

**EFFECT OF SOME KIND OF WAX ON MAINTAINING FRUIT QUALITY OF
 "KEITT" MANGO CULTIVAR DURING COLD STORAGE AND MARKETING
 BY**

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ABSTRACT

This study was carried out during two seasons 2005, 2006 on mango fruits as late and promising cultivar for export. The investigation focused to study the effect of two waxes (bees and Astiaric) as coated for mango fruits and different storage temperatures 8°C, 13°C (85-90% RH) and ambient temperature (25-30°C), 55-60% RH on fruit quality. Green mature fruits were harvested from private orchard in Berkash at Giza governorate. Physical and chemical properties were studied during storage and marketing period.

Results revealed that, there was negative correlation between storage period, temperature and fruit shelf life. Coating mango with both of two waxes effectively reduced weight loss, delayed chlorophyll breakdown, develop β carotene, ripening index and retention flesh firmness during cold storage as compared with control fruits.

Cold storage and waxing, extend storage life of fruits from three to four folds as compare to control fruits held at ambient temperature 25-30°C.

INTRODUCTION

Mango is considered as fruit of excellence and thus has prominent position among commercial fruits grown in Egypt. Egyptian export of fresh mango fruit to 20 countries in the Near East and Europe countries (FAO, 2007). Low temperature and some supplemental treatments very important to extend the storage life of fruits and reduce physiological disorders during storage.

Pesis (2004) illustrated that two organic coating for post harvest application have been recently developed in USA. One coating is colloidal solution based on bees wax and the other is based on carnauba wax. Coating mango cultivars "Tommy Atkins", "Kent" and "Keitt" with organic coating delayed fruit softening, color development, acid breakdown and weight loss, ensuring longer shelf life of fruits after storage. Organic coating of mango fruit with natural based wax did not produce off flavors as accumulation of anaerobic metabolites. Moreover, coating fruit reduced the internal breakdown to a great extent exhibiting better fruit texture. Dhemre

et al. (2005) subjected freshly harvested mango fruits cultivar. Kasar to wax (6%), wax coupled with carbendazim (0.1%) and captan (0.2%) treatments. The treated and untreated fruits were kept for storage at room temperature and in cold storage 10°C with (90-95% R.H.). Fruits treated with wax coupled with carbendazim could be kept up to 50 days in cool storage compared to 20 days at room temperature. Data on shelf life, physiological loss in weight, total soluble solids, and acidity and total sugars indicated that the cool storage might be an ideal storage facility to increase the domestic as well as export marketing of kasar fruits. Gaikwad *et al.* (2006) found that the "Alphonso" mango fruits treated with CaCl₂ 2% + waxol (6%) + carbendazim (0.1%) could be kept up to 16 days at room temperature and 28 days in cool storage. El Oraby *et al.* (2004) found that "Fagri Kilan" mango held at 10°C showed any symptoms of chilling injury till the end of storage period 28 days while fruits held at 5°C showed chilling injury symptoms after 21 days from cold storage. Phakawatmongkol *et al.* (2004) stored

mango fruit of six cultivars at 4, 8 and 12°C (85-90% R.H.). The symptoms of chilling injury in mangoes stored at 4,8°C develop more rapidly and were more dramatic than in those stored at 12°C. Habib *et al.* (2007) found that on his study on sensory properties of mango that control fruits had higher percentage of weight loss, lower retention of total soluble solid as acidity and very low score of other quality such as skin color, flesh color, and texture respectively during 15 days of storage period at 32-35°C in comparison with fruits packed in modified atmosphere. Galale (2008) showed that "Zebda" and "Ewais" mango peel color decreasing trend for "a*" value and increasing for "b*" values during cold storage at 10°C, 13°C. In pulp color, "a*" and "b*" values increase as the storage period extended in all temperatures and cultivars studied, that suggested turning of pulp color to yellow or orange yellow. Total carotenoids in pulp of two cultivars increased with storage temperature and storage period.

The aim of research is to study the effect of two waxes (bees and Astiaric) as coated for mango fruits and different storage temperatures (8°C, 13°C) 85-90%RH and ambient temperature (25-30°C) 55-60% RH. on fruit quality and storability.

