle attenuation on a CIELAB diagram (with ISCC-NBS color names).

RESULTS AND DISCUSSION

General appearance: -

Data in table (1), showed that fruits of the 1st season has slightly a better general appearance (5.93), compared to 2nd year's fruit (5.27). Fruits

where kept in ambient temperature were significantly better in appearance than those in cold store (6.9 compared to 5 at 1st year) . While in 2nd year, there were no significant differences in appearance among fruits in ambient and cold store (5.13 and 5.4 respectively) regardless of treatments. It is probable that fruits of 1st year were picked in an early mature stage, so they tolerated well for 15 days at ambient conditions while 2nd year fruits were fully mature and prone to more defects (like browning). But in cold store, fruits of 2nd season had more consistency in appearance notes, and PEHD treatments were the best in both seasons (9 and 7 at 1st and 2nd years respectively). Control fruits in cold store had the lowest appearance note in both seasons (3 or unacceptable note in both seasons). It' s clear from table (1) that PEHD had the best appearance, when looking at the general average in both seasons (9 in 1st year, and 5.67 in 2nd year).

Table (1): Avocado fruit physical characters after storage in ambient conditions and cold store (10°C) in first season.

Characters		General appearance	Weight Loss%	Firmness Lb/inch²	Taste note
Kind of Storage	Treatments				
Average at start		0.00	0.00	17.1	0.00
Ambient Temperature after two weeks	PEHD 30 µ	9.00	2.65	7.17	9.00
	PELD 30 µ	3.00	3.41	7.33	7.67
	PELD+iron sachets	9.00	1.09	8.00	9.00
	PVC 10 µ	7.00	2.82	8.67	7.00
	Control	6.33	2.93	10.00	5.67
	Mean	6.87	2.58	8.23	7.67
Cold storage after 4 weeks	PEHD 30 µ	9.00	0.84	8.73	9.00
	PELD 30 µ	7.00	1.69	6.23	6.33
	PELD+iron sachets	3.00	1.44	11.17	5.00
	PVC 10 µ	3.00	2.70	5.33	7.00
	Control	3.00	3.74	5.33	5.33
	Mean	5.00	2.08	7.36	6.53
Grand mean		5.93	2.33	7.80	7.10
General average	PEHD 30 µ	9.00	1.75	7.95	9.00
	PELD 30 µ	5.00	2.55	6.78	7.00
	PELD+iron sachets	6.00	1.27	9.59	7.00
	PVC 10 µ	5.00	2.76	7.00	7.00
	Control	4.67	3.34	7.67	5.50
L.S.D at 5 % level for					
Storage degree (S)		1.11	N.S	N.S	N.S
Treatments (T)		1.76	1.14	1.78	N.S
SxT		2.49	N.S	2.52	1.76

* Average fruit weight 279.8 ± 16.8 gm.

Weight loss: -

Table (1) showed no significant differences in fruit weight loss between cold storage and ambient conditions in both seasons (2.58% at ambient. condition., and 2.08% in cold store in 1st season, and 3.33% in ambient. condition, and 2.98% in cold store in 2nd year). But average weight loss in 1st season was markedly less than in 2nd season (2.3% vis à vis 3.2%).

Second season fruits were probably more advanced in ripening, thus had softer tissues and that facilitated water vapor transmission to around

atmosphere. PVC packaged avocados had generally a higher weight loss than other treatments, irrespective of storage kind (2.76% in 1st year and 4.68% in 2nd year), but control fruits had the highest weight loss in 1st year (2.39% in amb. Cond, and 3.74 % in cold storage). PEHD packaged fruits had the lowest value of weight loss in 2nd year (2.1%), while PELD+ iron sachets had the lowest value in 1st year (1.36%). 1st year (tan average of 1.4% in both storage kinds), while in 2nd year PEHD packaged fruit had the least weight loss (in both storage types, 2.1%).

Firmness: -

Flesh firmness at start indicated a higher value of 17.1 lb/in^2 at 1st year and 12.3 lb/in^2 at 2nd year (possibly and year fruits were more advanced in maturity). Firmness value decreased as fruits become softer after storage. No significant difference in flesh firmness was noted between cold storage and ambient conditions storage in both seasons, but fruit firmness was generally higher at 1st year (an average of 7.8) compared to 2nd year (an average of 5.65 lb/in^2). Control fruits had the lowest firmness in cold storage in both seasons (5.3 and 1.47 lb/in^2 in 2001 and 2002 respectively) and also in ambient conditions at season of 2002, control fruit were significantly more softened than all treatments (2.4 lb/in^2 vis à vis 8.27 for PEHD and 7.47 for PELD + iron sachets for example). Treatments had some variability in flesh firmness evaluations. PEHD packaged fruits had a higher firmness average values in both seasons (8 and 8.5 lb/in^2) respectively. Polyethylene high density film (30 μ) kept a higher percentage of Co_2 around fruits in closed bags, and that delayed softening of fruit, (in accordance with Meir *et al* 1998).

