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انضاج ثمار المانجو باستخدام مواد طبيعية

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الملخص العربى

أجري هذا البحث خلال موسمى ٢٠٠٩ – ٢٠١٠ بمعهد بحوث البساتين – قسم بحوث تداول الفاكهة قطفت ثمار مانجو صنف كيت فى مرحلة اكتمال النمو وبداية طور النضج من مزرعة خاصة بمنطقة القناطر الخيرية. وتم تنظيف الثمار واستبعاد المصاب منها وقسمت الثمار الى أربعة مجموعات بحيث تم تخصيص مجموعة لكل معاملة من المعاملات الآتية: معاملة بمادة الأيثريل وثانية بزيت الليمون وثالثة بمخلوط زيوت طيارة (لافندر وبرتقال) وبتركيز واحد لكل معاملة ٢٠٠ جزء/مليون، علاوة علي المقارنة. وضعت الثمار في كراتين كل كرتونة طبقة واحدة من ٥ كجم ثمار تقريبا وخزنت لمدة ٧ أيام علي ١٣°م ثم ٤ أيام علي ١٨°م وذلك لمحاكاة ظروف التسويق. ثم أخذ أربعة عينات طوال فترة التجربة لتقدير صفات جودة الصفات المتعلقة بإكتمال النضج مثل الفقد في الوزن ونسبة التالف وصلابة اللحم والمواد الصلبة الذائبة الكلية وتغير لون القشرة والحموضة ودرجة الجودة للأكل.

أوضحت النتائج أن الثمار المعاملة بزيت الليمون ومخلوط الزيوت الطيارة والإثيريل قد فقدت وزنا أكبر من ثمار المقارنة (٦.٧ – ٧.٣% للثمار المعاملة في مقابل ٦% للثمار في السنة الأولي ونتائج مماثلة في السنة الثانية). ونسبة الثمار المصابة بالأعفان كانت من ٦.٢ – ٧.٨% لكل الثمار المعاملة وغيرها فيما عدا ثمار الزيوت الطيارة التي كانت نسبة الإصابة فيها ٤.٢% السنة الأولي و ٤.٣٥ السنة الثانية وقد انخفضت صلابة الثمار بشكل عادي خلال الموسمين (من قيم البداية ٢٢٦كجم/سم٢ في السنة الأولي لتصل إلي متوسط قدره ٦١.٥كجم/سم٢ في نهاية التجربة ومن ٣٠٧كجم/سم٢ في بداية السنة الثانية لتصل ٨٥.٥ كجم/سم٢ في نهاية السنة الثانية) وهو ما يدل علي تأثير واضح لتشجيع النضج من طرف المواد المستخدمة للإنضاج وهو ما أشارت إليه كذلك نتائج المواد الصلبة الذائبة الكلية (من ١٠.٤% في بداية السنة الأولي إلي ١٣.٣% متوسط الثمار المعاملة بينما سجلت المقارنة ١٢.٧%) وكانت نتائج السنة الثانية شبيه بالأولي. أما النسبة المئوية للثمار ذات التطور اللوني الملحوظة للقشرة فقد كانت ثمار الإيثريل هي الأولي (٩٨% – ٩٧%) للعام الأول والثاني علي التوالي ويليها الثمار المعاملة بزيت الليمون (٨٥% – ٨٢%) في مقابل (٣٩% و ٥٥%) لثمار المقارنة. أما الجودة الأكلية فكانت الثمار المعاملة ذات درجة ممتازة عالية في مقابل ثمار المقارنة الأقل جودة. أعطت نتائج المعاملة بزيت الليمون وخليط الزيوت الطبيعية نتائج مماثلة للمعاملة بالإيثريل عند استخدامها للحث علي نضج ثمار المانجو.

