

## USING ETHREL FOR BANANA RIPENING

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### Abstract

Three banana varieties, namely, Hindi, Maghraby and Williams, produced in Egypt were ripened by dipping in 250, 500, 750, 1000, and 1250 ppm of ethrel. The effect of dipping treatments was studied through measuring physical, chemical and organoleptic properties, these properties were measured at 3 days intervals after treatments for up to 12 days. physical properties revealed that when the ethrel concentration increased the percentage of weight loss decreased.

Chemical properties showed an increase in total soluble solids and titratable acidity until 9 days then decreased gradually during ripening. All treatments had high sugar contents, however ascorbic acid decreased by increasing the ethrel concentrations. Ethrel treatments highly decreased the level of phenols in banana during storage. Treatments of banana fruits with different concentrations of ethrel gave better taste compared to the untreated fruits (control).

### INTRODUCTION

Banana (*Musa* spp.) is one of the most popular and nutritious fruits. Banana fruits are the least expensive fruits available in the diets of the tropical countries, banana serve as a major source of starch. In the developed countries bananas are marketed principally as fresh fruit, puree commonly used in baby food preparations, dried banana chips, and in pastries (Slabaugh and Grove, 1982).

Hulme; (1971) demonstrated that banana produce ethylene as a plant hormone. Treatments of green banana with ethylene at concentration 0.1 p.p.m. or higher accelerated the onset of the climacteric. In commercial trade, the green fruits are placed in special ripening rooms (controlled temp. and relative humidity) and ripening is initiated by the ethylene treatment, about 1000 ppm (Ching, 1968 and Palmer, 1971).

Generally, banana fruits are harvested green 3/4 to full mature, then the unripe banana are artificially ripened in special ripening rooms, (Brazil and Rossi, 1980) whose reported that unripe banana in containers, are treated by ethylene at 100 ppm or im-

mersed in cyclohexamide at 100 ppm for 8 hours, the acid phosphate rose during ripening with or without ethylene but did not rise in cyclohexamide treated fruits. They found that oxidation of malic acid increased but at base declined and stated that the best treatment to ripe banana was at a concentration of 1000 dipping in ethrel for 5min.

Singh, *et al.*, (1977) found that Ethrel concentration at 5000 ppm induced ripening after 2-2.5 days and at 3000 ppm level induced ripening after 3-3.5 days, while the control took about 7-10 days to ripen. The treatment with calcium carbiamide or 2,4-D, or covering with dry banana leaves at ambient temperature and humidity had slower ripening effect compared to the ethrel and produced inferior fruits.

Abou Aziz and El-Tanahy (1975) found that mature banana bunches were sprayed with ethrel at (0-200 ppm) and artificially ripened at 21-24°C for up to 18 days. Colour development was accelerated by ethrel at 500 ppm and by time until the fruits could easily be peeled. This treatment shortened the ripening period by 8-6 days, respectively.

El-Bana (1976) found that ethrel treatment shortered the time required for the artificial ripening of Maghraby banana through its effect on colour development and peeling quality. Thus fruit reached maximum ripening after 4, 6 and 14 days when treated with high concentration of ethrel 500-1000 ppm, low concentrations of 100 - 250 ppm and control treatments, respectively.

The other treatments slowered the ripening compared to the ethrel treatments and produced inferior fruits. Ram *et al.*, (1979) found that when fully mature banana fruits were dipped in ethrel at 125-1000 ppm for 5 minutes or exposed to smoke generated by burning leaves in a closed chamber for 24 h., at 12-20°C and 70-72% RH, ethrel treatment exhibited yellow colour which increased with the ethrel concentration level, and the 500 ppm level was the optimal concentration with regard to fruit appearance and flavour, however smoking gave poorer results but quicker ripening (3 days). Kohli and Reddy (1983) dipped robusta banana hands in ethrel at (250-2000 ppm) for two minutes, they found that best results were generally obtained with 1000 ppm ethrel. Also, Leiva and Umazor (1984) found that freshly harvested green Gaint caven-dish fruits washed in aqueous 1000 ppm ethrel for 5 minutes, ripened much faster than untreated fruits.

Gheyas and Haque (1989) reported that fruit weight decreased during ripening in all banana during ripening and storage, also the pulp to peel ratio and moisture per-

centage increased during ripening.

