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POSSIBILITY OF DETERMINING MATURITY STAGES ACCORDING TO FLOAT/SINK PHENOMENON AND EFFECT OF ETHYLENE ABSORBENT ON EXTENDING STORAGE LIFE AND KEEPING QUALITY OF KEITT MANGO FRUITS

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ABSTRACT: *This study was conducted to determine maturity stages of Keitt mango fruits according to float/sink phenomenon (by putting fruits in water or 1,2, 2.5,5 % salt solution) and to evaluate the effect of ethylene absorbent (1 or 2 sachets, each one contains 2g. potassium permanganate/5kg fruit) on extending storage life at 18°C. Fruit quality characteristics; monitored by analyzing a* value of peel & pulp, TSS, total acidity percentage, stage of ripening and days to ripe at 13, 18°C & room temperature; proved that maturity degree can be assessed according to float/sink phenomenon. We suggest that mango fruits that floated in water can be considered as immature, fruits that sink in 2 % salt solution can be considered as optimum mature and fruits that sink in 5% salt can be considered as over mature. Results indicated that it was possible to store Keitt mango fruits for 3 weeks at 18°C with high quality. As to the length of storage period and fruit quality, fruits packed in boxes that contained 2 ethylene absorbent bags proved to be the best treatment during storage period, as firmness, colour development values l, a and b especially a* value and shelf life slowly decreased and T.S.S. accumulation slowly increased compared with untreated fruits.*

Keywords: *Maturity stage, float/sink phenomenon, storability, fruit quality characteristics, potassium permanganate and ethylene absorbent.*

INTRODUCTION

Mango is one of the most popular tropical fruits and is considered as one of the finest fruits in the world. Maturity at harvest is the key factor for quality and postharvest life. Determining the mature green stage for harvesting mango is a difficult task. There is no reliable way to know when mango fruits are ready for harvest. Many methods exist for determining the harvest time of mango that require a set of maturity-related physiological or quality attributes. Measures such as peel colour (Jha *et al.*, 2006; Sobeih and El-Helaly, 2002), titratable acidity (Dutta and Dhua, 2004; Lechaudel *et al.*, 2004) total soluble solids (Lechaudel and Joas, 2006) are used, but they are

destructive tests and have limited application. Non destructive methods can also determine maturity by using floatation technique (classifying degree of maturity according to float/sink test), where mangoes are immersed in a salt solution (especially 2%). Mango fruits that sink are considered as mature, while those that float are considered as immature (Amarakoon *et al.*, 1999 and Roy & Joshi, 1989). Amarakoon *et al.* (1999) reported that although mature mango fruits of Willard and Velleicolomban passed the float test, Karuthacolomban did not respond consistently. However, Medlicott (2001) noted that float/sink test would need to be checked as varieties behave differently. He also added that some immature fruit sink.

The plant hormone ethylene (C2H4) played a major role in the ripening process of climacteric fruits. Ethylene levels at harvest influenced the magnitude of the climacteric curve, and therefore the final product quality (Lalel *et al.*, 2003). While ethylene gas is used under controlled conditions as a ripening agent, even small amounts of ethylene gas during shipping and storage caused most fresh produce to deteriorate faster. Ethylene gas and its removal were both important in giving the consumer the best possible product. One of the simplest ways to remove ethylene from the atmosphere was to absorb and oxidize it with potassium permanganate to produce CO_2 and H_2O.

Delaying mango fruit ripening, reduction of weight loss and storage disorders, the complete control of decay incidence for up to 21 days and keeping fruit firmness were all achieved by using potassium permanganate (Briceno *et al.*, 1999; Castro *et al.*, 2005; Wavhal & Athale, 1989 and Yuniarti & Suhardi, 1992).

The aim of this experiment is to determine the relationship between float/sink phenomenon and maturity stage of Keitt mango fruits, as well as to extend storability of Keitt mango fruits by using ethylene absorbent.