Flesh color: -

Hue angle color of avocado flesh was estimated for 2nd year fruits, as is shown in table (1). Most values were clustered around 100° ± 6° or a greenish yellow color. Although some statistical significance in differences among treatments in flesh color was recorded, we suppose that these differences are due to natural variability among fruits. Control fruits and PVC packaged fruits recorded the highest hue angle values (106.5 and 105.2 respectively in ambient conditions and 109.07 and 106.9 in cold storage), which means a tendency towards more greenish color. There' s no assured link between flesh color and progress in ripening in avocado case.

Taste Judgement: -

Taste quality was slightly higher in fruits stored in ambient conditions than in cold stored fruits in both seasons (estimated by notes of 7.7 and 7.9 for ambient stored fruits in 1st and 2nd year respectively and 6.53 and 7.5 for cold stored fruits in 1st and 2nd seasons). Average taste note in the 2nd year (7.7) was slightly higher than 1st year (7.1), and that may be associated with more matured fruits in 2nd year than in 1st year. Control fruit in three fruit categories had the least acceptance taste note 5.7 and 5.3, in ambient and cold store conditions in the 1st season, and a note of 5.7 in cold store the 2nd season). Stored fruits in high density Polyethylene had always higher notes (9 in both storage categories, the1st season, and 8 for both categories in the

2nd season). Generally speaking other treatments had a lesser note of taste in 1st season, but had almost similar acceptable taste note (around 8) in 2nd season.

Total Soluble Solids T.S.S.: -

Fruits of 2nd year (as shown in tables 2 and 4) had a bigger value of T.S.S. (an average of 8.01) compared to 1st year fruits (an average of 5.5%). This fact confirms what' s already known about difficulty of maturity identification in avocado, as the fruit continues in accumulating dry matter and oil content all over the maturation phase (generally from September till December every year). Although our fruits were picked at the same date in both years, but climatic and cultural conditions had some fluctuations in both years, and may certainly contribute in slowing or hastening full fruit development and maturation (Lee *et al* 1983). There were no big differences in T.S.S. of fruits between cold and ambient storage in both year. In 1st year T.S.S. varied between 4.6% and 6.1% while in 2nd year it varied from 7.1% to 8.4%.

Table (2): Avocado fruit chemical characters after storage in ambient conditionsand cold store (10°C) in first season.

Characters		T.S.S. %	Oil %	P.H value
Kind of Storage	Treatments			
Average at start		5.60	11.10	6.40
Ambient temperature after two weeks	PEHD 30 µ	5.83	11.33	6.90
	PELD 30 µ	5.17	11.47	6.97
	PELD+iron sachets	5.73	8.67	7.10
	PVC 10 µ	6.07	6.33	7.06
	Control	5.50	10.20	6.80
	Mean	**5.66**	**9.60**	**6.97**
Cold storage after 4 weeks	PEHD 30 µ	5.67	13.33	6.66
	PELD 30 µ	4.57	10.87	6.57
	PELD+iron sachets	5.17	9.67	6.83
	PVC 10 µ	5.83	12.07	6.40
	Control	5.40	10.27	6.60
	Mean	**5.33**	**11.24**	**6.61**
Grand mean		**5.49**	**10.42**	**6.79**
General average	PEHD 30 µ	5.75	12.33	6.78
	PELD 30 µ	4.87	11.17	6.77
	PELD+iron sachets	5.45	9.17	6.97
	PVC 10 µ	5.95	9.20	6.73
	Control	5.45	10.24	6.70
L.S.D at 5 % level for				
Storage degree (S)		N.S	N.S	0.12
Treatments (T)		0.62	1.82	0.20
SxT		N.S	N.S	N.S

Average fruit weight 279.8 ± 16.8 gm.

Oil content: -

Oil content at start recorded 11.1% in 1st year and 12.3% in 2nd year (as shown in Tables 2 and 4). Oil content in ambient conditions fruits decreased very slightly in both seasons (an average of 10.2% in 1st year and 12.1% in 2nd year), compared to cold stored fruits which showed a stability in

oil content (11.2% in 1st year and 12.6% in 2nd year as averages) .It seemed that ambient conditions (high temperature) stimulated more utilization of oil in metabolism. In all four categories of treatments fruits of PEHD had higher oil content compared to other fruit treatments. (11.3%, 13.3% and 13.2%, 13.1% in ambient and cold storage respectively in both years), oil content was not influenced by the treatments as indicated by the non significance of differences among treatments (in table 2 & 4).

PH value: -

Avocado fruit has more acidity at the start (immediately after picking) as indicated by a low PH value (6.4 in 1st year and 6.1 in 2nd year). This free acidity decreased after storage either in cold store or in ambient conditions, as indicated by higher PH values (as shown in table 2 and 4) an average of 6.7 in 1st year and 6.8 in 2nd year. In cold storage 1st year, there was still more free acidity in treatments compared to this acidity in cold storage 2nd year (an average of 6.6 in 1st year and 6.8 in 2nd year).