They also found that malic acid is the main acid in banana. Brasi and Rossi (1980) found that malic acid was increased during ripening of banana with or without ethylene. however, Collin and Dalnic (1991) studied the physico-chemical characteristics of plantain cultivar and found that the increase in pulp was due to an increase in citric acid.

Nour El-Din (1985) found that the total soluble solids were higher in Hindi cultivar pulp as significant increase in total soluble solids appeared after treatment with ethephon, then decrease, after 10 days of storage, however Gheyas and Haque (1989) found that the total soluble solids percentage in four cultivars of banana fruits significantly increased during ripening.

Abd El-Migid (1974) stated that the moisture content of banana fruits increased by increasing the storage time of the one minute dipped fruits in 1000 ppm ethrel for 12 days.

Agravante *et al.*, (1990) found that the pulp contained about 10% starch at the green stage and less than 1% at the green stage. Total sugars increased from 1% to 20% at the fully ripe stage. Sucrose constituted more than 60% of the total sugars. Also, Collin and Dalnic (1991) found that the colour changes during ripening were accompanied by a decrease in fruit firmness and starch content and an increase in acidity and total sugars.

Desai and Desphande (1975) found that there was an increase in the ascorbic acid from 2.4 to 7.08 mg/100 g pulp of three different banana cultivars during the storage at 20°C. Patil and Magar (1975) stated that the activity of ascorbic acid oxidase in stored bananas at 13°C increased until the banana turned yellow and then remained steady during the ripening period. El-Motaium (1980) found that the ascorbic acid content increased after one week followed by a gradual decrease until the end of the storage period.

Abd El-Sattar (1978) noted that the phenolic compounds were higher in peel of healthy banana fruits after, ethrel treatment.

Noar El-Din (1985) studied the effect of ethephon treatments on Hindi and paradica banana cultivars, he found that ethephon treatment had no significant effect on total phenols, however, Hindi fruits showed higher significant decrease in total phenols with the development of ripening compared to the paradica cultivar.



Goldstein and Swain (1963) showed preliminary evidence of loss of astringency during ripening of banana which resulted from the increased polymerization of tannin.

Collin and Dalinc (1991) reported that the colour change during ripening was accompanied by a decrease in fruit firmness and starch content, pulp firmness was linearly correlated with starch level.

In this work, the effect of different ethrel concentrations on the quality of three banana varieties cultivated in Egypt was evaluated.

## MATERIALS AND METHODS

### A- Materials:

Mature green Hindi, Maghraby and Williams banana fruits were obtained from Monofia Governorate and were used as a source of fruits in this investigation. Green banana fruits were picked at maturity stage. Bunches were in a good physical conditions, and uniform in size.

Ethrel (2-chloro ethyl phosphonic acid) produced by Rhone - AG Company, U.S.A (Ethers commercially available and obtained from the local market) was used for ripening fruits.

### B- Methods:

After harvesting, bunches were shipped directly to the laboratory on sponge covered carriers. Bunches were left for 24 hrs at ambient temperature, then they were handed and the hands were dipped in aqueous sodium hypochlorite solution (5 ml./L) for fifty seconds and washed under tap water, the washed banana hands were left to dry at room temperature 20-27°C for 15 min., before treatments.

Hands were divided into 6 parts for six treatments each part was dipped for one minute in solution, concentrations were 0, 250, 500, 750, 1000, 1250 PPM. Different treatments and control were stored for 12 days at room temperature. During the ripening and storage period some physical, chemical and organoleptic properties of fruits were determined at 3 days intervals.

Fruit sample were weighed at sampling date and weight loss was calculated as:

$$\text{Weight loss \%} = \frac{(\text{Original weight} - \text{Sample weight}) \times 100}{\text{Original weight}}$$

Fruit sample were weighed and peeled then the pulp percentage was calculated as:

$$\text{The pulp \%} = \frac{\text{pulp weight}}{\text{Fruit weight}} \times 100$$

Moisture content, total soluble solids, titratable acidity, sugars and ascorbic acid were determined according to the A.O.A.C. (1990).

Total sugars were determined according to the method described by Galal *et al.*, (1993)

Phenolic compounds were determined using the colorimetric methods described by Snell and Snell (1953).

For organolyptic evaluation, astringent, starchy, sweet, and very sweet were the terms used to describe the taste.