MATERIAL AND METHODS

This investigation was carried out during 2005 and 2006 seasons. Keitt mango fruits were harvested at green maturity stages according to harvest indices of maturity Sobeih and Hassan (2007) from berkash, Giza governorate. In post harvest fruit handling lap, fruits were washed with water and air dried, then divided into three groups. The first group washed with water without any treatment (control), the second group of fruits was sprayed with astiaric wax 4% and the last group of fruits was sprayed with bee's wax 4% and the fruits lifted to dry.

Fruits were packed in one layer in carton boxes, each box contain 6 fruits. Four boxes from each treatment were held at 8°C, 13°C and 85-90% RH. The last groups of boxes were held at ambient temperature 25-30°C and 60-65% RH. Fruit physical and chemical characters were determined every 10 days interval through out the storage period as fellow.

1- Fruit weight loss was calculated as a percentage.

- 2- Flesh firmness was determined by using a hand magness taylor pressure tester with 5/16 plunger. The flesh firmness was measured in Lb/in².
- 3- Peel and pulp color: peel and pulp color was quantified using hunter colorimeter model Dp 9000, "a" value negative (green) positive (red), "b" value negative (blue) positive (yellow) Mc Gjuire (1992) and a*/b* ratio was calculated .
- 4- T.S.S.: was determined by Abbe digital refractometer.
- 5- Titratable acidity: Total acidity was determined in the juice as citric acid according to A.O.A.C. (1990)
- 6- Ripening index (RI) was calculated by T.S.S./ Acidity %
- 7- β-carotene, was determined in the pulp according to A.O.A.C. (1990)

Data collected through this study was statistically analyzed using the analysis of various methods as described by Snedecor and Cochran (1990), L.S.D. method at 0.05 level was used to compare between means.

RESULTS AND DISCUSSION

Weight loss:

Results in Tables (1, 4) show that fruit weight loss increased with extending the storage period in treated and control fruits in all storage temperatures.

Mango fruits stored at 8°C caused significantly lower fruit weight loss than those stored at 13°C. In the first season the mean weight loss of fruits stored at 8°C was 4.5 and at 13°C was 6.2. The same trend was observed in the second season.

Table (1): Effect of storage temperatures and wax treatments on fruit weight loss percentage of "Keitt" mango during 2005-2006

Treat-ments	1 st season					2 nd season				
	Storage life (days)					Storage life (days)				
	Storage temperature 8°C									
	10	20	30	40	M	10	20	30	40	M
Control	3.75	4.99	6.39	9.03	6.04 a	3.28	4.94	6.62	9.27	6.03 a
Astiaric wax	2.10	3.12	4.20	5.80	3.81 b	2.00	3.53	4.62	5.72	3.97 b
bee's wax	2.00	3.05	4.25	6.00	3.83 b	2.00	3.36	4.81	5.99	4.04 b
Mean	2.62 d	3.72 d	4.95 d	6.94 d	4.56	2.43 d	3.94 c	5.35 b	6.99 a	4.68
Storage temperature 13°C										
Control	4.53	5.46	5.97	11.80	6.94 a	4.27	6.60	8.60	11.10	7.64 a
Astiaric wax	3.90	4.26	5.61	7.99	5.44 c	3.78	4.41	5.92	7.80	5.48 b
bee's wax	3.60	4.80	9.32	7.15	6.22 b	3.32	4.64	5.88	7.89	5.43 b
Mean	4.01 d	4.84 c	6.97 b	8.98 a	6.20	3.79 d	5.22 c	6.80 b	8.93 a	6.18

Table (2): Effect of storage temperatures and wax treatments on fruit flesh firmness (Lb/in²) of "Keitt" mango during 2005-2006

Treat-ments	1 st season						2 nd season					
	Storage life (days)						Storage life (days)					
	Storage temperature 8°C											
	in	10	20	30	40	M	in	10	20	30	40	M
Control	28	28	26	24	20	25.2 a	28	28	25	24	19	24.8 a
Astiaric wax	28	28	26	24	20	25.2 a	28	28	25	24	20	25.0 a
bee's wax	28	28	26	24	20	25.2 a	28	28	25	24	21	25.2 a
Mean	28 a	28 a	26 b	24 c	20 d	25.2	28 a	28 a	25 b	24 b	20 c	25.0
Storage temperature 13°C												
Control	28	19	15	10	8	16 c	28	20	15	10	8	16.2 b
Astiaric wax	28	20	17	14	10	17.8 b	28	22	18	15	10	18.6 a
bee's wax	28	22	18	14	10	18.4 a	28	22	18	15	10	18.6 a
Mean	28 a	20.3 b	16.7 c	12.7 d	9.3 e	17.4	28 a	21.3 b	17 c	13.3 d	9.3 E	17.78

Values having the same letter in the Sam column or Sam raw not significantly different at 5% level using L.S.D.