ENHANCEMENT OF MANGO RIPENING BY USING NATURAL MATERIALS

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ABSTRACT: *This investigation was carried out during two successive seasons (2009 and 2010) at Hort. Res. Inst., Fruit Handling Department. Mango fruits of Keitt variety were harvested at green mature stage from El-kanater El-kairya district. Fruits were cleaned and the defective ones were discarded then divided into four groups, each group was treated with one of these materials: Ethrel, Lemon oil and a mixture of vegetative essential oils (a solution of 200 PPM in each case) plus a control. For simulation of marketing conditions, fruits were afterwards packed in 5 kg one layer carton boxes and stored for 7days at 13°C, in addition to 4days on 18°C for full ripening. Samples were taken 4 times during the whole experiment period to evaluate mango quality parameters that are related directly to the ripening phase such as, weight loss, decay, flesh firmness (texture), total soluble solids, acidity, fruit percentage reaching a noticeable color change in the peel, during cold storage at 13°C and the complementary ripening at (18°C) and the eating quality. Results generally indicate that fruits treated with lemon oil, biological oils treatments, and Ethrel lost more weight than the control (6.7% - 7.3% for treated fruits, compared to 6% for control by the end of the first year, similar results were obtained in the second year). Fruit decay percentages range were 6.2% to 7.8% for all treated and control fruits, except fruits treated with biological oils which seemed to be noticeable lower decay percentage (4.2% and 4.3% by end of 1st and 2nd year, respectively). All fruits softened correctly during this two seasons (from a start value of 226 kg/cm^2 in the first year, firmness values clustered around 61.5 kg/cm^2 by the end of experiment, and from307 kg/cm^2 to an average value of 85.5 kg/cm^2 in the second year) which confirms a clear stimulation of ripening. Results of evolution of T.S.S indicated its effectiveness of the applied ripening stimulators (from 10.4% at start in the first year, treated fruits had an average of 13.3% by the end of experiment, while control recorded 12.7% and the second year fruits behaved in the same manner). Percentage of fruits with a clear peel color evolution by the end of the experiment was higher in all the treated fruits in both seasons, but Ethrel treated fruits came on the top with 98% - 97%, respectively for both seasons followed by lemon oil treated fruits with (85% -82%) compared to lower coloration percentages (39% and 55%) for control fruits .The eating quality of treated fruits was superior especially with Ethrel and lemon oil treated fruits, compared with control fruits. Lemon oil and essential oils application yielded similar results as Ethrel when used as ripening agents to induce better marketing quality for mango fruits.*

Key words*: Mango, Keitt, maturity stage, ripening, fruit quality.*

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important tropical fruits with a global production exceeding 27 million tons (FAOSTAT, 2008) and about 600000 tons produced annually in Egypt (M.A.O