Taste of banana fruits immediately after treatment with ethrel as well as after 3, 6, 9 and 12 days of storage at room temp. were subjectively - detected by panel test of 15 untrained panellists.

Firmness was determined as pressure pound/inch<sup>2</sup> at the three days intervals during the storage period.

## RESULTS AND DISCUSSION

### 1-Loss of weight:

Data in Table 1 present the weight loss percentage for the three studied banana cultivars. The percentage of weight loss increased gradually by increasing the concentration of ethrel from 250 to 1250 ppm. After 12 days of storage the weight loss was the highest for the Williams, followed by Hindi and Maghraby, the values were 12.9, 12.6 and 12.2% respectively. These results may be attributed to that ethrel as a ripening agent, increased the rate of respiration which in turn be responsible for the weight loss. Also, comparable values were obtained for ethrel treatment especially at the end of storage (Gheyas and Haque 1989)

### 2- The pulp content:

The results of the pulp percentage are shown in table 2. The peel percentage can easily be obtained by subtracting the pulp percentage from 100.

Table 1. Effect of different ethrel concentrations on weight loss, %, of banana fruit pulp during storage.

Treatment (Ethrel ppm)	Storage period (days)																	
	%wt. loss, Hindi				%wt. loss, Maghraby				%wt. loss, Williams									
	0	3	6	9	0	3	6	9	0	3	6	9						
Control(0.0)	0.0	2.8	3.7	6.8	6.9	6.9	6.8	6.9	0.0	1.4	3.8	4.1	4.3	0.0	1.9	3.2	4.6	6.6
250	0.0	2.9	4.7	7.9	9.0	9.0	4.7	7.9	0.0	1.6	4.1	5.3	8.3	0.0	1.9	3.6	7.9	9.3
500	0.0	2.7	4.8	8.0	10.5	10.5	4.8	8.0	0.0	3.8	4.2	5.9	9.7	0.0	1.9	3.9	8.1	10.9
750	0.0	2.1	4.9	8.1	11.7	11.7	4.9	8.1	0.0	3.9	4.9	6.1	11.2	0.0	2.0	3.5	8.2	11.6
1000	0.0	2.1	5.1	8.3	12.3	12.3	5.1	8.3	0.0	4.2	5.8	7.0	12.0	0.0	2.3	3.5	8.9	12.3
1250	0.0	2.0	5.4	8.9	12.7	12.7	5.4	8.9	0.0	3.9	6.3	9.0	12.1	0.0	2.4	3.9	9.0	12.8

Table 2. Effect of different ethrel concentrations on the pulp, %, of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	%of pulp, Hindi				%of pulp, Maghraby				%of pulp, Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	52.4	56.0	56.9	59.8	63.7	52.5	55.0	57.0	59.1	61.1	53.0	55.5	56.1	57.0	57.1
250	52.4	57.0	57.8	60.0	65.0	52.5	58.0	58.1	58.9	64.9	53.0	58.5	58.7	58.9	60.0
500	52.4	58.1	59.3	61.0	66.0	52.5	58.0	58.4	65.2	66.4	53.0	58.4	59.1	59.8	63.0
750	52.4	58.3	59.8	61.8	66.3	52.5	55.5	60.9	66.4	67.6	53.0	59.7	59.9	60.1	63.9
1000	52.4	58.2	59.9	63.0	66.9	52.5	56.5	61.8	66.6	68.1	53.0	59.8	59.9	60.8	64.8
1250	52.4	60.0	60.1	65.0	68.9	52.5	57.6	61.9	66.9	69.9	53.0	59.9	60.0	62.3	65.6



From this table slight differences can be observed between the different banana fruits at a certain period of storage after harvesting and during ripening. Also from these results, it is clear that, the higher the ethrel concentration used, the higher the increase in the pulp percentage.

### 3- Moisture content:

The results of the effect of ethrel treatment on the moisture content of the pulp for the three studied banana cultivars are shown in table 3. The moisture content of banana pulp was markedly increased for the treated fruits by ethrel compared to the untreated (control) fruits. Also, it is evident that the moisture content of the pulp increased with increasing the ethrel concentration for up to 12 days of storage. The increase in the moisture content of the 1250 PPM treated Maghraby fruits was the highest after 12 days of storage (around 6 %) compared to (4.8) for the Hindi and (4.6) for the Williams, while the control had 3.9 , 3.8 and 2.7% increase in the moisture content after 12 days of storage for the three studied banana cultivars, respectively. These results agree with Abd El-Migid (1974).