The weight loss percentage of fruits stored at 8°C and 13°C for 40 days had approximately fruit weight loss of fruits stored 10 days at ambient temperature (25-30°C).

Concerning the effect of treatments on weight loss, the data illustrated that there was no obvious differences between two kinds of waxes, but there was significant differences

between treated and control fruits in all storage temperatures.

These finding are in harmony with those of Dhemre *et al.* (2005) who indicated that the cool storage might be an ideal storage facility to extend marketing period of Kasar mango fruits. The role of wax in reducing weight loss may be due to inhibit respiration

rate and delay ripening development in fruit Pesis (2004).

Firmness:

Tables (2, 4) indicated that fruit firmness decreased as the storage period increased in all storage temperatures and in treated and control fruits in the two seasons of study.

Also there were significant differences between the storage temperatures on their effect on fruit firmness. The rate of soften was accelerated in fruits held at ambient temperatures (25-30°C) followed by 13°C in comparison with 8°C. Concerning the effect of wax in maintain, firmness was obvious in fruits stored at high temperature 13°C and (25-30°C) as compare to 8°C. These results are in line with those of El-Oraby *et al.* (2004) who found that fruit softing was retard by low storage temperature.

Also, these results supported by Pesis (2004) who found that organic coating delayed fruit softing.

Total soluble solids/ acid ratio percentage (RI):

Data shown in Tables (3, 4) cleared that ripening index (RI) of "Keitt" fruits stored at 8°C, 13°C and 25-30°C increased gradually during storage period. Fruit stored at 8°C showed the least value in comparison with 13°C and 25-30°C. These values were 15.36, 29.38 and 43.99 at the end of storage period respectively. The results were similar in the two seasons of study.

Concerning the effect of wax on (RI) It is clear that both of two wax delayed (RI) in all storage temperatures as compare to control fruits. The increase of (RI) during storage due to the increase of total soluble solids and decrease of acidity. The increase of Total soluble solids are directly correlated with hydrolytic changes in starch and conversion of starch to sugar being on important index of ripening process in mango Kittur *et al.* (2001). The decrease in acidity might be due to the degradation of citric acid during ripening or may be due to their conversion into sugars Gowda and Huddar (2001).

The role of wax and cold storage in extend storage life of fruits by reduce ripening development are in agreement with El Oraby *et al.* (2004), Dhemre *et al.* (2005) and Gaikwad *et al.* (2006).

Peel and pulp color.

1-Peel color:

Fig (1) and Table (4) showed a*/b* ratio of peel color of "Keitt" mango, highly negatives of this ratio at the beginning of storage this it mean that peel was dark green. Decreasing these values during storage period, it means that dark green change to light green by degradation of the chlorophyll. Peel color development was rapid in fruits held at 25-30°C and 13°C as compare to fruits held at 8°C.

Comparing the a*/b* ratio in treated and fruits with wax, it can be noticed that a*/b* ratio in treated fruits less than untreated ones, this it means that wax delayed ripening fruits, till the end of storage at all storage temperatures.

The effects of two kinds of wax were similar in its effect of peel color, the same results were found in two seasons.

In this respect Hassan and Gihan (2004) found that peel color developed slowly at low temperature in three cultivars of mango. The effect of wax on peel color are in agreement with pesis (2004), Fonseca *et al.* (2004) illustrated the retention of green color related to the use of the wax is due to the creation of a physical barrier against the gas exchange, which reduced the gain of oxygen that is necessary for the biodegradation of chlorophyll a.

2-Pulp color:

Fig (2) and Table (4) indicated that a*/b* ratio of pulp revealed that the beginning of storage date pulp color was pale yellow. As the storage period extended a*/b* ratio increased in all storage temperature, this suggested turning pulp color to yellow. Fruits stored at 25-30°C had more pulp color followed by 13°C and 8°C respectively.

