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Effect of Postharvest Treatments on Quality Aspect of Maghrabi Banana Fruit

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Abstract: The effect of postharvest treatments with ethrel or with hot water, ethanol, acetaldehyde, mandarin volatile oil, ascorbic acid, calcium chloride, potassium permanganate or sodium benzoate on enhancing or delaying of the ripening and quality aspect of mature Maghrabi banana fruit were investigated. Untreated and treated banana fruit had a normal ripening process and similar good freshness at the ripening time. This demonstrate that the used materials were relatively more effective in delaying ripening and as, can be arrange the appearance of banana fruit in the market and may open up more distant markets with good quality. Such, color development of peel, easy peeling condition, loss of firmness and increase of pulp/peel ratio and total soluble solids/titratable acidity ratio were used as a good criterion of evaluating the ripening.

Key words: Banana ripening · Ethrel · Hot water · Volatile compounds · Ethylene absorbent ($KMnO_4$) · Preservatives · Antioxidant

INTRODUCTION

Banana fruit offers a different marketing problem from that of most other fruits, because ripe bananas are a perishable commodity and, even when ripped in the best possible manner, they still require prompt distribution to retailers and consumers. Banana must be uniformly ripened and colored to gain acceptance by the user and these two processes occur simultaneously. Commercial the ripening of banana fruits may be coordinated by the application of ethylene. For the meantime, banana treated with ethylene reached the normal table ripe stage (in terms of peel color) about 2 days after treatment (7-9 days earlier than controls without ethylene treatment) [1]. In some instances, it is desirable to maintain the fruits in the unripe state to regulate their marketing life, such, some treatments currently use to prevent decay or to preserve texture and color, can compromise aroma quality. Hot water has often been evaluated as a means for quarantine purposes of banana and to extend the commercial life of the fruit [2], to determining the most feasible method for optimum ripening, found that the maximum physiological loss in weight and ideal for uniform ripening were obtained with treatment of hot water piping at 55°C and ethephon (ethrel) at 50 up to 1000 ppm [3, 4].

Essential oils are typically volatile substances produced by many plant species, however, when it was absorbed into packing paper, used to protect fruits from water loss and pathogens[5], this was observed when use aqueous leaf extracts of some medicinal plants on banana fruits[6]. Acetaldehyde and ethanol are two products of anaerobic respiration in fruits, they accumulate during ripening, contributing to fruit aroma and are capable of retarding senescence and inhibiting ethylene production in plants [7]. Such, using externally these volatiles compounds had pronounced effect on the banana ripening delay [8].

Ascorbic acid (Vit.C) induce many stimulating effects of some physiological activities, i.e. stimulation of lipase, catalase and peroxides isoenzymes, also, it revealed an effect on the metabolism of GA [9]. Fruit ripening at room temperature was accelerated by calcium chloride and slowed by ascorbic acid [10]. Whence, banana was treated with ascorbic acid had the higher firmness [11].Calcium generally seen as protective in reducing the rate of plant senescence and fruit ripening [12].

Potassium permanganate is a stable purple solid that is a strong oxidizing agent and readily oxidizes ethylene [13]. Application of $KMnO_4$ as an ethylene absorbent, delayed ripening, proved most effective in reducing rot and maintained the physical appearance and quality of fruit in fresh condition [14].

Organic acids have been extensively used on foods for years and are classified as generally regarded as safe (GRAS), some acids such as benzoic acid is used in food mainly for their fungi static effect also, influenced the biochemistry of the fruits [11].

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These materials play an integrated role in many of the biochemical changes that occur during the ripening such as, moisture, ash [15], sugar [16] and color and texture [17].

The purpose of this work was to investigate the response of banana to control ripening with some safe treatments to maintain ideal eating quality of Maghrabi banana fruit.