### 4- Total soluble solids

The changes in the total soluble solids of the pulp of the three studied banana cultivars, as affected by ethrel treatments, are shown in Table 4. For the ethrel concentration of 500 ppm treatment, results showed the higher increase in the T.S.S. % compared to the other concentrations, while T.S.S. % increased in Williams cultivar from 1.8 to 12.5, but T.S.S. % of control increased from an average of 1.8 to an average of 5.8 for the three studied cultivars after 12 days of storage at room temperature. These results agree with those obtained by Nour El-Din, ( 1985 ) and Gheyas and Haque (1989).

### 5- Total acidity:

The changes in acid content during ripening and storage of banana cultivars at room temperature are shown in Table 5. From these results it can easily be seen that there was a gradual increase in acidity during storage for all the ethrel treated Banana cultivars compared to the control.

From the same table it could be observed that the acidity was increased for all treatments by increasing ethrel concentration after 3 days of storage, then increased gradually during storage, also the results revealed that the high acidity were after 6 and 9 days of storage, then decreased after 12 days of storage.



Table 3. Effect of different ethrel concentrations on the moisture content, %, of banana fruit pulp during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi				Maghraby				Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	72.6	74.8	75.3	76.1	76.4	73.0	74.5	75.9	76.1	76.9	75.1	75.9	76.2	77.0	78.0
250	72.6	75.0	753.6	76.8	77.1	73.0	75.6	76.0	77.3	773.9	75.1	76.2	77.9	78.2	77.5
500	72.6	76.3	77.2	77.9	78.3	73.0	76.0	77.1	77.7	78.1	75.1	76.9	77.2	78.4	78.9
750	72.6	76.5	77.6	78.2	78.9	73.0	76.3	76.5	77.9	78.2	75.1	76.9	77.4	78.9	79.0
1000	72.6	76.7	77.9	78.4	78.9	73.0	76.5	76.9	78.1	78.4	75.1	77.0	77.6	78.9	79.4
1250	72.6	76.9	78.0	78.9	79.1	73.0	76.7	77.1	78.3	78.7	75.1	77.3	77.9	79.0	79.6

Table 4. Effect of different ethrel concentrations on the total soluble solids, %, of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi					Maghraby					Williams				
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	1.7	1.8	2.8	4.0	6.6	1.7	1.9	4.3	4.4	4.7	1.8	1.8	2.3	2.7	6.3
250	1.7	1.9	5.6	8.3	9.4	1.7	32.1	5.1	8.9	9.9	1.8	1.9	9.0	9.4	11.0
500	1.7	1.9	7.9	10.0	12.3	1.7	5.1	5.9	9.4	10.8	1.8	2.4	10.1	11.1	12.5
750	1.7	1.8	7.1	9.6	10.2	1.7	6.2	6.4	9.6	10.9	1.8	3.1	9.6	10.6	10.9
1000	1.7	2.1	9.1	9.0	9.9	1.7	6.3	6.5	10.1	10.3	1.8	2.9	10.3	10.7	11.1
1250	1.7	2.0	7.3	9.2	10.0	1.7	6.2	6.3	9.7	10.1	1.8	2.9	10.0	10.3	10.9

Table 5. Effect of different ethrel concentrations on the changes in total acidity, % of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi					Maghraby					Williams				
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	0.20	0.25	0.30	0.34	0.30	0.20	0.23	0.29	0.37	0.32	1.8	0.23	0.27	0.25	0.28
250	0.20	0.29	0.52	0.62	0.68	0.20	0.21	0.27	0.67	0.48	1.8	0.20	0.58	0.66	0.66
500	0.20	0.29	0.84	0.55	0.46	0.20	0.20	0.22	0.69	0.60	1.8	0.20	0.60	0.84	0.64
750	0.20	0.31	0.59	0.76	0.65	0.0	0.21	0.24	0.74	0.65	1.8	0.25	0.60	0.62	0.58
1000	0.20	0.28	0.70	0.70	0.67	0.20	0.20	0.21	0.73	0.62	1.8	0.28	0.62	0.59	0.53
1250	0.20	0.28	0.68	0.70	0.65	0.20	0.21	0.23	0.65	0.48	1.8	0.28	0.61	0.61	0.60