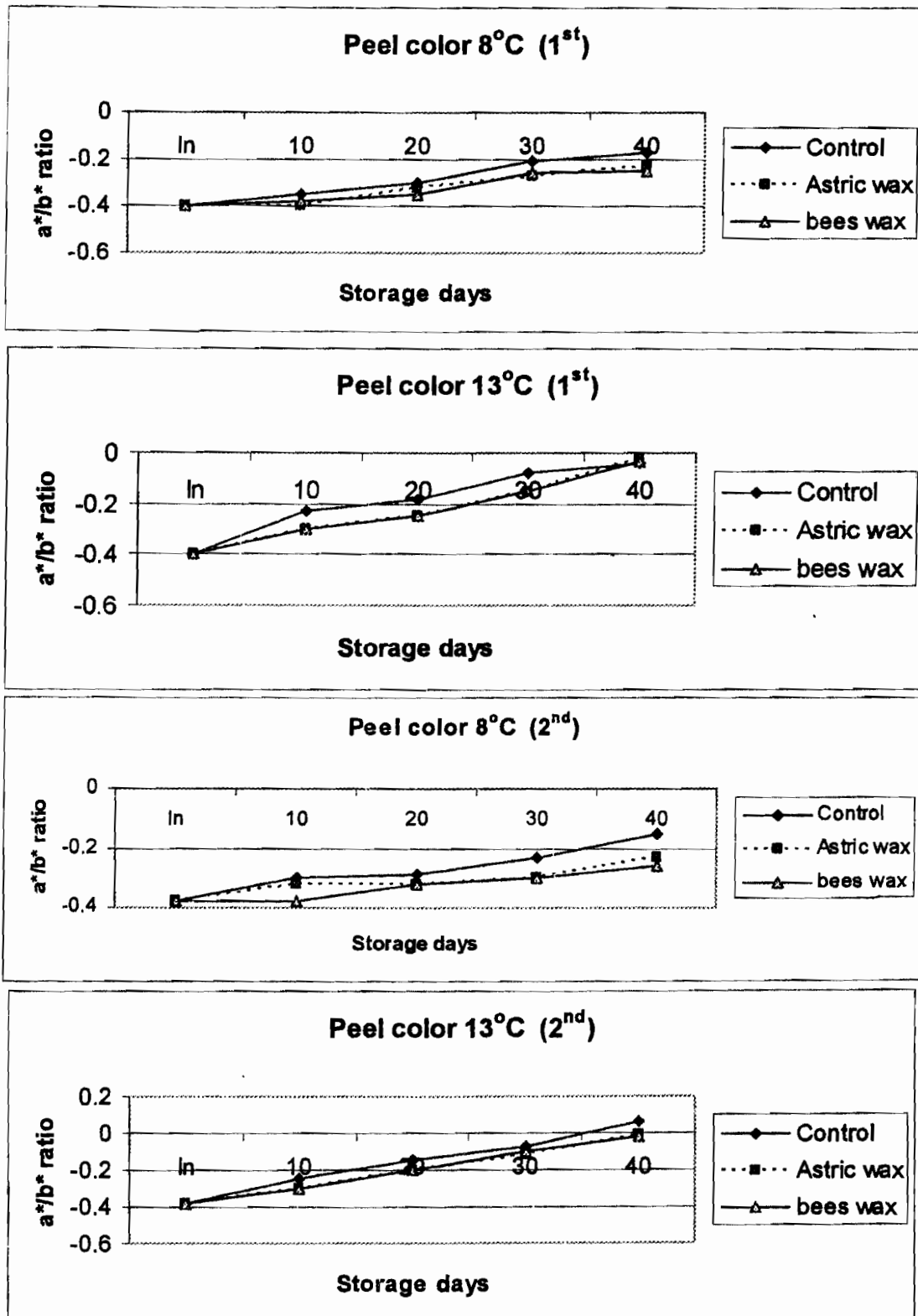


Fig (1): Effect of storage temperatures and wax treatments on peel fruit a*/b* ratio of "Keitt" mango during 2005-2006