MATERIALS AND METHODS

Fruit Material: Mature banana bunches at commercial maturity (full three quarters) were picked during the winter of 2006-2007 and 2007-2008 seasons from well grown, uniform plants of *Musa sp.*AAA type, cv.Maghrabi which were grown in a private orchard in Oseim, Giza, Governorate, Egypt. Those were shooting at the second half of September of every season. Bunches were left after harvest in a ripening hall for one day as a wilting period, then were dehanded; 2-3-4 hands were selected from one bunch to avoid differences in physiological development. Hands were washed, drained and randomized to the following treatments. Treatments were replicated three, each replicate consisted of three hands. The treatments as follows:

Treatment No	Matter	Application methods
1	Untreated	--
2,3	# Ethrel, hot water*	Submerged in 500 ppm concentration for 3 minutes#, immersed at 45 °C for 10 minutes*
4,5	Ethanol, acetaldehyde**	Exposed to vapour in 0.5 ml concentration for 2 hours**
6,7.8,9,10	Mandarin Volatile Oil (MVO), ascorbic acid , calcium chloride , potassium permanganate, sodium benzoate	Wipe on stalk and fingers of hand by saturated cotton wiper with the solution of any matter at 0.5% concentration especially MVO at 0.05%

2Dichloro phosphonic acid

* Done by using a water bath "stainless steel" holding 20L of water, temperature of banana was monitored with a temperature measurement, followed by dipping in ambient temperature water to finish the treatment effect.

** Done by using 20 litres air-tight glass jars with blaster band, also using a rate of 4 ml ethanol or acetaldehyde /kg fruits added to a 3 litre sealed container jars as noted by Hewage *et al.* [18]. To facilitate ethanol or acetaldehyde vaporation, reagent grade ethanol or acetaldehyde were pipetted into a folded 9 cm diameter filter paper positioned on a Petri plate inside each jars according to Ritenour *et al.* [19] then the jars were opened and ventilated.

At the end of the treatments, all hands were allowed to dry and transferred to standard cartons boxes and stored at ambient conditions (i.e. room temperature, 18±2°C, relative humidity, 70±5%) until the natural ripening (when the fingers reached color between 5-7 degree) Von Loesecke [20]. Properties of Maghrabi banana fingers at maturity were: color degree 1 and 1,peeling condition 1 and 1, pulp/peel ratio 1.2 and 1.1, firmness (lb/inch^2) 24 and 24.7, total soluble solids (TSS%) 2.5 and 3.0, titratable acidity (TA%) 0.241 and 0.261 and TSS/TA ratio 10.37 and 11.49 in the first and second seasons, respectively.

Fruit Quality Determinations at the Ripe Stage

Ripening Period: Was recorded (in day) of all treatments.

Weight Loss: Was calculated by difference between the initial weight and that recorded at ripe.

Pulp Color: Was recorded using the standard color scale of Von Loesecke [20] and closely examined as 1: Green, 2: Green with trace of yellow, 3: More green than yellow, 4: More yellow than green, 5: Green tip, 6: All yellow and 7: Yellow flecked with light brown.

Peeling Condition: Was scored as follows 1: unpeeling, 2: hard peeling, 3: peeling, 4: easy peeling.

Pulp/peel Ratio: Was calculated by dividing the weight of pulp by the weight of peel.

Firmness: Was measured on unpeeld fingers using pressure tester (Magness and Taylor) and recordered in Lb/inch^2.

Fruit Freshness: Was measured by a rating system and fruit as scored as poor = 1, unacceptable = 3, acceptable = 5, good = 7 and very good = 9.

Total Soluble Solids: (TSS) in juice by Azeiss hand refractometer.

Titratable Acidity: (TA) in juice was calculated as percentage of malic acid fresh weight according to AOAC [21].

TSS /TA Ratio: was calculated from the obtained data.

Dry Matter: was determined according to the method of AOAC [21].

Statistical Analysis: The statistical analysis of the obtained data was carried out according to Snedecor and Cochran [22].

RESULTS AND DISCUSSION

Effect of postharvest treatments on some quality aspect of Maghrabi banana fruit have been investigated at the ripening time as shown in Table 1. Fruit were treated with ethrel followed with those untreated took lower time to ripen in the two seasons while those were treated with hot water in the first season or treated with sodium benzoate or ascorbic acid in the two seasons took longer to ripe. The results demonstrated that used materials (postharvest treatments) were relatively more effective in delaying ripening and such, can be arrange the appearance of banana fruit in the market. Such, peel colour changes in relation to pulp firmness and soluble solids content were highly correlated and proceeded simultaneously throughout ripening [23]. Postharvest materials have been used to cause different ripening rates of fruits and help ripening delay were supported by Abd El-Naby and Ahmed [8] with acetaldehyde, Ahmed and Abd El-Naby [24] with ethanol, Arumugam *et al.* [3] with hot water, Kamdee *et al.* [25] with heat treatment, Abd El-Naby and Soliman [26] with calcium chloride, Kesta *et al.* [27] with $KMnO_4$ and Neelam *et al.* [10] with ascorbic acid which, the consumer himself wants to keep his banana for a longer time in his home.