Table 6. Effect of different ethrel concentrations on the sugars content, %, of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi				Maghraby				Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	3.3	3.4	4.5	15.0	18.0	1.6	1.7	2.0	11.2	11.5	1.7	1.7	2.5	3.8	6.5
250	3.3	4.8	10.7	26.5	31.0	1.8	2.2	6.2	14.1	14.9	1.5	2.6	4.5	12.4	16.1
500	3.3	4.8	24.9	25.4	35.0	10.6	2.1	9.8	7.6	13.1	1.7	2.7	15.1	17.8	21.9
750	3.3	5.4	33.8	37.3	33.9	1.8	2.2	17.9	14.6	15.4	1.5	3.2	15.9	22.7	18.5
1000	3.3	4.9	19.6	28.7	32.5	1.7	2.3	6.7	15.2	14.2	1.6	2.6	12.9	13.5	128.3
1250	3.3	4.7	27.9	29.3	29.2	1.9	2.2	8.8	12.5	12.1	1.4	2.5	19.1	16.8	17.1



These results are in agreement with those obtained by Abd El-Migid (1974) and Collin and Dalinc (1991).

#### **6- Sugar contents:**

The change in the sugar contents of the three banana cultivars at three days intervals, during their storage at room temperature are shown in Tables 6-8 there was a gradual increase in sugar contents by the time of storage, the untreated fruits changed in Hindi, Maghraby and Williams from 3.3, 4.2 and 2.8 to 17.8, 18.0 and 18.5 (an average) after 12 days of storage respectively for the ethrel treatment after 12 days figures were 35, 59.6, 37.3 (an average) respectively. The same trend were noticed in reducing and non-reducing sugar, while the non-reducing sugars were about 50% of the total sugars.

Generally, the highest sugar contents were found in the Maghraby cultivar compared to Hindi, and Williams. These results are in the same line with El- Motaium (1980) who found that reducing sugar increased during storage periods and Collin (1991) who noticed that changing during ripening were accompanied by a decrease in the starch content and an increase in the total sugars.

#### **7- Ascorbic acid:**

The results presented in table 9 show that scorbic acid contents, of the ethrel treated banana cultivars, slightly increased after different storage periods, compared to the control. As the concentration of the ethrel increased (up to 750 - 1000 ppm) the preserving effect was more pronounced.

Generally, the best treatment was at the low concentrations of ethrel till 750 ppm in the three banana cultivars, because it succeeded to keep the maximum level of the ascorbic acid all over the storage periods especially fruits treated with 500 and 750 ppm of ethrel. Ascorbic acid was low in Williams banana fruits compared to Maghraby and Hindi banana cultivars. These results are in agreement with those obtained by El-Motaium (1980) and Patil and Mager (1975)

#### **8- Total Phenol:**

Total phenols were determined in the treated and control banana fruits. cultivars Data in Table 10 show that untreated fruits (control) contained higher total phenols compared to the treated samples.

Table 7. Effect of different ethrel concentrations on the sugars content, % of "Maghraby" banana cultivars during storage.

Treatment (Ethrel ppm)	Storage period (days)																	
	Total sugars						Reducing sugars						Non-reducing sugars					
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12			
Control(0.0)	4.2	4.6	9.7	16.5	19.0	2.2	2.5	5.4	9.2	11.0	2.0	2.1	4.3	7.3	8.0			
250	4.2	5.5	14.7	19.4	29.2	2.2	2.6	5.9	10.3	13.2	2.0	2.9	8.8	9.1	16.0			
500	4.2	6.8	15.4	27.5	44.0	2.3	2.8	7.3	12.1	15.2	1.9	4.0	8.1	15.4	28.0			
750	4.2	8.9	18.0	33.0	58.3	2.3	3.2	9.3	14.5	19.8	1.9	5.7	8.7	18.5	38.5			
1000	4.2	9.3	18.6	35.2	60.1	2.3	3.7	9.8	15.4	21.1	1.9	5.6	8.8	19.8	39.0			
1250	4.2	10.4	22.3	38.0	34.0	2.2	3.8	10.6	17.4	16.1	2.0	6.6	11.7	20.6	17.9			