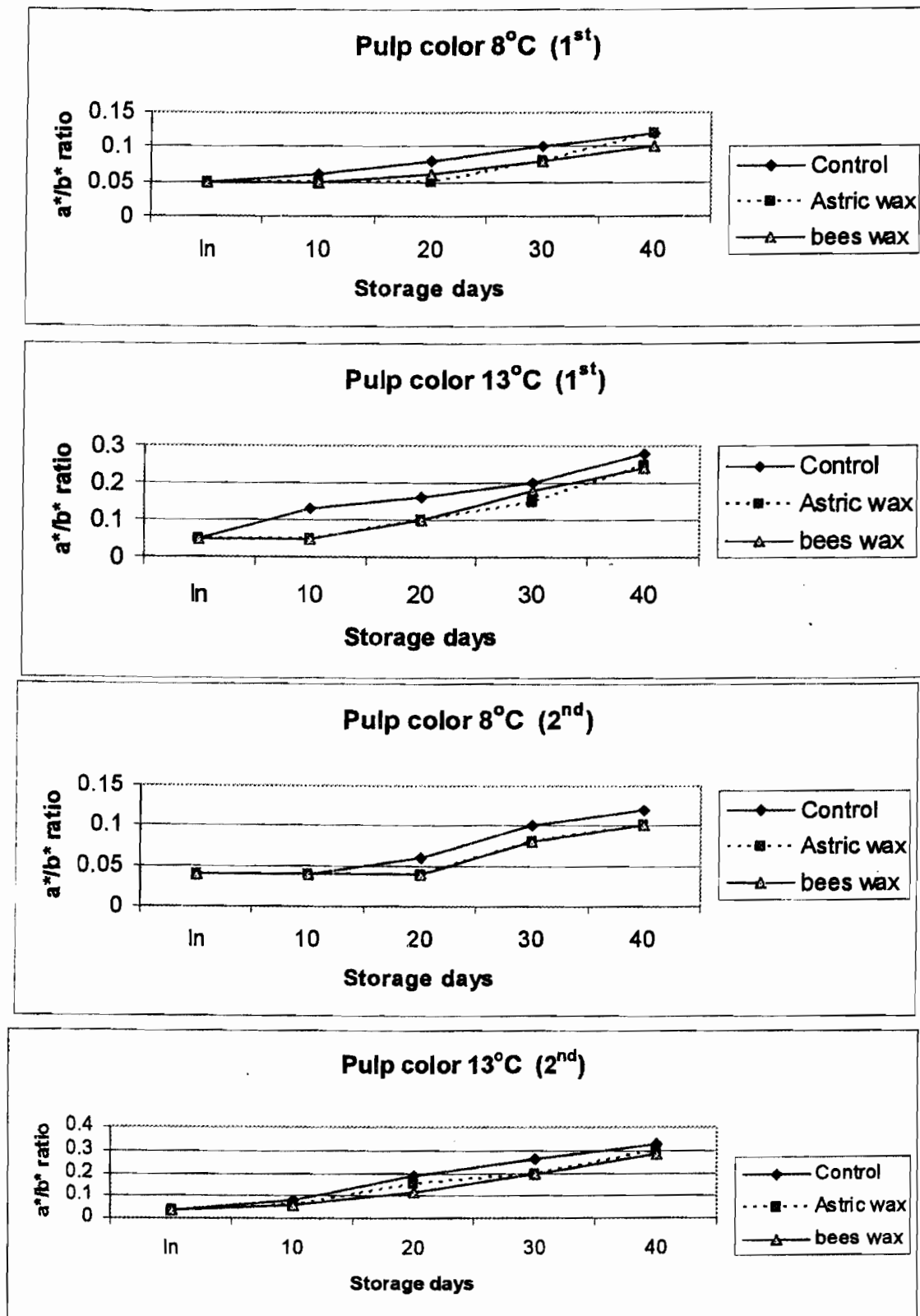


Fig (2): Effect of storage temperatures and wax treatments on pulp fruit a*/b* ratio of "Keitt" mango during 2005-2006

Table (3): Effect of storage temperatures and wax treatments on fruit T.S.S./Acid ratio (Ripening index) of "Keitt" mango during 2005-2006

Treatments	1 st season						2 nd season					
	Storage life (days)						Storage life (days)					
	Storage temperature 8°C											
	in	10	20	30	40	M	in	10	20	30	40	M
Control	4.08	5.25	7.56	15.8	19.1	10.4 a	4.5	5.4	7.84	16.1	18.9	10.5 a
Astiaric wax	4.08	4.18	5.1	12.2	13.4	7.79 b	4.5	4.75	5.96	11.3	13	7.9 b
bee's wax	4.08	4.6	5.4	11.8	13.6	7.89 b	4.5	4.75	5.74	11.8	13	7.95 b
Mean	4.08 e	4.68 d	6.02 c	13.3 b	15.4 a	8.68	4.5 e	4.97 d	6.51 c	13.1 b	15 a	8.8
Storage temperature 13°C												
Control	4.08	7.33	11.6	23	37.5	16.7 a	4.5	7.03	11.1	21.7	37	16.3 a
Astiaric wax	4.08	6.4	9.7	18.3	26.5	13 b	4.5	6.94	9	16.7	23.6	12.1 b
bee's wax	4.08	6.3	9.7	18	24.2	12.5 c	4.5	6.94	10.2	17.8	23	12.5 b
Mean	4.08 e	6.68 d	10.3 c	19.8 b	29.4 a	14	4.5 e	6.97 d	10.1 c	18.7 b	27.9 a	13.6