MATERIALS AND METHODS

Keitt mango fruits were harvested (from Giza region – private farm) at various physiological maturities in the last week of September 2004 and 2005 years.

Fruits were divided into two experiments.

Experiment 1

The aim of this experiment was to determine the relationship between float/sink phenomenon and maturity stage of Keitt mango fruits. Fruits were washed, weighed individually, immersed in water, 1, 2 , 2.5 or 5% salt solution in a beaker, then subjected to float/sink test as follows:

Group 1- Fruits sinking in 5% salt.

Group 2- Fruits sinking in 2.5 % salt solution but floating in 5% salt solution.

Group 3-Fruits sinking in 2 % salt solution but floating in 5 % salt solution (except group 2).

Group 4-Fruits sinking in 1 % salt solution but floating in 5 % salt solution (except group 2, 3).
Group 5- Fruits floated in water .
Each group contained 15 fruits (replicated 3 times). Maturity of mango was defined in terms of maturity index (peel & pulp colour measurement, titratable acidity, total soluble solids, stage of ripening at harvest and days to ripe) at 13, 18°C or at room temp.

Fruit maturity characteristics were measured as follows:

Peel & pulp colour measurement (L, a & b values): was determined by using a Hunter colorimeter type (DP-9000) for the estimation of L, a, b values, (a* (green-red) and b* (blue-yellow) values).
The instrument was calibrated with white and black standards.

Titratable acidity %: Titratable acidity 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).

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

Stage of ripening at harvest: According to Miller *et al*, (1991) stage of ripening was subjectively rated on a scale of 1 to 5, where 5 = overripe [very soft, very slight resistance to moderately applied finger pressure (MAFP)], 4 = soft-ripe (eating stage, slight resistance to MAFP), 3 = partially ripe, fairly soft (moderate yield to MAFP), 2 = fairly inedible, fairly hard (slight yield to MAFP), and 1 = inedible, hard (no yield to MAFP).

Days to Ripe: were considered when fruits reached score 3 of ripening stages (partially ripe, fairly soft - moderate yield to MAFP)

Experiment 2

Mature Keitt mango fruits were harvested (from Giza region – private farm), packed in carton boxes, where each box contained a single layer(approx. 5Kg). Then, fruits were divided into three treatments, each treatment had 3 replicates and each replicate contained 9 carton boxes. The first treatment had one sachet of ethylene absorbent containing 2g. of potassium permanganate (sachets permeable to gases and impermeable to vapor). The second treatment had two sachets, while the third treatment had no sachets. Characteristics, storability and ripening behaviour were being determined during three weeks at 18°C.
Ripening was monitored by analyzing fruit parameters as follows:

Physical Properties:

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 was measured at regular intervals on two peeled fruits, using fruit pressure tester (mod. FT 327, Italy), having a probe of 0.79 cm. width. Fruit firmness was recorded in Kg/cm^2.
Peel & pulp colour measurement, titratable acidity and total soluble solids were determined as mentioned before (Experiment 1)

Shelf life: A sample of 10 fruits of each replicate was taken out of storage after 1, 2 or 3 weeks and left at room temperature (23-25°C). When 50% of fruits were unmarketable, the experiment was terminated and the number of days was calculated and considered as shelf-life.

Statistical analysis:

The obtained data were statistically analyzed using excel micro software (one factor randomized complete block design) according to Snedecor and Cohran (1990) and the L.S.D. test at 5% was applied to compare degrees of maturity (experiment 1) and ethylene absorbent treatments (experiment 2).

RESULTS

Experiment 1

The relationship between float/sink phenomenon and maturity stage of Keitt mango fruits is presented in tables (1 & 2). Data reflected that float/sink cases depicted similar maturity levels, which were supported by results of a* values, total acidity, total soluble solids percentage, stage of ripening and days to ripe.