statistics). The nutritional value and benefits of mango (high content of minerals vitamins and beta carotene) encourage a raising trend of its consumption (Masibo & He, 2008). The known varieties which are cultivated in most farms of Egypt include local and somehow ancient ones like Hindi, Ewes, Zepeda, Soukary, Mabrouka, Gluck, Pairi and Langara (El-Khoreiby, 1997). Fruits of these varieties are not fully colored when mature (having green or light yellow color at ripe stage). This factor decreases the quality rating of these varieties especially in European countries. (Dutta, *et al*., 2008; Melo *et al.*, 2008; Robles-Sanchez *et al.*, 2009). New varieties have been introduced recently in Egypt to obtain fruits with higher productivity, better skin color, and good taste in the meantime, and therefore contribute to the widening of the mango marketing season. This goal could be achieved by certain practices like breeding smaller tree size and taking more care in harvesting and post harvesting operations. Hopefully fruits of these new varieties and modern practices enjoy with attractive color, fine taste, and preserving all other intrinsic quality characteristics of these cultivars (Gil, *et al.*, 2006; González- Aguilar *et al.*, 2008). Among these new varieties, Keitt mango has proved to be successful in Egypt for its appreciable sugars, flavors and acceptable firmness level of flesh when ripe (not very juicy) .The fruit has a fully green color at the beginning of maturity stage but when attaining ripening it develops a nice reddish or orange stain over the background green color of its peel with a flesh free of fibers. Picking of mango begins generally when the fruit is fully developed and at the threshold of the physiological maturity. Natural ripening has one major drawback. Mangoes on trees will not ripen at the same time. Some are ripe and some are still green, and also some parts of the fruit are already yellow while others are still green. Therefore, it is preferable for some varieties to trigger ripening of their fruits after picking so that fruit may attain their full eating quality potentials in a harmonious way for all fruits (Kader, 1994). To facilitate successful marketing of mangoes, using conventional packaging and postharvest handling methods, mangoes destined for export to lucrative markets are harvested at the mature green stage while still firm. The fruit are then ripened after they arrive in these markets by the wholesalers, retailers, or consumers (Kader and Mitcham, 2008). As ripening proceeds in mango fruits, many important changes took place in their tissues. Ripening is associated with a loss in firmness, peels chlorophyll and pulp acidity, and with increasing soluble solids as polysaccharides is broken in to simple sugars, and with a concomitant increase in flavors. Most notably, there is a change in peel color towards distinguished color of the variety (yellow or yellow red or others). These ripening changes result in a more attractive fruit with a good eating quality (Parikh *et al.*, 1990; Seymour *et al.*, 1993). The above mentioned changes are initiated by a well known gaseous plant hormone called ethylene. This gas is synthesized in small quantity in plants and in fruits during their growth and maturity phase (Watada, 1986). When fruits are exposed externally to a certain concentration of this gas or dipped in an ethylene releasing solution (for example Ethrel), this latter enhances and stimulates fruits ripening. This is exploited commercially in banana and kaki ripening, orange and grape coloring, and in other fruits (Lelievre *et al*., 1997). Usually spraying or dipping of fruits in Ethrel was recommended for enhancing ripening, but it is a cumbersome process, and may cause some problems if commercially available Ethrel is provided with chemical impurities (Dhillon and Mahajan, 2011). Exposing mango to ethylene for stimulating ripening is carried out usually using a dose of 100 ppm from gas cylinders for 12 to 24 hours at 20-22 °C in special cold rooms. Ethylene concentration in ripening rooms should be monitored carefully to avoid possible risks of explosion and mortal danger when reaching the concentration of 3.2% in the room air. Other safe and simple methods to generate ethylene are sought to enhance safety and simplicity of fruit ripening operation and to replace the traditional method of ethylene exposure from gas cylinders which are generally costly and should imported from foreign countries. Essential aromatic oils

are experimented largely for their beneficial effects as antiseptic agents (Misbsa and Danby, 1994), but they may be used also to satisfy a particular need. Some essential oils can be manipulated to be used in generating ethylene because of their high content of volatile compounds and monoterpenes with double bond ends like linalool, Geranial, Campene, Pinene and Limonene (Librando *et al*, 2003). Precedent work by El zayat and Allam, 2006 has showed the efficiency of some selected essential oils in stimulating banana ripening. The aim of this research work is testing the impact of certain essential oils (Orange and Lavender) on mango ripening compared with synthetic ethylene releasing substances (Ethrel) in order to stop using this later substance and diffuse application of these oils as organic and safe ripening agents.

MATERIALS AND METHODS

The experiment was designed principally to simulate conditions of local marketing which needs a small period of cold storage (at 13°C) in whole sale marketing conditions before delivering fruits to retailers where fruits are kept normally in a higher temperature for a few days (a selected temperature of 18°C). This last temperature enhances ripening and coloring of mango (Kader and Mitcham, 2008). Mango fruits (Keitt) were brought from a farm located in El-kanater El-kairya (Kalyoubia Governorate) during the month of October of both successive seasons 2009 and 2010. Selected fruits for the experiments were picked in the early maturity stage with a clear green color, free from defects with a homogenous size. One hundred kilograms of fruits were consecrated for the experiment purpose each season. Fruits were divided into 4 lots; three lots were allocated to the experiment treatments in addition to the control fourth lot. All used essential oils are naturally and purely extracted and purchased from a public sector company. The synthetic ethylene releasing material used here was Ethrel (a formulation of 50% active material) and the method of application adopted in this experiment is described below:

