Effect of Ethrel on Fruit Ripening in a Farm Level Ripening Chamber

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Abstract
This work describes the effect of ethrel in aqueous solution and ethylene gas liberated from ethrel in an alkaline medium on uniform ripening of selected fruits namely mango, banana and papaya. Experiments were conducted with different levels of temperature (20, 25 and 30°C), ethylene concentration (100, 150 and 200ppm) and exposure time (15, 20 and 25h). Banana fruits exposed to 100ppm ethylene for 25h and subsequently stored at 20°C retained significantly higher values of quality parameters. Mango fruits exposed to 150ppm ethylene for 25h and subsequently ripened at 23°C and papaya fruits exposed to 200ppm ethylene for 25h and subsequently stored at 30°C retained significantly higher values of quality parameters among different treatment combinations. Ethylene released from ethrel triggered fruit ripening at all concentrations used and the effect of ethylene on fruit ripening was evaluated by enhanced climacteric peak of respiration, increase in peel color, increase in total soluble solids, decrease in flesh firmness and number of days to attain bright yellow color. This work demonstrated that matured green banana, mango and papaya fruits took four, five and three days respectively to ripen uniformly. A low-cost fruit ripening chamber at farm level was developed by this ripening study.

Keywords: Fruits, Ethylene, Maturity, Quality, Ripening
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Introduction
Fruits are important supplement to human diet as they are the richest source of vitamins, minerals and fiber, required for maintaining good health. Mango, banana and papaya are the major fruit crops of India and in spite of the fast rate of market expansion for fruits; a problem of heterogeneous ripening among fruits from the same lot has been reported. This postharvest problem of appearance affects consumer acceptability, despite its delicious flavor and taste. Traditional method of ripening takes long time and renders tasteless and toxic fruits. The chemical substance ripens the fruit in much lesser time, to meet the surge in market demand. The fruits are generally ripened in the markets by calcium carbide and use of this chemical is prohibited due to health hazards like vomiting, diarrhea, abdominal pain, thirst and weakness (PFA, 2003). Therefore, alternative measures need to be investigated for improving the ripening of fruits, so that uniformly ripened and quality fruits are made available to consumers in domestic and distant markets. Extensive work has been done to study the effect of chemical substance to induce ripening (Medlicott, *et al*,1987). Commercially ethylene gas is used to ripen the fruits at minimum concentration and exogenous application of ethylene in the form of ethrel accelerates ripening, increases color and eating quality with reduced spoilage in different varieties of mango (Salveit, 1993). The present study was taken up to study the effect of ethylene treatment on ripening and sensory quality characteristics of matured banana, mango and papaya fruits and to develop a low-cost fruit ripening chamber to use at farmers and traders level.

Materials and Methods
Grand Naine variety of banana, Banganapalli variety of mango and Sunrise solo variety of papaya fruits were harvested at green mature stage. Commercial maturity of 75% was determined by visual observation (Robinson,

Table 1: Postharvest treatments and ripening Conditions

Fruit	Temperature (°C)	Exposure time (h)		Ethylene concentration (ppm)	
Banana	20	T_1	15	C_1	100
		T_2	20	C_2	150
		T_3	25	C_3	200
Mango	25	T_1	15	C_1	100
		T_2	20	C_2	200
		T_3	25	C_3	300
Papaya	30	T_1	15	C_1	100
		T_2	20	C_2	200
		T_3	25	C_3	300

1996) and the experimental trials are shown in Table 1.

Low cost ripening chamber

A low-cost ripening chamber developed is a collapsible plastic chamber of polypropylene with a dimension of 7ft x7 ft x7 ft (l x b x h). The capacity of the ripening chamber is 500 to 700kg of mango/banana fruits for use at traders level (Fig.1). Chamber has four outlets at the base of the four corners which are closed tightly with a plastic string and released manually when required to have a ventilating effect inside the chamber.

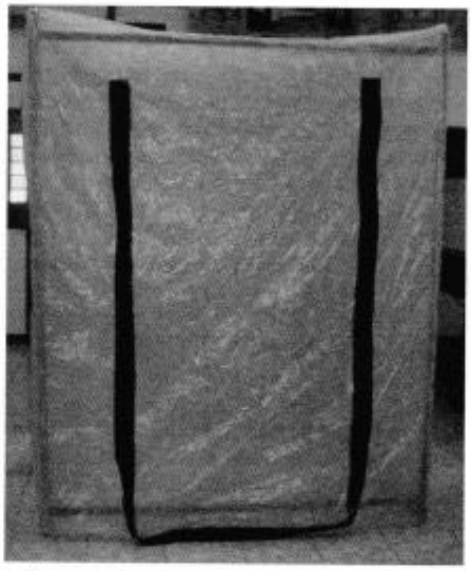

Figure 1: Low cost fruit ripening chamber for fruits ripening

Ripening of Fruits

Treatment with ethylene released from ethrel was carried out after determining the free space volume of the chamber. Fruits were placed in crates and a beaker containing known amount of ethrel and sodium hydroxide were kept inside the chamber. Calculated amount of ethrel and NaOH released required concentration of ethylene gas and the chamber was closed immediately. The chambers were opened at the desired exposure time and fruits were subsequently ripened at their ripening temperature.

Observations recorded

Attainment of bright yellow color of skin was considered as completion of ripening process. The quality of fruits after ripening were assessed in terms of physiological loss in weight (PLW), firmness, color, pH, total soluble solids and sensory evaluation.