Peel & pulp colour Development (L, a, b Values):

L* Values: Data in table (1) indicated that L* values of peel or pulp colour proved to be an unreliable guide for estimating the differences between maturity stages determined by float/sink phenomenon because of values' fluctuation.

a* Values : There was also a noticeable increase of a* value of peel that is correlated with the progress of maturity stages (manifested through the decrease of negative values), as the highest negative values (-12.6, -12.7) were recorded by group 5 (fruits floated in water), while group 1 (fruits sank in 5% salt) was the only group that recorded positive value (1.3). Hence, group 1 (fruits sank in 5% salt) could be classified as partially ripe. The same trend was observed with a* pulp values, but values were positive, where group 3 (fruits sank in 2 % salt solution but floated in 5 % salt solution, except group 2) and group 5 (fruits sank in 5% salt) recorded 3 – 4 times more than group 5 (fruits floated in water) respectively. All a* values of peel and pulp were significant. Accordingly, a* value could be used as a reliable indicator for maturity development of Keitt mango fruits.

Table (1): Characteristics of Keitt Mango Fruits in Relation to Degrees of Maturity According to Floating/Sinking Phenomenon in 2004 Season.

Characteristics / Treatments	Peel Colour			Pulp Colour			Acidity %	T.S.S %	Stage of Ripening	Days to Ripe		
	l	a	b	l	a	b				at 13°C	at 18°C	Room Temp.
T1	49.8^{ab}	1.3^{a}	18.2^{a}	67.0^{a}	9.8^{a}	58.1a	0.73^{c}	14.0^{a}	2.8^{a}	3.7^{d}	2.0^{e}	1.7^{d}
T2	51.2^{a}	- 4.2^{b}	16.8^{b}	67.7^{a}	5.7^{b}	57.3a	0.93^{bc}	11.1^{b}	2.3^{a}	16.0^{c}	9.0^{d}	4.3^{c}
T3	49.2^{ab}	- 6.2^{b}	15.0^{c}	66.7^{a}	3.8^{bc}	56.6a	1.10^{b}	10.2^{bc}	1.3^{b}	21.7^{b}	14.3^{c}	6.0^{c}
T4	49.0ab	- 8.8^{c}	13.3^{d}	67.2^{a}	2.24^{c}	58.2a	1.27^{b}	9.2^{cd}	1.0^{b}	24.0^{b}	18.0^{b}	8.7^{b}
T5	47.05b	- 12.6^{d}	12.9^{d}	66.2^{a}	1.75^{c}	57.3a	2.24^{a}	8.3^{d}	1.0^{b}	29.7^{a}	21.0^{a}	16.0^{a}

Treatment 1: fruits sinking in 5% salt, treatment 2: fruits sinking in 2.5 % salt solution but floating in 5% salt solution, treatment 3: fruits sinking in 2 % salt solution but floating in 5 % salt solution (except group 2), treatment 4: fruits sinking in 1 % salt solution but floating in 5 % salt solution (except group 2, 3) and treatment 5: fruits floated in water .
Values followed by the same letters within the column are not significantly different at $P<0.05$.

Table (2): Characteristics of Keitt Mango Fruits in Relation to Degrees of Maturity According to Floating/Sinking Phenomenon in 2005 Season