1. Ethrel: 2cm of Ethrel is dissolved in 5 liters of water before placing fruits in this solution for one hour (a solution of 200 PPM).
2. Lemon Oil: 1cm of lemon oil is dissolved in 5 liters of water(a solution of 200 PPM) with addition of 5 cm of a tempering pH agent used to accelerate decomposition of the essential oil , constituting a solution whose pH is 2.51, before placing fruits in this solution for one hour.
3. Biological oils or a mixture of essential oils: - two essential oils (lavender &orange) are mixed in equal concentrations 1:1(1cm of this Biological mixture is dissolved in 5 liters of water (a solution of 200 PPM) with the addition of a tempering pH agent (5 cm) used to accelerate decomposition of these essential oils, constituting a solution whose pH is 2.39, before placing fruits in this solution for one hour.
4. Control:-without treatment

After subjecting fruits to the above cited treatments, mangoes were dried in air, and then placed in cartons containing 5 kilograms of fruits in each and transferred to cold storage at 13 °C for one week, then 4 days at 18°C. Quality Characteristics and ripening behavior were being determined three times during seven days of storage at 13°C and once by the end of 4days at 18°C.

Ripening was monitored by evaluating fruit quality parameters as follows:

- **Percentage of weight loss**: Fruits were periodically weighed and the percentage of weight loss was recorded by calculating the difference between the initial weight and that recorded at the date of sampling.
- **Fruit firmness (texture)**: Was measured at regular intervals on peeled parts in four fruits in each sample, using fruit pressure tester (mod. FT 327, Italy), equipped with a probe of 0.79 cm. width. Fruit firmness was recorded in Kg/cm^2.

- **Decay percentage:** The number of spoiled fruits was counted in each chosen date and then these fruits were removed from the experiment. This may be taken as an indirect indication of the speed of ripening and attaining senescence.

- **Total soluble solids percentage**: Abbé refractometer was used to determine the percentage of total soluble solids in fruit juice (A.O.A.C., 1990).

- **Titratable acidity percentage**: Titratable acidity in mango juice was determined in terms of anhydrous citric acid percentage after titration against 0.1 N. Sodium hydroxide using phenolaphthaline as indicator (A.O.A.C., 1990).

- **Fruit eating quality:** A panel of four persons gives a note based on a scale from 0.0 to 10, so as increasing mark denotes a higher appreciation of the taste and the range of 0.0 to 4 indicate unacceptable taste, while surpassing the note of 4 designates the degree of taste acceptability.

- **Fruits percentage in each lot with a noticeable peel color change:** By counting in each lot, the number of fruits having a noticeable change in their peel color, estimated by a surface coloration (reddish or orange) of 33 percent or more of the peel surface area of the fruit.

Statistical analysis: The obtained data were statistically analyzed using excel micro software (one factor randomized complete block design) according to Snedecor and Cohran, 1980 where the L.S.D. test at 5%.

RESULTS AND DISCUSSION

Effect of treatments on mango weight loss:

Treated mango fruits with Ethrel,

recorded in the first year the biggest loss in fruit weight by end of 7 days (5%) at 13°C and after 4 days at 18°C (7.33%) (Table 1). Ripening treatments induced the path of rapid maturity towards full ripening, therefore tissues were turgescent and that implies a greater susceptibility of fruits to lose humidity while staying in cold storage because of the transfer of humidity from stored fruits to the air of the store as the air relative humidity of the store and surrounding fruits is less than that of fruits. This trend was clear also in fruits treated with lemon oil and the biological oils, as both treatments pushed fruits to lose weight gradually, reaching a percentage of 6.58% and 6.73%, respectively by end of the experiment. Control fruits had the least weight loss recording a value of 6% by the end of the 4 days at 18°C, which proves that control fruits had a slower rate of ripening and a lesser aptitude of losing humidity. In the second year, fruits had the same trend but the amplitude of weight loss was collectively lower than the first year. However, all treated fruits have a weight loss situated in the range of 5.93%-6.93% by the end of storage compared to 5.81%for control fruits. These results were in total harmony with the information cited by Robles-Sanchez *et al.*, 2009 and in the booklet of the USDA (Hardenburg *et al.*, 1986) and those of (Elzayat and Hassan 2006) on stone fruits.