Table (4): Effect of room temperature (25-30°C) and waxing on fruit quality of "Keitt" mango during 2005-2006

Treatments	1 st season								
	Weight Loss % After 10 days	Firmness Lb/in ²		a*/b* ratio (peel)		a*/b* ratio (pulp)		T.S.S./acid ratio	
		In	After 10 days	In	After 10 days	In	After 10 days	In	After 10 days
Control	8.62 a	28	5 a	-0.40	0.03 a	0.05 a	0.34 a	4.08	49.47 a
Astiaric wax	7.10 b	28	8 b	-0.40	-0.15 b	0.05 b	0.31 b	4.08	36.27 b
bee's wax	7.07 b	28	8 b	-0.40	-0.20 b	0.05 b	0.30 c	4.08	46.25 c
2 nd season									
Control	8.80 a	28	6 a	-0.38	0.06 a	0.04	0.34 a	4.50	63.30 a
Astiaric wax	7.25 b	28	9 b	-0.38	-0.10 b	0.04	0.32 b	4.50	33.27 b
bee's wax	7.14 b	28	10 c	-0.38	-0.20 b	0.04	0.30 c	4.50	33.09 b

Values having the same letter in the Sam column or Sam raw not significantly different at 5% level using L.S.D.

Concerning the effect of treatments on pulp color, untreated fruits were more advanced in turning of pulp color to range yellow than treated fruits. The results of first season were supported by the second season.

These results are in harmony with those of Galale (2008), Pesis (2004) illustrated that coated "Keitt" mango with wax delayed color development.

Effect of storage temperatures and waxing on development of β carotene of "Keitt" mango at the end of storage period:-

It is clear from Table (5) that β carotene of pulp fruits increase with increasing storage temperature. The highest values were obtained from fruits stored at (25-30°C) followed by 13°C and 8°C respectively, during two seasons of study.

Regarding the effect of waxing, Data indicated that there were significant difference between beginning and after 40 days at 8°C, 13°C and 10 days at (25-30°C). The untreated fruits contain more β carotene than fruits treated with bees and Astiaric wax respectively, this may be due to that wax delay ripening fruits at all storage temperatures, similar results were obtained in the second season and agree with those of Vazquez and Lakshminarayana (2006) who found that total and β carotenoids were significantly higher at (22-28°C) than (16-20°C) in "Keitt" mango.

Sensory quality of "Keitt" mango as affected by cold storage temperatures and wax treatments after transfers to ambient temperature 25-30°C as marketing period:-

Data in Tables (6, 7) illustrated that there were negative correlation between storage temperature, period and fruit shelf life.

Fruits stored at 8°C for 10 or 20 days had 10 days as shelf life at 25-30°C, while fruits stored 30 or 40 days had 7 days. At 13°C this period reached to 7 and 5 days respectively. All the parameters of ripening were development after transfer the fruits from cold storage to ambient temperature 25-30°C, peel and pulp color were progressively developed,

firmness decreased while T.S.S. /Acid ratio increased.

In general all eating quality was progressively increased during marketing period but the rate of progress was faster in fruits stored at 13°C than 8°C. Regarding the effect of treated fruits in comparison with untreated fruits, both of wax delayed ripening process. The results of two seasons were similar.

These results coincide with those of Habib *et al.* (2007) who found that sensory properties of mango at 32-35°C changes quickly than those packed in modified atmosphere. The main factor which limited the storage life of fruits was appeared chilling injury, symptoms as black spots on the peel of fruits after 30 days from storage at 8°C during marketing period for control fruits while chilling symptoms did not appeared on treated fruits with both of wax till the end of storage.

Similar findings were obtained by El-Oraby *et al.* (2004) and Phakawatm Ongkol *et al.* (2004) who found that the symptoms of chilling injury in mangoes develop more rapidly in mangoes stored at 4°C, 8°C than in those stored at 12°C.