Untreated fruit in the first season, potassium permanganate treated fruit in the two seasons and ethrel treated fruit in the second season lost the lower weight compared to those of other materials, while sodium benzoate treated fruit lost the highest weight in the two seasons.

The results in Tables 1 and 2 showed that the ripening of banana developed more of both color index (5.05-6.55) , peeling condition (3.6-4.0), pulp/peel ratio (1.47-2.11), total soluble solids (TSS) (10-16.25) and total soluble solids /titratable acidity (TSS/TA) ratio (42.75 – 128.3) and developed less of both firmness (5-8.33) and titratable acidity (0.101-0.241) compared with maturity of banana at the harvest. Also, both treated and untreated banana did not show significant differences in good freshness at the ripening stage (8-8.7). Such, color of peel is the most obvious change occurs as result of postharvest treatments, also, peeling condition is used as a good criterion for evaluating the ripening (Table 1), color development was more advanced in potassium permanganate treated fruit then those of sodium benzoate treated fruit in the two seasons, while it was less advanced in untreated or hot water treated fruit in the second season and ethrel treated fruit in the two seasons. Although, almost these fruit appeared more easy peeling condition expect both of hot water treated fruit in the second season and sodium benzoate treated fruit in the first season which appeared less easy peeling. Such, when both temperature and immersion period of hot water are to be carefully selected, Al Haqu *et al.* [28] found retain the peel color quality of pears.

Table 1: Effect of postharvest treatments on some quality aspect of Maghrabi banana fruit during 2007-2008 seasons

Character	Ripening period(day)		Weight loss %		Color index		Peeling condition		Firmness (Lb/inch^2)		Fruit freshness	
Treatment	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Untreated	25 f	24e	7.00g	12.89bc	6.22abc	5.05d	4.0a	4.0a	8.00ab	5.00c	8.3a	8.3a
Ethrel	21f	17f	11.13efg	10.92c	5.40e	5.51cd	4.0a	4.0a	8.33a	7.67a	8.6a	8.7a
Hot water	54a	30d	10.69efg	13.06bc	6.40ab	5.03d	4.0a	3.6d	6.33bcd	5.00c	8.1a	8.1a
Ethanol	35de	35cd	18.72bc	13.84bc	6.20abc	6.15ab	4.0a	4.0a	8.33a	8.00a	8.3a	8.2a
Acetaldehyde	37 cde	30d	18.51bc	14.65bc	6.34ab	6.17ab	4.0a	4.0a	7.67ab	5.00c	8.2a	8.2a
Mandarin volatile oil	32e	30d	20.92ab	17.42ab	5.82cde	6.03abc	3.9b	3.8c	8.00ab	7.00ab	8.0a	8.0a
Ascorbic acid	41bc	41ab	11.90def	16.3b	5.99bcd	6.06abc	3.9b	3.9b	6.00cd	5.00c	8.6a	8.5a
Calcium chloride	37 cde	37bc	15.01cde	13.35bc	5.56de	5.92bc	3.5e	4.0a	5.00d	5.00c	8.5a	8.6a
Potassium permanganate	32e	30d	10.00fg	9.53c	6.55a	6.50a	3.8c	4.0a	5.33d	7.00ab	8.1a	8.1a
Sodium benzoate	44b	44a	23.41a	22.51a	6.43a	6.30ab	3.6d	3.9b	8.33a	6.00bc	8.2a	8.1a

Means having the same letter (s) within a column are not significantly different at 5% level

Table 2: Effect of postharvest treatments on some quality aspect of Maghrabi banana fruit during 2007-2008 seasons