Table 1. Effect of ripening treatments on fresh weight losses (%) of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	0.00	1.96	3.96	6.00	2.98 b
Ethrel	0.00	2.30	5.00	7.33	3.65 a
Lemon Oil	0.00	1.72	3.78	6.58	3.02 a
Natural Biological	0.00	1.89	4.03	6.73	3.16 a

Mean	0.00 d	1.96 c	4.19 b	6.66 a	3.20

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	0.00	1.70	2.90	5.81	2.60 b
Ethrel	0.00	2.02	4.09	6.93	3.26 a
Lemon Oil	0.00	1.72	3.03	5.93	2.67 b
Natural Biological	0.00	1.90	3.10	6.03	2.75 b
Mean	0.00 d	1.83 c	3.28 b	6.17 a	2.82

Effect of treatments on decay percentage of fruits:

Data from Table (2) for both seasons indicate that all fruits (treated and control)were intact and in a good sanitary condition till the end of 7 days at 13°C, but after transferring them to ambient conditions at 18°C for 4 days, decay appeared in a noticeable manner and Ethereal treated fruits had the biggest percentage of infected fruits, recording 7.83% and 6.46% at the first and second year, respectively followed by lemon oil treated fruits, while biological oils treated fruits had the lowest decay percentage with 4.16% at the first year and 4,3% at the second year. This finding may be explained by a slight antiseptic effect exerted by these essential oils; therefore treated fruits were in a relatively better condition compared with control fruits which recorded higher percentages of decay (6.8% and 6.5% in the first year and second year respectively). Fruits ripened by biological oils have entered slowly into this phase of senescence, in which fruits have a higher aptitude to be attacked by decay organisms, by contrast to Ethrel and lemon oil treated fruits with more softened flesh and a bigger content of soluble solids in the flesh that facilitate penetration of microbial agents. The obtained data are in harmony with the results of Gonzalez-Aguilar *et al.*, 2008 on mango, Elzayat and Allam, 2006 on peaches.

Effect of treatments on fruit firmness:

Results in Table (3) showed a clear and gradual drop in firmness of fruits in all treatments and control. Starting from a value of 226kg/cm^2, Ethrel treated fruits among all treatments, had softened in a rapid pace to reach by end of cold storage the value of 77kg/cm² in the first year and to record 63 kg/cm² after 4 days in 18°C. Meanwhile, control fruits had the lowest value by the end of ambient storage (50 kg/cm²). A disorderly trend was observed in the second year, but Ethrel and lemon oil treated fruits recorded the lowest firmness value by end of ambient storage (81 and 62 kg/cm², respectively), while biological oils treated fruits had the highest firmness value (105 kg/cm²). This possible slower effect in enhancing ripening may be due to the natural variability factor among fruits that caused a little conformity of the data with the expected pattern of normal results.

Table 2. Effect of ripening treatments on Decay fruit (%) of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	0.00	0.00	0.00	6.80	1.70 a
Ethrel	0.00	0.00	0.00	7.83	1.95 a
Lemon Oil	0.00	0.00	0.00	6.73	1.68 a
Natural Biological	0.00	0.00	0.00	4.16	1.04 b
Mean	0.00 b	0.00 b	0.00 b	6.38 a	1. 59

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	0.00	0.00	0.00	6.50	1.62 a
Ethrel	0.00	0.00	0.00	6.46	1.61 a
Lemon Oil	0.00	0.00	0.00	6.20	1.55 a
Natural Biological	0.00	0.00	0.00	4.30	1.07 b
Mean	0.00 b	0.00 b	0.00 b	5.80 a	1.45

Table 3. Effect of ripening treatments on fruit firmness as measured by texture of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	226.00	141.00	50.00	37.00	113.5 c
Ethrel	226.00	161.00	77.00	63.00	131.75 b
Lemon Oil	226.00	168.00	90.00	76.00	140.00 a
Natural Biological	226.00	175.00	105.00	57.00	140.75 a
Mean	226.00 a	161.25 b	77.25 c	61.50 d	131.50

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	307.00	214.00	102.00	94.00	179.25 c
Ethrel	307.00	227.00	127.00	81.00	185.50 b
Lemon Oil	307.00	230.00	134.00	62.00	183.25 b
Natural Biological	307.00	231.00	136.00	105.00	194.75 a
Mean	307.00 a	225.50 b	124.75 c	85.50 d	185.68

These results agree with those obtained by Shivashankara *et al.*, 2004 and Nunes *et al*., 2007 who reported that fruit firmness decreased significantly during storage regardless of the storage temperature or cultivar. Also, El-Oraby *et al*., 2009 found that Keitt mango firmness decreased as the storage period increased in all temperatures. In addition, fruit softening was related to low temperature of storage.