Characteristics / Treatments	Peel Colour			Pulp Colour			Acidity %	T.S.S %	Stage of Ripening	Days to Ripe		
	l	a	b	l	a	b				at 13°C	at 18°C	Room Temp.
T1	67.0^{a}	1.3^{a}	48.0^{a}	63.0^{a}	10.3^{a}	46.5^{d}	0.64b	15.3^{a}	2.7^{a}	3.3^{d}	2.3^{e}	2.0^{e}
T2	67.7^{a}	- 4.2^{b}	49.8^{a}	57.0^{b}	4.1^{b}	44.7^{c}	0.93b	11.4^{b}	2.3^{ab}	13.7^{c}	9.3^{d}	4.7^{d}
T3	66.7^{a}	- 6.2^{b}	47.9^{a}	58.7^{bc}	3.0^{bc}	44.0^{b}	1.57ab	9.9^{bc}	1.7^{bc}	20.7^{b}	15.0^{c}	6.7^{c}
T4	67.2^{a}	- 8.8^{c}	47.9^{a}	60.0^{cd}	2.1^{c}	42.7^{ab}	1.35b	8.7^{cd}	1.0^{c}	22.3^{b}	18.7^{b}	9.7^{b}
T5	66.2^{a}	- 12.7^{d}	49.8^{a}	59.7^{d}	1.6^{c}	40.3^{a}	2.45a	7.0^{d}	1.0^{c}	28.7^{a}	22.7^{a}	17.0^{a}

Treatment 1: fruits sinking in 5% salt, treatment 2: fruits sinking in 2.5 % salt solution but floating in 5% salt solution, treatment 3: fruits sinking in 2 % salt solution but floating in 5 % salt solution (except group 2), treatment 4: fruits sinking in 1 % salt solution but floating in 5 % salt solution (except group 2, 3) and treatment 5: fruits floated in water . Values followed by the same letters within the column are not significantly different at $P<0.05$.

b* values : Tabulated data (tables 1 & 2) indicated that yellow colour increased according to maturity stage. In other words, most of peel and pulp b* values increased starting from group 5 to 1 group, i.e. characteristics increased according to float/sink phenomenon.

These results agreed with those obtained by Sobeih and El-Helaly (2002), who explained that mature Alphonso mango fruits still had negative a* values, while positive values increased with the progress of ripening process. They also added that there was correlation between the enhancement of fruit colour development and maturity advance.

Jha *et al.* (2006) reported that yellowness of mango fruits increased during both growth and storage. They also stated that maturity of mango could be predicted by measuring size and colour.

Total Acidity Percentage:

Data in tables (1 & 2) showed that total acidity decline went along with maturation advance assessed according to float/sink phenomenon, where the least percentage was attained by Group 1 fruits (0.64-0.73%). On the other hand, the highest percentage significant was attained by Group 5 fruits (2.24-2.45%). Because of the great variation, this characteristic could be used as a sign for maturity stage.

In general, results relevant to the effect of maturity degree (assessed according to float/sink phenomenon) on fruit acidity percentage go in line with those reviewed by Dutta and Dhua (2004), who reported that a gradual increase in total soluble solids was observed, while acidity declined with the advance of maturity. Similar results were obtained by Lechaudel *et al.* (2004), who pointed out that acidity decreased as the fruit developed.

Total Soluble Solids Percentage:

It is clear from tables (1 & 2) that accumulated TSS % rose and widely varied with the stages of maturity assessed according to float/sink phenomenon. Data showed that T.S.S. concentration in group 1 (14.0, 15.3%) was significantly higher than the other treatments in both seasons, followed by group 2 (11.1, 11.4%), then group 3 (10.2, 9.9%). On the other hand, the least accumulation of T.S.S. was recorded by group 5 fruits (8.3, 7.0%). Similar results were reviewed by Kudachikar *et al.* (2001), who pointed out that the levels of total soluble solids (TSS) increased gradually with maturity up to 120 days after fruit set.

Due to the great variation, this characteristic could be used as an indicator for evaluating the effect of maturity stage assessed according to float/sink phenomenon. These results were also confirmed by Lechaudel and Joas (2006), who reported that total soluble solids could be used as physiological indices for Cogshall mango fruit.

Stage of Ripening

Tables (1&2) clearly indicated that determining the degree of maturity according to float/sink phenomenon by studying both stage of ripening at harvest and days to ripe characteristics proved to be the easiest and most explicit method, especially that differences were significant. Data showed that groups 4 & 5 did not exceed ripening stage no. 1 (inedible, hard; no yield to MAFP) in both seasons, while the ripening stage of group 3 ranged between 1.3-1.7 and group 1 recorded 2.8–2.7, i.e. group 1 was close to stage 3 (partially ripe, fairly soft).