Table 8. Effect of different ethrel concentrations on the sugars content, % of "Williams" banana cultivars during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	0			3			6			9			12		
	Total sugars			Reducing sugars			Non-reducing sugars								
Control(0.0)	2.8	3.4	4.4	15.7	18.4	1.6	1.7	2.1	9.7	12.2	1.2	1.7	2.3	6.0	6.2
250	2.8	9.3	25.4	29.0	33.0	1.6	1.9	9.4	12.7	12.8	1.2	7.4	16.0	16.3	20.2
500	2.8	10.8	18.9	27.2	36.9	1.6	3.0	10.8	10.9	16.9	1.2	7.8	8.1	16.3	20.0
750	2.8	12.4	24.6	25.7	32.0	1.7	3.6	11.5	11.8	15.1	1.1	8.8	13.1	13.9	16.9
1000	2.8	11.1	26.2	27.4	31.0	1.7	3.3	12.1	13.3	15.1	1.1	7.8	14.1	14.1	16.1
1250	2.8	10.6	24.9	32.5	37.0	1.6	4.1	12.7	13.9	16.1	1.2	6.5	12.2	18.6	20.9

Table 9. Effect of different ethrel concentrations on the sasorbic acid (mg/g) of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi				Maghraby				Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	2.5	3.8	5.8	6.0	7.6	2.5	2.8	3.4	4.4	6.4	2.4	4.2	5.2	5.4	7.2
250	2.5	3.9	5.2	6.0	8.2	2.5	2.9	3.4	6.6	8.4	2.4	4.3	5.4	5.8	6.9
500	2.5	3.8	5.2	5.2	9.2	2.5	2.7	3.6	8.6	12.0	2.4	4.0	5.6	5.8	10.0
750	2.5	3.4	5.6	6.6	10.0	2.5	2.8	4.4	9.0	10.4	2.4	4.2	5.5	5.9	8.0
1000	2.5	3.7	5.0	6.9	10.0	2.5	3.2	4.2	8.6	9.6	2.4	4.0	5.6	5.8	8.0
1250	2.5	3.9	4.2	5.1	7.0	2.5	3.6	3.8	8.2	9.0	2.4	3.0	3.8	6.0	8.4



Table 10. Effect of different ethrel concentrations on the total phenol contents (mg/g) of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi				Maghraby				Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	6.10	5.90	5.60	2.30	1.00	12.60	11.99	9.90	3.50	2.50	34.90	32.60	30.70	18.60	9.20
250	6.10	5.60	4.40	1.70	0.92	12.60	11.30	8.80	3.30	2.20	34.90	29.50	26.70	9.20	0.80
500	6.10	5.40	4.40	1.50	0.93	12.60	10.30	7.80	3.00	2.50	34.90	29.50	18.60	11.10	0.80
750	6.10	5.20	4.30	1.90	0.95	12.60	9.90	3.60	2.50	2.20	34.90	23.40	23.00	12.30	0.92
1000	6.10	5.00	4.00	2.00	1.00	12.60	9.40	3.80	2.60	2.30	34.90	28.70	26.70	11.30	0.91
1250	6.10	4.80	4.30	1.00	0.90	12.60	10.30	3.90	2.20	2.10	34.90	27.00	15.80	10.50	0.90

Hindi banana fruits treated with almost all tested concentrations of ethrel gave higher levels of total phenols than that present in control. Maximum amounts of total phenols were noticed in treated fruits with 250 and 500 PPM of ethrel after zero, 3 and 6 days of treatment then decreased after 9 and 12 days compared to the control treatment. However, the application of 250 ppm increased the levels of phenolic compounds. Generally, there was a negative correlation ship between phenolic contents and storage period. since these compounds decreased as the storage periods increased.

The untreated Maghraby banana fruits (control) contained slightly to moderately higher amounts of phenolic compounds compared to the treated fruits. After about 9 days of storage at room temperature, treated samples showed comparable or even higher concentration of such compounds. Data, also showed higher phenolic contents in treated fruits with 500, 1000 and 1250 ppm, stored at different storage periods than these treated with 750 ppm ethrel and stored at the same periods, however, the application of 750 ppm decreased the level of phenol contents. Generally, these data show that phenolic compounds were reduced as storage period advanced.

Ethrel total phenolic compounds of Williams banana fruits gradually decreased during storage periods. Such conclusion could be found for both treated and untreated fruits. Maximum amount of phenolic compounds were noted in untreated fruits and those treated with 250 ppm of ethrel. Also, it can be noticed from these data that phenol contents were higher in treated fruits with 1000 and 1250 ppm ethrel compared to the fruits with treated 500 and 750 ppm ethrel. Generally, the previous results exhibited that Williams banana cultivars contained higher amount of phenolic compound during storage periods as compared to Hindi and Maghrby banana varieties. Also, ethrel treatments released higher levels of phenols treatment. These results are in agreement with those obtained by Abd El-Sattar (1978) and Nour El-Din (1985).