Table (5): Effect of storage temperature and waxing on development of β carotene (mg/100g) of "Keitt" mango.

Treatments	Stored at (25-30°C)			
	1 st season		2 nd season	
	First	End	First	End
Control	38.30	593.52 a	40.20	584.50 a
Astiaric wax	38.30	345.49 c	40.20	352.17 c
bee's wax	38.30	444.22 b	40.20	437.54 b
Stored at (8°C)				
Control	38.30	101.87 a	40.20	91.85 a
Astiaric wax	38.30	66.80 c	40.20	56.10 c
bee's wax	38.30	87.30 b	40.20	85.20 b
Stored at (13°C)				
Control	38.30	235.47 a	40.20	230.46 a
Astiaric wax	38.30	156.50 c	40.20	155.31 c
bee's wax	38.30	272.21 b	40.20	237.14 b

Table (6): Sensory quality of "Keitt" mango as affected by cold storage temperature 8°C and wax treatments after transfer to ambient temperature (25-30°C).

Treatment	1 st Season				
	Weight loss %	Firmness Lb/in ²	T.S.S./Acid ratio	a*/b* (peel)	a*/b* (pulp)
	10 days at 8°C + 10 days at 25-30°C				
Control	7.50 a	11.60 b	35.80 a	-0.03 a	0.20 a
Astric wax	7.11 a	15.30 a	35.00 a	-0.25 b	0.20 a
Bees wax	7.00 a	14.30 a	25.14 b	-0.25 b	0.13 b
20 days at 8°C + 10 days at 25-30°C					
Control	7.90 a	10.00 b	36.00 a	0.01 a	0.22 a
Astric wax	7.00 b	12.00 a	36.00 a	-0.08 b	0.21 a
Bees wax	7.00 b	12.00 a	36.00 a	-0.13 b	0.13 b
30 days at 8°C + 7 days at 25-30°C					
Control	8.00 a	9.60 a	66.33 a	0.11 a	0.22 a
Astric wax	7.50 b	9.60 a	37.80 a	-0.08 b	0.20 b
Bees wax	7.90 b	9.60 a	37.20 a	-0.08 b	0.13 c
40 days at 8°C + 7 days at 25-30°C					
Control	9.00 a	7.30 a	72.66 a	0.16 a	-0.22 a
Astric wax	8.11 b	7.00 a	45.50 b	-0.09 b	0.18 b
Bees wax	8.50 b	7.30 a	42.40 b	-0.09 b	0.15 c
2 nd season					
10 days at 8°C + 10 days at 25-30°C					
Control	7.31 a	10.60 b	36.00 a	-0.06 a	0.22 a
Astric wax	6.03 b	12.30 a	35.80 a	-0.22 b	0.20 b
Bees wax	5.97 b	12.30 a	25.86 b	-0.25 b	0.18 c
20 days at 8°C + 10 days at 25-30°C					
Control	7.50 a	9.30 b	37.00 a	0.06 a	0.20 a
Astric wax	6.99 b	10.00 a	36.00 a	-0.18b	0.20 a
Bees wax	6.00 c	10.00 a	36.00 a	-0.18 b	0.18 b
30 days at 8°C + 7 days at 25-30°C					
Control	8.00 a	7.60 a	63.30 a	0.15 a	0.23 a
Astric wax	7.11 b	7.50 a	46.25 b	-0.08 b	0.20 b
Bees wax	7.60 c	7.60 a	46.25 b	-0.08 b	0.18 c
40 days at 8°C + 7 days at 25-30°C					
Control	9.11 a	6.00 a	72.66 a	0.15 a	0.23 a
Astric wax	8.53 b	6.00 a	47.00 b	-0.06 b	0.20 b
Bees wax	8.60 b	6.30 a	45.50 c	-0.06 b	0.18 c

Values having the same letter in the Sam column or Sam raw not significantly different at 5% level using L.S.D.

Table (7): Sensory quality of "Keitt" mango as affected by cold storage temperature 13°C and wax treatments after transfer to ambient temperature (25-30°C).