Days to Ripe:

Tables (1&2) clearly indicated that determining the degree of maturity according to float/sink phenomenon by this characteristic (days to ripe) proved to be the easiest and most obvious method.

At 13°C: days to ripe were 3.7- 3.3 days, recorded by group 1 (over mature fruits, partially ripe), and they were not less than 20.7- 21.7 days, recorded by group 3 (optimum mature fruits).

At 18°C: days to ripe were 2.0- 2.3 days, recorded by group 1 (over mature fruits, partially ripe), and they were not less than 14.3- 15.0 days, recorded by group 3 (optimum mature fruits).

Generally, at room temperature days to ripe were 1. 7- 2.0 days, recorded by group 1 (over mature fruits, partially ripe), and they did not surpass 6- 6.7 days, recorded by group 3 (optimum mature fruits). Immature fruits (group 5) recorded 16-17 days to ripe.

These results confirmed previous results obtained by Seymour *et al.* (1990), who pointed out that ripening was retarded more effectively in immature than in mature mango fruit. However, Medlicott *et al.* (1990) stated that immature Keitt mango fruits failed to develop full ripeness characteristics, while mature and half-mature fruits underwent limited ripening during storage at 12 degrees, the extent of which increased with progressive harvests during the season. They also reported that ripening changes during storage for 21 days were less at 8 and 10 degrees than at 12 degrees.

Having studied peel & pulp colour measurement, titratable acidity, total soluble solids, stage of ripening and days to ripe characteristics, which had significant differences between treatments, we suggested that maturity degree could be assessed according to float/sink phenomenon as follows:

Group 5 (fruits floated in water) could be considered immature mango fruits, Group 4 (fruits sank in 1 % salt solution but floated in 5 % salt solution, except group 2, 3) as just mature, Group 3 (fruits sank in 2 % salt solution, but floated in 5 % salt solution, except group 2) as optimum mature, Group 2 (fruits sank in 2.5 % salt solution, but floated in 5% salt solution) as advanced mature and Group 1 (fruits sank in 5% salt) as over mature fruits, partially ripe.

Experiment 2

Physical Properties:

Weight loss percentage:

Results presented indicated that a gradual increase of weight loss associated with the longevity of storage period (tables 3 & 4). After three weeks storage, the highest percentage (12.9%) was recorded by control fruits (no sachet with fruits), while the least percentage (5.8%) was recorded by two sachet ethylene absorbent fruits. This might be due to the fact that ethylene absorbent delayed ripening, so respiration and weight loss were much more less than in untreated fruits.

This result was in line with that of Munishamanna (2002) and Dhemre & Waskar (2004), who stated that the rate of physiological weight loss (PWL) and rotting percentage increased as storage period extended.

Chattopadhyay (1989) noted that physiological weight loss was minimum in mango fruits treated with potassium permanganate.

Firmness:

During three weeks of cold storage a gradual decrease occurred in firmness (table 3 & 4). After 3 weeks untreated fruits reached 1.4 Kg/cm^2, one sachet treated fruits reached 2.3 Kg/cm^2 and two sachet fruits reached 2.5 Kg/cm^2. This finding might be related to the efficiency of ethylene absorbent for delaying repining. Concerning the effect of 2-sachets ethylene absorbent with fruits, it was found that the percentage of firmness was significantly higher than other treatments.

These results confirmed those of Ashwani & Dhawan (1995), who stated that fruit firmness and total acidity decreased with increasing storage duration. Results also go in line with those attained by Wen *et al.* (2006), who found that pulp firmness decreased dramatically at 6 days after harvest.

Peel colour development (L, a, b Values):

Tabulated data (3 & 4) showed that L* value (Lightness) & b* value (blue-yellow) slightly increased towards the end of the storage period, but there was some fluctuation. No significant differences were observed between treatments in either l or b values during different storage periods.