Character	Pulp/peel ratio		Total soluble solids%		Titratable acidity%		TSS/TA ratio		Dry matter %	
Treatment	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Untreated	1.61 cd	2.11a	12.50d	12.50c	0.134c	0.167c	93.32cde	75.28c	26.19a	20.72d
Ethrel	1.47 e	1.52f	12.50d	12.50c	0.134c	0.201b	97.95bcd	63.61c	24.08ab	27.00ab
Hot water	1.87 ab	1.65e	15.50a	11.25d	0.181ab	0.167c	85.66de	67.76c	22.69bc	21.18d
Ethanol	1.82 b	1.48 f	15.00ab	10.00e	0.134c	0.134d	116.43ab	77.83c	25.57a	27.98a
Acetaldehyde	1.79 b	1.78cd	13.12cd	12.50c	0.184ab	0.201b	71.09e	62.18c	22.17c	25.38bc
Mandarin volatile oil	1.67 c	1.80c	13.75bcd	10.00e	0.167b	0.234a	82.88de	42.75d	24.77ab	24.87c
Ascorbic acid	1.87 ab	2.00b	15.50a	16.25a	0.121cd	0.241a	128.3a	67.42c	24.70ab	26.84ab
Calcium chloride	1.70 c	1.73d	15.00ab	15.00b	0.201a	0.241a	76.28de	62.23c	26.21a	25.50bc
Potassium permanganate	1.91 a	1.78cd	14.25abc	12.50c	0.127cd	0.134d	112.57abc	97.95b	24.90ab	25.73bc
Sodium benzoate	1.54de	2.02b	12.50d	15.00b	0.101d	0.121d	123.76a	124.09a	19.66d	25.00c

Means having the same letter (s) within a column are not significantly different at 5% level

Loss of firmness (softening) of fruit is one of the most common physical parameters to assess the progress of ripening. Ethanol or ethrel treated fruit in the two seasons and those treated with sodium benzoate in the first season had the higher firmness at ripening compared to the other treatments, while the lowest value occurred with calcium chloride treated fruit in the two seasons. Such, exposing avocado fruits to 80% ethanol saturated air delayed ripening, the delay being expressed as firmer fruit [19].

Table 2 indicated that as the fruit ripening was occurred, the pulp/peel ratio was increased, such potassium permanganate treated fruit in the first season and untreated fruit in the second season showed the highest ratio while, ethrel treated fruit in the two seasons and acetaldehyde treated fruit in the second season showed the lowest ratio compared to the other materials.

It is clear that total soluble solids (TSS) content was high in ascorbic acid treated fruit in the two seasons and hot water treated fruit in the first season while it was low in untreated or treated fruit with ethrel or sodium benzoate in the first season or with ethanol or mandarin volatile oil in the second season. On the other hand, titratable acidity (TA) content was low in sodium benzoate treated fruit in the two seasons and those treated with potassium permanganate or ethanol in the second season, this resulted to increase of TSS /TA ratio in sodium benzoate treated fruit in the two seasons and ascorbic acid treated fruit in the first season or potassium permanganate treated fruit in the second season. Also, it is clear that high TA in mandarin volatile oil treated fruit resulted to decrease of TSS /TA ratio. This hold true in the two seasons.

Ethanol treated fruit had the high value of dry matter content in the two seasons. Also, untreated fruit or calcium chloride treated fruit were on the par in the first season. While, fruit treated with sodium benzoate in the first season or hot water treated fruit or untreated in the second season contained low values of dry matter.

The acid treatment "ascorbic acid" influenced the biochemistry of the fruits, perhaps through affecting the ethylene induced ripening system [11]. Also, it induces many stimulating effects of some physiological activities [9].

The possible mechanism for the retardation of ripening, under these anaerobic conditions is that ethanol accumulate, therefore, inhibits or slows down the ripening process in some ways [29]. So, conversion of acetaldehyde in the plant tissue to acetyl- Co A which is a major compound in many cycles [30]. On the other hand, calcium generally seen as protective in reducing the rate of plant senescence and fruit ripening [12].

From the abovementioned results, it can be arrange the appearance of banana fruit in the market by using these materials which cause different ripening rates of fruit with gain acceptance by the user.

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