Total soluble solid percentage:-

Effect of treatments on total soluble solids content of fruits are represented by data in Table (4), which shows that total soluble solids increased gradually during storage to reach their highest values by the end of 4 days at 18 °C. In the first year all treated fruits with ripening agents had a T.S.S of 10.4% at start , reaching a range of values 13.9 -13.2% by the end of the experiments, while T.S.S values in the second year mounted up from an initial value of 11.4% to attain higher values with the range of 14.9 -15.3%. Ethrel treated fruits had the top value in first year with 13 .9% but lemon oil was higher in the second year (15.3%). Control fruits had a slower rate of metabolism and recorded a lower rule of T.S.S% in both seasons (12.7% in first year and 14.5% in second year). The experimented ripening materials proved to be effective in ripening stimulation as expressed by the conversion of high complex carbohydrates to sucrose, glucose and fructose in treated mango fruits. In the mean time, these results are clear evidence of the variability of total soluble solids content in fruits from one year to another. These results go in line with those obtained by Paddaa *et al.*, 2011.

Acidity percentage:

Effect of treatments on acidity evolution in fruits:

All fruits of mango had high acidity content at the beginning of the experiment (1.11% in the first year and 1.10%in the second year), Table (5). Acidity of fruits decreased slowly in cold storage to reach about 0.9% for all treated fruits including control, except for Ethrel treated fruits which having a value of 0.78% by the end of 7 days at 13°C in the first year. In the second year the same trend was clear as all treated fruits (except Ethrel) and control which recorded almost 1% of acidity by the end of cold storage, while Ethrel treated fruits recorded 0.85%. When transferring fruits to ambient conditions of 18°C for 4 days, acidity decreased rapidly to reach a range of 0.45% to 0.5% for all treated and control fruits in the first season but Ethrel treated fruits had the much lower value of 0.35%. In the second year Ethrel treated fruits recorded the lowest value of acidity (0.42% by end of the ambient storage followed by lemon oil treatment (0.43%).

Differences between treatments were not significant, but Ethrel proved to be more effective in lowering acidity during the maturation phase, followed by lemon oil treatment. These results are in accordance with those obtained by Kader and Mitcham, 2008 and Elzayat and Hassan, 2006 on peach and apricot.

Table 4. Effect of ripening treatments on T.S.S. % of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	10.43	9.90	11.63	12.73	11.17 a
Ethrel	10.43	10.80	10.80	13.90	11.49 a
Lemon Oil	10.43	10.46	11.86	13.50	11.56 a
Natural Biological	10.43	10.80	11.73	13.20	11.54 a
Mean	10.43 c	10.49 c	11.51 b	13.33 a	11.44

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	11.35	12.90	13.95	14.50	13.17 a
Ethrel	11.35	13.75	14.30	14.90	13.57 a
Lemon Oil	11.35	13.50	14.55	15.30	13.67 a
Natural Biological	11.35	13.30	14.10	15.00	13.43 b
Mean	11.35 c	13.36 b	14.22 a	14. 92 a	13.46

Table 5. Effect of ripening treatments on acidity (%) of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	1.11	1.20	0.90	0.45	0.91 a
Ethrel	1.11	0.90	0.78	0.35	0.78 a
Lemon Oil	1.11	1.13	0.90	0.46	0.90 a
Natural Biological	1.11	0.98	0.91	0.50	0.87 a
Mean	1.11 a	1.05 b	0.87 b	0.44 c	0.86 N.S

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	1.10	1.08	0.97	0.51	0.91 a
Ethrel	1.10	1.02	0.85	0.42	0.84 a
Lemon Oil	1.10	1.07	1.00	0.43	0.90 a
Natural Biological	1.10	1.01	1.00	0.55	0.91 a
Mean	1.10 a	1.04 a	0.95 a	0.47 b	0.89 N.S

