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RIPENING MANGOS WITH ETHYLENE AND ETHEPHON

CHARLES R. BARMORE

IFAS Agricultural Research and Education Center
Lake Alfred

Abstract. **Effects of ethylene and ethephon [(2,-chloroethyl) phosphonic acid, Ethrel] on ripening (softening time) and color development of several mango cv. (Mangifera indica L.) were examined. Both materials reduced ripening time and resulted in uniform ripening. Effect on color was limited primarily to a more rapid development of the yellow color, concomitant with the disappearance of the green color (chlorophyll). Red color development was not affected. Color response differed for each cv. Commercial use of ethylene gas and ethephon solution and consumer acceptance of ethylene ripened fruit is discussed.**

Use of ethylene gas for initiating fruit ripening and accelerating the degradation of chlorophyll is well documented (6, 7, 9). In the fruit industry, ethylene is obtained either in gas cylinders or by production from catalytic generators. Recently, the chemical ethephon which produces ethylene upon chemical degradation has been extensively tested on other agricultural crops (5).

Ethylene is produced by many fruits especially during ripening (1, 2, 3) and is considered a natural ripening hormone (4). Ethylene production from mango fruit tissue, like many other climacteric fruit, is maximal at the onset of the climacteric phase of fruit ripening (3, 8). Burg and Burg (3) have reported that the small amount of ethylene present in the fruit at harvest is sufficient to initiate ripening. Additional ethylene accumulation, supplied either exogenously or endogenously during this time, will further hasten the ripening process.

The purpose of this study was to measure the effects of ethylene and ethephon dip treatments on the softening and color development processes of ripening. Possible use of ethylene for commercial use was examined.

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Materials and Methods

Mature-green (color) fruits of cv. 'Haden,' 'Tommy Atkins,' 'Van Dyke,' 'Carrie,' 'Palmer,' and 'Edwards' were harvested from orchards located at Canal Point and Homestead. Each lot of fruit was washed using a detergent and graded for maturity and color soon after harvesting.

Fruit receiving ethylene and ethephon treatments were randomized into lots of 8 to 10 fruit each, replicated 3 times. Ethylene treatments consisted of 5 and 10 ppm at 30°C (85°F) and 95% relative humidity. Treatment times of 24 or 48 hr were used followed by storage at 21°C (70°F) until soft. A separate group of 'Tommy Atkins' fruit were held under continuous 10 ppm ethylene at 21°C until soft. Ethephon at 500 or 1000 ppm was applied with Triton X100 as a 1 min dip treatment. After air drying, each lot of fruit was held at 21°C until soft.

During storage at 21°C, fruit were observed for softening and decay. When soft, color was scored on the basis of percentage increase in yellow color in the area initially green. A numerical score of 1 to 5 was used: 1-0% yellow, 2-25% yellow, 3-50% yellow, 4-75% yellow, and 5-100% yellow.

Ethylene production from ethephon treated fruit was measured during ripening at 21° and 30°C using cv. 'Van Dyke.' Two replications of 3 fruit each treated with 0, 500, or 1000 ppm ethephon were placed in glass containers. The containers were sealed and ethylene was allowed to accumulate for 1 hr prior to sampling the gas in the head space. Gas samples were taken every 24 hr and analyzed for ethylene with a Varian Model 1800 gas chromatograph equipped with a H-flame ionization detector.

Results and Discussion

Effects of ethylene on ripening and color development. Ethylene was very effective in initiating the ripening process, thus reducing ripening

BARMORE 74

BARMORE '74

time of all mango cv. tested (Table 1). These results are similar to those reported by others (2, 4, 5). Ethylene treatments of 5 or 10 ppm at 30°C for 24 or 48hr reduced ripening time adequately. In addition, ripening time within each cv. was very uniform. Burg and Burg (3) have reported that ripening of mangos can be initiated at ethylene concn as low as 0.4 ppm. However, the response will not be as immediate as with higher concn.

Number of days reduction in ripening time ranged from 1 to 6 days for the cv. tested. This is primarily related to the inherent ripening pattern of each cv. and to stage of maturity of a particular group of fruit. In general, reduction of ripening time with ethylene was most evident in cv. requiring longer ripening periods. Non-ethylene treated 'Carrie' fruit ripened in 4 days compared to 3 days for ethylene treated fruit. Whereas for 'Haden,' ripening time for non-ethylene treated fruit was 8 to 10 days and 5 days for ethylene treated fruit.

Temperature modifies the effectiveness of ethylene on ripening. Generally, the lower the temp during treatment the less immediate will be the response. 'Tommy Atkins' held under continuous 10 ppm ethylene at 21°C required 7 days to soften compared to 4 days for fruit treated with 10 ppm for 48 hr at 30°C, then held at 21°C.

Effect of ethylene on color was observed as a loss in green color (chlorophyll) concomitant with an increase in yellow color in this area (Table 1). Red color did not appear to be affected by ethylene under these treatment conditions. Effect of ethylene on color development was different for each cv. Generally, the final color as a result of ethylene treatment approximated that which would occur naturally during storage. Ethylene only accelerated this process.

Treatment temp and time are important factors determining the effectiveness of ethylene on color development. With 5 or 10 ppm ethylene at 30°C

Table 1. Effect of ethylene on color development and ripening time of several mango cv. Fruit were held at 30°C during ethylene treatment, then transferred to 21°C storage until ripe.