Treatment	1 st Season				
	Weight loss %	Firmness Lb/in ²	T.S.S./Acid ratio	a*/b* (peel)	a*/b* (pulp)
	10 days at 8°C + 10 days at 25-30°C				
Control	6.11 a	8.60 c	60.30 a	0.04 a	0.23 a
Astric wax	6.03 a	12.30 b	44.75 b	-0.10 b	0.16 b
Bees wax	6.00 a	13.30 a	35.80 c	-0.10 b	0.13 b
	20 days at 8°C + 10 days at 25-30°C				
Control	7.00 a	7.30 b	63.30 a	0.17 a	0.28 a
Astric wax	6.90 a	10.30 a	46.95 a	-0.08 b	0.22 b
Bees wax	6.50 a	10.30 a	46.25 a	-0.10 b	0.15 c
	30 days at 8°C + 7 days at 25-30°C				
Control	7.70 a	7.60 a	66.33 a	0.18 a	0.28 a
Astric wax	6.90 a	7.30 a	47.25 b	-0.08 b	0.17 b
Bees wax	6.90 a	7.60 a	46.25 b	-0.08 b	0.18 b
	40 days at 8°C + 7 days at 25-30°C				
Control	8.90 a	5.00 a	73.33 a	0.26 a	0.27 a
Astric wax	7.50 b	5.00 a	55.00 b	-0.06 a	0.25 b
Bees wax	7.80 b	5.00 a	47.85 c	-0.06 a	0.24 b
	2 nd season				
	10 days at 8°C + 10 days at 25-30°C				
Control	6.14 a	8.60 b	60.67 a	0.01 a	0.23 a
Astric wax	5.83 b	10.30 a	45.75 b	-0.08 b	0.20 b
Bees wax	5.89 b	8.60 b	45.25 b	-0.08 b	0.15 c
	20 days at 8°C + 10 days at 25-30°C				
Control	6.00 a	7.00 b	47.50 a	0.18 a	0.25 a
Astric wax	6.50 a	9.00 a	46.25 b	-0.08 b	0.20 b
Bees wax	6.50 a	9.00 a	46.25 b	-0.08 b	0.15 c
	30 days at 8°C + 7 days at 25-30°C				
Control	7.00 a	6.00 b	68.00 a	0.20 a	0.25 a
Astric wax	6.90 a	6.30 a	47.50 b	-0.07 b	0.20 b
Bees wax	6.80 a	6.30 a	47.50 b	-0.08 b	0.20 b
	40 days at 8°C + 7 days at 25-30°C				
Control	8.12 a	4.00 b	73.33 a	0.24 a	0.28 a
Astric wax	7.92 b	4.00 b	53.25 b	-0.07 b	0.20 b
Bees wax	7.90 b	5.00 a	50.25 c	-0.10 b	0.20 b

Values having the same letter in the Sam column or Sam raw not significantly different at 5% level using L.S.D.

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تأثير بعض أنواع الشموع في المحافظة علي جودة ثمار المانجور صنف كيت المتأخرة خلال التخزين المبرد والتسويق

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أجريت هذه الدراسة خلال موسمي ٢٠٠٥-٢٠٠٦ علي ثمار مانجور صنف "كيت" متأخرة واعدته للتصدير. ويلقي البحث الضوء علي تأثير التشميع بواسطة نوعين من الشمع (شمع نحل العسل- شمع استيارك) كمواد مغلقة كذلك التخزين علي درجات حرارة مختلفة ٨ م^٠ -١٣ م^٠ ورطوبة نسبية ٨٥-٩٠% بالإضافة إلي درجة حرارة الغرفة ٢٥-٣٠ م^٠ ورطوبة نسبية ٥٥-٦٠% ومدى تأثير ذلك علي جودة الثمار. تم جمع ثمار مكتملة النمو خضراء من مزرعة خاصة في برقاش محافظة الجيزة. وتم دراسة الصفات الطبيعية والكيميائية للثمار أثناء التخزين المبرد وفترة التسويق. وقد أوضحت النتائج ان هناك علاقة سلبية بين درجة حرارة التخزين وفترة حياة الثمرة. كذلك وجد ان التشميع بأى من نوعي الشمع المستخدم كان له تأثير علي تقليل الفقد في الوزن- تأخير تكبير الكلوروفيل- تكون β كاروتين- معدل النضج - تأخير انخفاض الصلابة أثناء التخزين المبرد بالمقارنة مع الثمار الغير معاملة. التخزين المبرد والتشميع أطال من فترة حياة الثمار من ثلاث إلي أربع مرات بالمقارنة مع الثمار الغير معاملة التي وضعت علي درجة حرارة الغرفة ٢٥-٣٠ م^٠