Effect of treatments on the extent of surface color expansion of mango peel:

The effect on peel color here is represented by the number of these fruits with more than 33% of their peel surface having a yellow or reddish tint by the end of experiment. These numbers are transformed to percentages displayed in Table (6). It is clear in this Table that Ethrel treated fruits had the biggest color evolution ,recording a percentage of 72.13% by the end of cold storage and 98.3% by the end of ambient storage in the first year and 86.6% and96.6%for the same periods in the second year. Fruits treated with lemon oil and biological oil followed the same trend but in a relatively linear way than Ethrel, with values situated in the range of 80.6 - 85.3% by the end of the experiment in the first year and 81.6% in the second year. In both seasons control fruits had the least percentage of colored surface area fruits with 39.3% by the end of storage in the first year and 55% in the second year. These results proved a clear ripening stimulation of the materials used in the experiment to enhance maturation, while control fruits had not the same pace of evolution. These results are in total agreement with the results obtained by Paddaa *et al*. 2011, concerning the color development of mango.

Effect of treatments on organoleptic fruit quality:-

As indicated by Table (7), it is clear that at the beginning of the experiment, mango fruits taste was not acceptable, expressed by the value of 2.16 and 3.16 (in first and second year, respectively) but after cold storage at 13 °C, all treatments had higher values for taste, as more sugars are formed and acidity decreased and more flavor appeared. Ethrel caused the highest score of taste (7) in the first year and (7.5) in the second year, followed by both ripening treatments recording an average of 6.16% in the first year and 6.6% in the second year. By the end of ambient storage, both treatments of Ethrel and lemon oil had the highest scores of taste (7.8 and 8.2 respectively) in the first year and (8.16 and 7.53) in the second year. Control fruits had an acceptable taste but with the lowest notes of (6.4) in the first year and (6.5) in the second year. These results also sustained the previous recorded date and indicated a clear stimulating ripening effect for Ethrel followed by lemon oil and biological oils came in the third place, compared with control fruits which were less developed in their maturation progress. These results go in line with those obtained by the experiment of Appiah *et al*., 2011 on Keitt mango whichever showed that chips produced from fully ripe Keittt mango fruits had more acceptable sensory grade than half ripe and unripe mango fruits because fully ripe mango has the highest sugars percentage.

Conclusion: The application of biological ripening agents prepared from lemon oil and a mixture of essential oils (Lavender and orange oils) on mango fruit (Keitt) has proved its usefulness in enhancing ripening of these fruits in the same way as synthetic releasing agent (Ethrel) and gave encouraging results. These materials are safer and cheeper than Ethrel and experiments should be multiplies to bestow credibility on these biological

agents and to diffuse their use commercially.

Table 6. Effect of ripening treatments on fruits color change (%) of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	1.66	2.33	28.00	39.33	17.99 c
Ethrel	1.66	32.66	72.13	98.33	51.19 a
Lemon Oil	1.66	22.33	60.83	85.33	42.53 b
Natural Biological	1.66	29.33	61.18	80.66	43.20 b
Mean	1.66 d	21.91 c	55.53 b	75.91 a	38.75

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	6.00	23.33	43.33	55.00	31.91 d
Ethrel	6.00	42.33	86.60	96.66	57.89 a
Lemon Oil	6.00	36.66	61.66	81.66	46.49 b
Natural Biological	6.00	36.66	73.33	81.66	49.41 b
Mean	6.00 d	34.74 c	66.23 b	78.74 a	46.42

Table 7. Effect of ripening treatments on test (eating quality) of Kiett mangoes during cold storage period and shelf life (2009 and 2010 seasons).