#### **9- Taste (astringency):**

The changes in the taste of pulp of banana cultivars during ripening when treated with different ethrel concentrations and storage at room temperature are shown in table 11. From these results, the mature green banana cultivars still have the astringent flavour immediately after treatment with different concentrations of ethrel the control treatment exerted similar taste but after 3 days the starchy flavour was observed in the ethrel treated banana compared to the control fruits which reached the grade starchy after 9 days. It showed sweet and very sweet taste after 9 and 12 days of treatment while untreated (control) fruits cultivars had starchy and slightly sweet at

Table 11. Effect of different ethrel concentrations on astringency of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi				Maghraby				Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	A	A	A	B	D	A	A	A	B	C	A	A	A	B	D
250	A	B	D	C	C	A	B	D	C	E	A	B	D	C	E
500	A	B	D	C	E	A	B	C	C	E	A	B	D	C	E
750	A	B	D	C	E	A	B	C	C	E	A	B	D	C	E
1000	A	B	D	C	E	A	B	D	C	E	A	B	C	C	E
1250	A	B	D	C	E	A	B	C	C	E	A	B	D	C	E

Table 12. Effect of different ethrel concentrations on firmness (pound/inch<sup>2</sup>) of banana fruits during storage.

Treatment (Ethrel ppm)	Storage period (days)														
	Hindi				Maghraby				Williams						
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Control(0.0)	29	25	24	23	21	28	27	26	25	22	28	27	24	23	21
250	29	21	20	16	14	28	23	21	19	17	27	27	21	19	15
500	29	17	16	13	10	28	21	19	17	14					
750	29	16	14	10	9	28	20	17	14	12	27	16	13	10	8
1000	29	14	11	8	7	28	17	13	11	9	27	13	9	7	4
1250	29	11	8	7	6	28	13	10	9	7	27	9	6	4	4



the same time intervals during storage.

These results are in agreement with Galal *et al.*, (1993). They observed that loss of astringency occurs during ripening of banana.

#### 10- Firmness:

Data of firmness in Hindi, Maghraby and Williams banana cultivars treated with different concentrations of ethrel and stored for 12 days at ambient temperature are shown in Table 12.

Ethrel treated fruits lose their firmness faster than control fruits and become over rip and more susceptible to rots. The Firmness was decreased from 27 pound/inch<sup>1</sup> an average to (5-6), (6-7), and (3-4) pound/inch<sup>2</sup> after 12 days of treat with different ethrel concentrations for Hindi, Maghraby and Williams, respectively.

Generally, Maghraby banana cultivars were firmer than Hindi, and Williams banana fruits. These results are in agreement with Collin and Dalnice (1991).

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## إستخدام الإثيريل في إنضاج الموز

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تم دراسة إنضاج ٣ أصناف من الموز وهي: وليامز وهندي والمغربي بإستخدام الغمر في محلول الإثيريل بتركيزات مختلفة ٢٥٠، ٥٠٠، ٧٥٠، ١٠٠٠، ١٢٥٠ جزء في المليون لمدة ١ دقيقة. وتم دراسة تأثير هذه المعاملات على الصفات الطبيعية والكيمائية والحسية كل ٣ أيام ولمدة ١٢ يوم بعد المعاملة.

وأظهرت الاختبارات الطبيعية أنه بزيادة تركيز الإثيريل تزيد النسبة المئوية للفقد في الوزن واللب والمواد الصلبة الذاتية، الحموضة حتى اليوم التاسع ثم تبدأ في التناقص. كما أوضحت النتائج إرتفاع نسبة السكر وتناقص نسبة فيتامين ج مع تزايد الإثيريل المستخدم وزيادة في نسبة الفينولات مع إرتفاع نسبة تركيز الإثيريل ولقد لوحظ تحسن كبير في الطعم بالمقارنة بالثمار الغير معاملة (الكونترول) مع زيادة سرعة وتجانس الإنضاج بزيادة تركيز الإثيريل حتى ١٠٠٠ جزء في المليون.