Thus, we can not depend on this character as an indicator for evaluating storage period behaviour of fruits

At the same time, a gradual and obvious increase of a* value (green-red) accompanied the progress of storage period (manifested through the decrease of negative values), as the highest negative value (-4.3) was attained by two sachet ethylene absorbent in fruits after two weeks, while no sachet fruits attained a positive value (2.2). In most case a* values of two sachet ethylene absorbent fruits were the least significant values of all treatments. This finding indicated that ethylene absorbent treated fruits had

Table (3): Effect of Ethylene Absorbent on Storability and Ripening Behaviour of Keitt Mango Fruits Stored at 18°C for 3 Weeks in 2004 Season

Characteristics / Treatments		Weight loss %	Firmness Kg/cm²	Peel Colour			Pulp Colour			Acidity %	T.S.S %	Shelf Life Per Day
				l	a	b	l	a	b			
Initial		0.0	15.0	49.1	-6.2	15.0	66.7	3.8	56.6	1.10	10.2	12.0
1 week	T1	3.3^{ab}	10.3^{b}	44.1^{a}	- 5.92^{a}	13.5^{a}	77.7^{a}	4.4^{c}	53.7^{a}	1.00^{a}	13.0^{a}	7.0^{a}
	T2	2.0^{b}	12.3^{a}	47.7^{a}	- 5.77^{a}	19.0^{a}	73.6^{a}	6.8$^{a\,b}$	58.7^{a}	1.00^{a}	12.9^{a}	7.0^{a}
	T3	6.8^{a}	9.9^{b}	35.7^{a}	- 5.6^{a}	16.1^{a}	44.7^{a}	7.8^{a}	59.7^{a}	1.00^{a}	13.8^{a}	7.0^{a}
2 weeks	T1	5.8^{b}	8.7^{a}	49.2^{a}	- 4.0^{b}	19.7^{a}	73.6^{a}	8.7^{b}	58.1^{a}	0.93^{a}	16.1^{ab}	5.0$^{a}_{b}$
	T2	4.4^{b}	9.0^{a}	47.8^{a}	- 4.3^{b}	18.1^{a}	77.7^{a}	7.8^{b}	60.0^{a}	0.93^{a}	15.2^{b}	6.0^{a}
	T3	10.6^{a}	6.8^{b}	46.0^{a}	2.2^{a}	16.1^{a}	69.7^{a}	12.7^{a}	60.0^{a}	0.86^{a}	17.6^{a}	4.0^{b}
3 weeks	T1	7.8^{ab}	2.3^{a}	48.0^{a}	6.3^{b}	21.0^{a}	68.0^{a}	9.9^{b}	59.7^{a}	0.68^{a}	18.1^{a}	4.0^{ab}
	T2	5.8^{b}	2.5^{a}	50.7^{a}	4.4^{b}	20.5^{a}	69.7^{a}	8.7^{b}	60.7^{a}	0.72^{a}	17.6^{a}	5.0^{a}
	T3	12.9^{a}	1.4^{b}	46.9^{a}	9.8^{a}	16.1^{a}	69.7^{a}	11.8^{a}	58.7^{a}	0.51^{b}	19.6^{a}	2.0^{b}

Treatment 1: treated with one sachet ethylene absorbent, treatment 2: treated with 2 sachets and treatment 3: control fruits.

Values followed by the same letters within the column are not significantly different at $P<0.05$.