2009

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	2.16	5.50	5.83	6.43	4.97 ab
Ethrel	2.16	6.46	7.00	7.83	5.86 a
Lemon Oil	2.16	5.66	6.16	8.16	5.53 a
Natural Biological	2.16	5.73	6.16	6.33	5.09 a
Mean	2.16 d	5.83 c	6.28 b	7.18 a	5.36

2010

Treatments	Zero	4 D / 13 °C	7 D / 13 °C	+4 D / 18 °C	Mean
Control	3.16	6.25	7.00	6.50	5.73 b
Ethrel	3.16	7.15	7.46	8.16	6.48 a
Lemon Oil	3.16	6.50	6.50	7.53	5.92 b
Natural Biological	3.16	5.02	6.66	7.66	5.62 b
Mean	3.16 c	6.23 b	6.90 b	7.47 a	5.93

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انضاج ثمار المانجو باستخدام مواد طبيعية

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الملخص العربى

أجري هذا البحث خلال موسمى ٢٠٠٩ – ٢٠١٠ بمعهد بحوث البساتين – قسم بحوث تداول الفاكهة قطفت ثمار مانجو صنف كيت فى مرحلة اكتمال النمو وبداية طور النضج من مزرعة خاصة بمنطقة القناطر الخيرية. وتم تنظيف الثمار واستبعاد المصاب منها وقسمت الثمار الى أربعة مجموعات بحيث تم تخصيص مجموعة لكل معاملة من المعاملات الآتية: معاملة بمادة الأيثريل وثانية بزيت الليمون وثالثة بمخلوط زيوت طيارة (لافندر وبرتقال) وبتركيز واحد لكل معاملة ٢٠٠ جزء/مليون، علاوة علي المقارنة. وضعت الثمار في كراتين كل كرتونة طبقة واحدة من ٥ كجم ثمار تقريبا وخزنت لمدة ٧ أيام علي ١٣°م ثم ٤ أيام علي ١٨°م وذلك لمحاكاة ظروف التسويق. ثم أخذ أربعة عينات طوال فترة التجربة لتقدير صفات جودة الصفات المتعلقة بإكتمال النضج مثل الفقد في الوزن ونسبة التالف وصلابة اللحم والمواد الصلبة الذائبة الكلية وتغير لون القشرة والحموضة ودرجة الجودة للأكل.

أوضحت النتائج أن الثمار المعاملة بزيت الليمون ومخلوط الزيوت الطيارة والإثيريل قد فقدت وزنا أكبر من ثمار المقارنة (٦.٧ – ٧.٣% للثمار المعاملة في مقابل ٦% للثمار في السنة الأولي ونتائج مماثلة في السنة الثانية). ونسبة الثمار المصابة بالأعفان كانت من ٦.٢ – ٧.٨% لكل الثمار المعاملة وغيرها فيما عدا ثمار الزيوت الطيارة التي كانت نسبة الإصابة فيها ٤.٢% السنة الأولي و ٤.٣٥ السنة الثانية وقد انخفضت صلابة الثمار بشكل عادي خلال الموسمين (من قيم البداية ٢٢٦كجم/سم٢ في السنة الأولي لتصل إلي متوسط قدره ٦١.٥كجم/سم٢ في نهاية التجربة ومن ٣٠٧كجم/سم٢ في بداية السنة الثانية لتصل ٨٥.٥ كجم/سم٢ في نهاية السنة الثانية) وهو ما يدل علي تأثير واضح لتشجيع النضج من طرف المواد المستخدمة للإنضاج وهو ما أشارت إليه كذلك نتائج المواد الصلبة الذائبة الكلية (من ١٠.٤% في بداية السنة الأولي إلي ١٣.٣% متوسط الثمار المعاملة بينما سجلت المقارنة ١٢.٧%) وكانت نتائج السنة الثانية شبيه بالأولي. أما النسبة

المئوية للثمار ذات التطور اللوني الملحوظة للقشرة فقد كانت ثمار الإيثريل هي الأولي (٩٨% – ٩٧%) للعام الأول والثاني علي التوالي ويليها الثمار المعاملة بزيت الليمون (٨٥% – ٨٢%) في مقابل (٣٩% و ٥٥%) لثمار المقارنة. أما الجودة الأكلية فكانت الثمار المعاملة ذات درجة ممتازة عالية في مقابل ثمار المقارنة الأقل جودة. أعطت نتائج المعاملة بزيت الليمون وخليط الزيوت الطبيعية نتائج مماثلة للمعاملة بالإيثريل عند استخدامها للحث علي نضج ثمار المانجو.