Results and Discussion

Banana

PLW of fruits increased during ripening (Table 2) and highest PLW was observed with 200ppm at 25h (5.62%) and in conventionally ripened fruits (6.1%) during ripening period of 4 days and resulted in shriveling, softening and over ripening of fruits and found unsuitable. The increase in weight loss during ripening of banana fruits by ethylene application might be due to upsurge in respiration rate of fruits. Firmness of fruits declined during ripening period in all treatments. Untreated control fruits were hard (22.9N) and remained un ripened, while ethylene (200ppm) treated fruits and conventionally ripened fruits using smoke were least firm (6.9 and 2.1N) and fruits treated with 150ppm ethylene registered adequate firmness (7.8N). Decrease in firmness, during ripening may be due to breakdown of insoluble protopectin into soluble pectin or by cellular disintegration leading to membrane permeability as indicated by Brinston *et al.* (1988). TSS content of fruits was highest (23°brix) with 150ppm ethylene gas and lowest (12.1°Brix) in control fruits, whereas conventionally ripened fruits registered 18°brix. Increase in TSS during ripening must be due to increase in concentration of organic solutes as a consequence of water loss. Sensory evaluation of fruits treated with ethylene gas (150ppm) recorded 8.4 score on 4th day and were rated as very much desirable and untreated (5.1) and conventionally ripened fruits (6.5) were rated poor in taste on 4th day. Banana fruits exposed with 150ppm ethylene for 25h and subsequently stored at 20°C retained significantly higher values of quality parameters among different treatments (Figure 2).

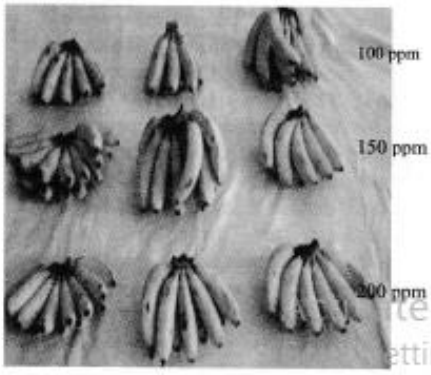

Figure 2: Ethylene treated banana fruits at

Table 2: Effect of ethylene on PLW, Firmness, pH, TSS and sensory quality during ripening of banana at 20°C

Exposure time (h)	Ethylene concentration (ppm)			control	conventionally ripened	CD (1%)
	100	150	200			
PLW (%)						
15	3.25	4.51	5.37	0.5	6.1	C= 0.3
20	3.90	4.26	5.42			t = 0.2
25	3.61	4.98	5.62			Cxt = 0.6
Firmness (N)						
15	22.5	18.6	10.8	22.9	2.1	C = 0.2
20	16.7	12.7	7.8			t = 0.2
25	15.7	7.8	6.9			Cxt = 0.3
pH						
15	4.97	4.51	4.4	4.9	4.5	C = 0.08
20	4.52	4.48	4.41			t = NS
25	4.5	4.40	4.20			Cxt = NS
TSS (°Brix)						
15	17.1	17.5	17.9	12.1	18	C = 0.4
20	19.4	19.9	20.2			t = 0.3
25	21.2	23.0	22.5			Cxt = 0.9
Sensory score						
15	7.9	7.8	7.9	5.1	6.5	C = 0.2
20	7.8	8.2	8.1			t = 0.1
25	8.1	8.4	8.1			Cxt = 0.3

Mango

Ethylene exposed fruits attained bright yellow color on 5th day of exposure. Fruits treated with different concentrations of ethrel solution recorded increasing PLW (2.01 to 3.13%) and could be due to upsurge in respiration rate leading to faster and uniform ripening compared to untreated fruits as observed by Mahajan *et al.* (2008). Rapid decline in fruit firmness values from 79.1N at 0th day to 8.8N in 300ppm ethrel treated fruits at full ripe stage of 5th day was due to breakdown of insoluble protopectin into soluble pectin or by cellular disintegration leading to membrane permeability. TSS of pulp during ripening increased from 7.9° to 20.1°B in 300ppm, 19.6°B in 200ppm and 19.3°B in 100ppm ethrel treated fruits at the end of 5th day storage might be due to the breakdown of starch into soluble sugars. There was consistent increase in yellowness value (b) of fruit pericarp with the ripening during the entire ripening period for all the treatments. The intensity of greenness in the peel of fruits increased with ripening and attained maximum 'a' value of

Papaya

Ethylene treated fruits attained bright yellow color on third day of exposure. There were significant differences among the various ripening treatments with regard to PLW, in general increased during ripening period. After three days of ripening, firmness score was 6.9N in 300ppm followed by 7.8N in 200ppm ethylene treated fruits, indicating firm to slightly firm nature of the fruit which is commonly acceptable to eat. Untreated fruits remained hard with a firmness value of 26.2N at the end of third day of ripening period. TSS progressively increased during ripening and the untreated fruits recorded only 8.7°Brix, while the ethylene treated fruits recorded the highest value of 14.6 °Brix at 300ppm followed by 13.9 °Brix at 200ppm of ethylene concentration. Ethrel treatment (300ppm) recorded highest 'b' value (61.48) and ethylene treatment is known to accelerate the chlorophyll degradation and induce yellowness in green tissues of the fruits.

The technique of using ethylene released from ethrel in alkaline medium was recommended as

simple, easy, safe, less expensive and more effective than other ripening techniques. This method may be adapted by small farmers and traders as an alternate to calcium carbide treatment.

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