Table (4): Avocado fruit chemical characters after storage in ambient conditions and cold store (10°C) in second season.

Characters		T.S.S. %	Oil %	P.H value
Kind of Storage	Treatments			
Average at start		7.90	12.30	6.10
Ambient temperature after two weeks	PEHD 30 µ	7.93	13.20	6.37
	PELD 30 µ	8.13	12.10	6.60
	PELD+iron sachets	7.53	12.00	6.57
	PVC 10 µ	8.00	11.00	6.77
	Control	7.07	12.10	6.70
	Mean	7.73	12.08	6.62
Cold storage after 4 weeks	PEHD 30 µ	7.67	13.10	6.63
	PELD 30 µ	8.03	13.00	6.73
	PELD+iron sachets	8.03	12.73	7.17
	PVC 10 µ	8.40	13.00	6.70
	Control	7.93	11.00	6.73
	Mean	8.01	12.57	6.79
Grand mean		7.87	12.32	6.71
General average	PEHD 30 µ	7.80	13.15	6.50
	PELD 30 µ	8.08	12.55	6.67
	PELD+iron sachets	7.78	12.37	6.92
	PVC 10 µ	8.20	12.00	6.74
	Control	7.50	11.55	6.72
L.S.D at 5 % level for				
Storage degree (S)		N.S	N.S	0.12
Treatments (T)		N.S	N.S	0.20
SxT		N.S	N.S	N.S

* Average fruit weight 288.3 ± 23 gm.

CONCLUSION

High density polyethylene packages were revealed to be useful in keeping avocado quality in cold storage and per short periods in ambient conditions.It' s difficult to judge avocado fruit maturity of picking by

appearance only or picking at the same date every year, because dry matter and oil accumulation is a continuous oparation through the final phase of maturation. Other treatments were less effective and control fruits gave unacceptable quality fruits.

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إستخدام عبوات مختلفة لتخزين وإطالة فترة عرض ثمار الزبدية

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جمعت ثمار زبديه صنف "نابال"من مزرعة نيموس (برقاش) فى مرحلة النضج البستانى وتم تعبئتها كل ٣ ثمار فى كيس مغلق تماما (٢٠ X ٣٠ سم) بإستخدام بولى إثيلين منخفض الكثافة (٣٠ ميكرون) , وبولى فينيل كلورايد (١٠ ميكرون) , وبولى إثيلين عالى الكثافة (٣٠ ميكرون) ومعامله رابعه من أكياس الحديد الخام الموضوعة فى أكياس بولى إثيلين منخفض الكثافة . وعبوات مقارنه (مفتوحة) .عرضت كل الثمار فى بداية التجربة (قبل التعبئة) إلى غازات الإنضاج (باستخدام فحم كربيد الكالسيوم).نصف العبوات تم تخزينها فى درجه حرارة الجو العادى (٢٠– ٢٥°م) لمدة ٢ أسبوع .وتم تخزين النصف الثانى فى غرفة تبريد (١٠° م) لمدة ٤ أسابيع . وبعد إنتهاء التخزين تم فحص الثمار لتقدير المظهر الخارجى وعوامل الجودة . احتفظت الثمار المعبأة بصفة عامه بالوزن الأصلى مع فقدان نسبه تتراوح من (٢–٣ %) منه بالمقارنة بثمار المقارنة (٣,٥% نسبة فقدان فى الوزن). تبين أن الجودة فى ثمار السنة الثانية كانت أعلى من ثمار السنة الأولى . حيث تميزت الثمار فى هذه السنة بارتفاع نسبة المواد الصلبة الذائبة الكلية ومحتوى الزيت , علاوة على درجة طعم أفضل قليلا من السنة الأولى . أعطت أكياس البولى إثيلين عالى الكثافة نتائج جيدة بصفة عامة , حيث تميزت الثمار المخزنة فيها بارتفاع الصلابة (٨ رطل/بوصة^2 فى العام الأول و ٨,٥ رطل/بوصة^2 فى العام الثانى) , وكذلك بارتفاع نسبة المواد الصلبة الذائبة الكلية (٥.٥ % فى العام الأول و ٨,٥% فى العام الثانى) , وارتفاع نسبة الزيت (١٢,٣% فى العام الأول و ١٣,٢% فى العام الثانى) . وأوضحت كذلك النتائج أن هذه الثمار حصلت على درجة أعلى فى الطعم . بينما أدت المعاملات الأخرى إلى نتائج غير حاسمة , ولم تكن إضافة الحديد الخام ذات أهمية تذكر . وأوضحت النتائج أهمية الزيت لتقدير ميعاد القطف , حيث أن ارتفاع هذا المكون إلى حده الأقصى هو أفضل دليل على قطف ثمار ذات قيمة غذائية عالية .