Cultivar	Treatment (ppm / hr)	Ripening time (days)		Color score[z]	
		C_2H_4	Control	C_2H_4	Control
Carrie	10 / 24	3	4-5	3.0	2.8
Van Dyke	5 / 24	7-8	10-12	4.3	4.2
	10 / 24	6-7	10-12	4.5	4.2
	10 / 48	5-6	10-12	4.7	4.2
Haden	5 / 24	6-7	9-10	4.3	4.7
	5 / 48	5-6	9-10	4.6	4.7
	10 / 24	5-6	9-10	4.6	4.7
	10 / 48	5	9-10	4.6	4.7
Edwards	5 / 24	6-7	8	4.5	4.5
	5 / 48	5	8	4.3	4.5
	10 / 24	4	8	4.5	4.5
	10 / 48	4	8	4.2	4.5
Tommy Atkins	10 / 24	6-7	10-12	4.8	4.9
	10 / 48	4-5	10-12	4.8	4.9
Palmer	10 / 24	5	7	1.8	1.8

[z]Description of color score values is given in Materials and Methods.

for 24 or 48 hr, final color development approximated that of control fruit when soft. However, when the treatment exceeded 48 hr at 30°C, chlorophyll degradation on several cv. was observed to be reduced and final color was dull in appearance. At lower temp, treatment time can be extended without causing undesirable effects on color development. 'Tommy Atkins' held under continuous ethylene at 10 ppm at 21°C developed very good color after 7 days.

Latex, from the severed stem, must be removed from the fruit surface if the fruit are to be treated with ethylene. Areas which are covered with latex will not degreen. Use of a detergent in the wash water was found to remove the latex without affecting color change.

Effect of ethephon on ripening and color development. Ethephon applied as a 1 min dip at concn of 500 or 1000 ppm reduced ripening time of all cv. tested (Table 2). The effect was not as immediate as was the ethylene treatment at 10 ppm for 24 or 48 hr. Effect of ethephon on color development was similar to that of ethylene (Table 2). Final color when soft was comparable to control fruit, though accomplished in less time. Red color development did not appear to be affected.

The action of ethephon is dependent upon ethylene evolution through chemical degradation of ethephon which, in turn, stimulates the fruit to produce ethylene. Ethylene evolution from ethephon can be detected within 1 hr after application (Fig. 1). As with ethylene treatments, the temp at which fruit is held following ethephon treatment affects ripening time. Both ethylene production and rate of ripening were found to be greater at 30°C than at 21°C (Fig. 1).

Anthracnose decay was not increased by either ethylene or ethephon treatments.

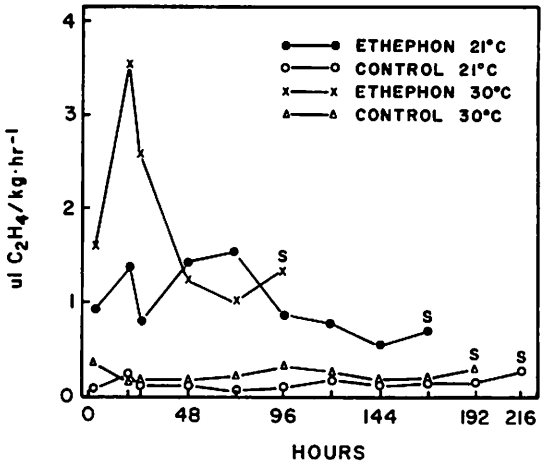

Table 2. Effects of ethephon on color development and ripening time of several mango cv. Fruit were stored at 21°C until ripe.

Cultivar	Treatment (ppm)	Ripening time (days)		Color score[z]	
		Ethephon	Control	Ethephon	Control
Carrie	500	3	4-5	2.8	3.1
	1000	3	4-5	3.1	3.1
Van Dyke	500	9	10-12	4.3	4.5
	1000	8	10-12	4.6	4.5
Haden	500	8-9	9-10	4.5	4.7
	1000	7-8	9-10	4.8	4.7
Edwards	500	7	8	4.2	4.3
	1000	6	8	4.1	4.3
Tommy Atkins	1000	8	10-12	4.3	4.5

[z]Description of color score values is given in Materials and Methods.

Consumer acceptance of ethylene treated fruit. Consumer acceptance of ethylene ripened fruit was very good. An increase in the sale of mango fruit was observed in a local supermarket when ethylene ripened fruit were added to the display containing mature-green mango fruit. Color, as well as immediate edibility, contributed to their acceptance. Quality of these fruit was comparable to that of naturally ripened fruit. Ethylene treatment can not be used to improve the quality of immature fruit.

Conclusion

Ethephon is not presently cleared for use on mangos and can not be recommended for use. When registered, ethephon would be ideal to use because of its ease of application. Ethephon could be applied during processing for fresh fruit shipment. The rate of ripening could then be controlled by storage at specific temp.

Ethylene gas can be used commercially to reduce the ripening time of mangos. Ethylene treatment could be given at either the packinghouse or at the retailers point of distribution (standard banana ripening rooms are suitable). Shipping of ethylene treated fruit long distances is not recommended since these fruit soften faster than non-treated fruit at comparable temp. Recommended conditions for treating mangos with ethylene are as follows: 5 to 10 ppm ethylene for 24 to 48 hr at 30°C with high humidity (95% rh). Lower temp can be used; however, the ripening response will be reduced. This technique should not be used to ripen immature fruit.

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