Table (4): Effect of Ethylene Absorbent on Storability and Ripening Behaviour of Keitt Mango Fruits Stored at 18°C for 3 Weeks in 2005 Season

Characteristics / Treatments		Weight loss %	FirmnessKg/cm²	Peel Colour			Pulp Colour			Acidity %	TSS %	Shelf Life Per Day
				l	a	b	l	a	b			
Initial		0.0	15.0	47.9	-9.8	20.2	58.7	3.0	44.0	1.57	9.8	14.0
1 week	T1	3.0^{a}	12.3^{b}	48.9^{a}	- 9.0^{a}	22.8^{a}	57.3^{a}	4.4^{b}	45.5^{a}	1.23^{a}	10.3^{b}	7.0^{a}
	T2	2.3^{a}	13.9^{a}	49.03^{a}	- 9.5^{a}	21.3^{a}	58.1^{a}	3.8^{c}	44.6^{a}	1.23^{a}	9.9^{b}	7.0^{a}
	T3	3.3^{a}	10.6^{c}	49.1^{a}	- 7.2^{a}	21.4^{a}	64.3^{a}	6.1^{a}	45.9^{a}	0.78^{b}	13.6^{a}	7.0^{a}
2 weeks	T1	6.1^{b}	11.4^{b}	50.6^{a}	- 4.0^{b}	19.8^{a}	66.7^{a}	6.3^{b}	46.3^{a}	0.74^{a}	11.1^{b}	6.0^{a}
	T2	4.4^{c}	13.6^{a}	50.2^{a}	- 8.8^{c}	20.4^{a}	63.0^{a}	5.6^{b}	44.3^{a}	0.78^{a}	10.3^{b}	6.0^{a}
	T3	9.8^{a}	4.4^{c}	49.4^{a}	3.8^{a}	22.4^{a}	60.0^{a}	10.3^{a}	46.7^{a}	0.51^{b}	15.2^{a}	5.0^{b}
3 weeks	T1	7.8^{bc}	2.3^{b}	52.5^{a}	7.8^{ab}	22.6^{a}	60.7^{a}	9.8^{b}	44.3^{a}	0.42^{ab}	16.1^{b}	4.0^{b}
	T2	6.3^{c}	3.0^{a}	51.4^{a}	5.6^{b}	21.6^{a}	63.3^{a}	7.8^{b}	46.0^{a}	0.56^{a}	15.1^{b}	5.0^{a}
	T3	11.2^{a}	1.8^{c}	45.9^{b}	9.9^{a}	22.1^{a}	66.0^{a}	13.3^{a}	46.9^{a}	0.30^{b}	19.7^{a}	3.0^{c}

Treatment 1: treated with one sachet ethylene absorbent, treatment 2: treated with 2 sachets and treatment 3: control fruits.

Values followed by the same letters within the column are not significantly different at $P<0.05$.

a slight development of colouration and ripening compared to untreated fruits. Thus, a* value can be used as a reliable indicator for ripening progress of Keitt mango fruits.

pulp colour development (L, a & b values):

The same trend of peel colour development (L, a & b values) was observed, but the a* value which is considered as a reliable indicator for ripening progress of Keitt mango fruits had positive values that increased from the beginning till the end of the experiment. These results were confirmed by Oosthuyse(1994), who reported that peel and pulp colouration increased during storage.

Chemical Properties:

Total acidity percentage:

It is clear from table (2) that titratable acidity of Keitt mango fruits in all treatments declined gradually towards the end of storage period. Titratable acidity of two-sachet fruits decreased from 1.1 % at harvest time to 0.7% after 3 weeks of storage, while one sachet fruits recorded 0.68 % . At the same time, total acidity of no- sachet fruits recorded more decrease as it reached 0.51%. Value variation between the treatments may be due to the increase of exchanges of respiration in fruits of advanced degree of ripening. In this connection Kumar *et al.* (1995) pointed out that total acidity of mango fruits decreased with the increase of storage duration. These results also go in line with those reviewed by Kahlon and Uppal (2005), who pointed out that acidity levels of the fruits decreased throughout the storage period.

Total Soluble Solids Percentage:

It is well known that fruits with slight T.S.S. accumulation have high storability than those with high T.S.S.

It is obvious that two sachets ethylene absorbent - Keitt mango fruits recorded the least values of T.S.S. as compared with other treatments during all storage period (15.1-17.6 % at the end of storage period). On the contrary, the highest values were attained by no sachets fruits (19.6-19.7 % at the end of storage period). Tabulated data indicated that the accumulation of TSS percentage increased towards the end of storage period for all treatments. Due to the great variation, this characteristic could be used as an indicator for the effect of treatment efficiency (under this study).

In this connection, obtained results agreed with those observed by Tandon and Kalra (1997) and Dhaka *et al* (2001), who stated that total soluble solid content (TSS) increased during storage and a rapid increase in TSS occurred during the ripening process.

Shelf life:

At the end of storage period, shelf life per day was 1.3-2.0 fold in one-sachet ethylene absorbent fruits and two-sachet fruits respectively, compared with control fruits, which indicated success of the experiment.

Regarding the effect of potassium permenganate, results obtained were similar to those mentioned by Illeperuma and Jayasuriya (2002), who reported that potassium permanganate could be recommended to increase storage life of 'Karuthacolomban' mango at 13°C.

Thus, we can conclude that storing Keitt mango fruits for 3 weeks with high quality in all treatments was possible. As to length of storage period and fruit quality, fruits packed with 2 ethylene absorbent bags proved to be the best treatment during shelf life period.

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إمكانية تحديد اكتمال النمو تبعا لظاهرة الطفو والغطس فى الماء وتأثير ماص الإيثيلين على إطالة فترة تخزين ثمار مانجو الكيت والاحتفاظ بجودتها

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الملخص العربى

أجريت هذه الدراسة لتحديد مراحل نمو ثمار المانجو صنف الكيت تبعا لظاهرة الطفو والغطس فى الماء (حيث يتم وضع الثمار فى الماء أو محلول ملح يتراوح تركيزه بين ١ ، ٢ ، ٢,٥ ، ٥%). كما استهدفت الدراسة أيضا تقييم تأثير ماص الإيثيلين على إطالة فترة التخزين على درجة حرارة ١٨ درجة مئوية (على الثمار المعبأة داخل كيس أو كيسين يحتوى كل منها على ٢ جرام من برمنجانات البوتاسيوم/٥ كيلو جرامات من الثمار). يمكن تحديد درجة اكتمال النضج تبعا لظاهرة الطفو والغطس وذلك من خلال دراسة صفات الجودة التى تم تقييمها عن طريق تحليل قيمة a* لكل من اللب ، والقشرة ، والمواد الصلبة الذائبة الكلية ، ونسبة الحموضة الكلية ، ودرجة النضج ، وعدد الأيام التى تصل فيها الثمار المخزنة على درجة حرارة ١٣ أو ١٨ درجة مئوية أو درجة حرارة الغرفة العادية إلى النضج الطبيعى. يمكن اعتبار الثمار التى طفت فى الماء ثمارا غير مكتملة النمو ، والثمار التى غطست فى محلول ملح تركيزه ٢% هى الثمار التى وصلت إلى الدرجة المثلى لاكتمال النمو ، أما الثمار التى غطست فى محلول ملح تركيزه ٥% فهى الثمار التى تخطت مرحلة اكتمال النضج.

ويتضح من النتائج أنه من الممكن تخزين ثمار مانجو كيت بجودة عالية لمدة ٣ أسابيع على درجة حرارة ١٨ درجة مئوية . فيما يتعلق بكل من طول فترة التخزين وجودة الثمار ، ثبت أن الثمار المعبأة داخل صناديق تحتوى على كيسين من ماص الإيثيلين هى أفضل الثمار أثناء التخزين حيث انخفضت ببطء الصلابة وقيم L, a & b الخاصة بتطور اللون خاصة قيم a* ، والعمر التخزينى ، وتراكمت المواد الصلبة الذائبة أيضا ببطء ، وذلك بالمقارنة إلى الثمار غير المعاملة.