International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 1142-1148

Received: 25-05-2020
Accepted: 28-06-2020

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Effect of post-harvest treatments on physico-chemical changes during ripening of papaya cv. red lady

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4i.9976

Abstract
Papaya fruits Cv. Red Lady treated with ethylene of different concentrations i.e. 60, 80, 100 and 120 ppm for five minutes at different temperature conditions *viz*., 16, 20, 24 and 28 ºC and 95% RH ripened in ripening chamber and untreated fruits kept at ambient temperature (30-35 ºC). Then the papaya fruits were analyzed for physico-chemical changes and sensory qualities. It was found that papaya fruits exposed to ethylene gas in the ripening chamber triggered the ripening process and showed that the increasing trends in L*, a*, b* values of colour, TSS (°Brix), Weight loss (%), reducing sugars (%) and decreasing trends in firmness (N), Titratable acidity (TA) during ripening in all the treatment combinations during advancement of ripening period from second day to eighth day. It was observed that papaya fruits Cv. Red Lady ripened by ethylene of 100 ppm for 5 minutes at 24 ºC, 95% RH showed better results in respect of a high overall acceptability score of 8.63.

Keywords: papaya**,** ethylene, temperature, ripening period, physico-chemical changes

Introduction
Papaya is native of tropical America and was introduced in to India in the 16th century. It is now grown in almost all tropical and subtropical countries of the world. Papaya fruit has gained importance in human diet because of its high nutritional and medicinal value. It is one of the richest source of carotene (Vitamin-A) and a fair source of vitamin C, besides being high in sugars and pectins. As papaya is a climacteric fruit, important biochemical changes occur during the process of ripening. Ripening in fleshy fruits is preceded by a shift in metabolism which leads to characteristic changes in their composition, texture and colour. The compositional changes include an increase in reducing sugars and aroma compounds and decline in acidity, astringency and chlorophylls (Selvaraj *et al.*, 1982) [19]. Ethylene is a naturally occurring plant growth substance that has numerous effects on ripening and storage life of fruits (Barry and Giovannoni *et al.*, 2007) [5].
Papayas are reported to ripen satisfactorily between 20 and 25 °C (Akamine, 1966; Broughton *et al.*, 1977) [1, 7] and not to ripen at 10 and 15 °C (Nazeeb and Broughton, 1978) [13]. The tolerance of papayas to temperatures below 10 °C varies with the maturity of the fruit and the duration and temperature of exposure. Temperatures above 32.2 °C cause delayed coloring and ripening, rubbery pulp texture, copious latex oozing, and fruit surface bronzing (Akamine, 1977) [2]. When papaya fruits ripen, they become softy and deteriorate in short time. As the matter of this, it is difficult to deliver ripened mango to larger market in big cities and hence, reduces the chance for better profit to farmers. Meanwhile, green mature mango is firm enough and can maintain its appearance during transportation and ethylene application can hasten fruit ripening. This brings more advantages to distribute to distant market places. The role of ethylene in the regulation of fruit ripening in many kinds of fruits was investigated. Montalvo *et al*. (2007) [12] concluded that ripening reactions controlled by ethylene can be increased by exposure of the fruit to an atmosphere containing exogenous ethylene in order to produce homogeneous external colour.
Quality conservation is a basic factor for papaya because the greatest part of the produce harvested is destined to fresh fruit commerce. So, there is a need to develop an appropriate

temperature condition when fruits exposed to ethylene gas in ripening chamber can be obtained to improve the storage life and quality, thus allowing a greater rationalization in its distribution and commercialization. Therefore, the present investigation was carried out to study the effect of different concentrations of ethylene at different temperatures on physico-chemical changes during ripening behaviour of papaya Cv. Red Lady.

2. Materials and Methods

The present research entitled "Effect of Post-Harvest Treatments on Physico-Chemical Changes during Ripening of Papaya Cv. Red Lady" was carried out in the Process Engineering Laboratory, Department of Processing and Food Engineering, Dr. NTR College of Agricultural Engineering, Bapatla, Guntur Dt., Andhra Pradesh during the year 2018 - 2019. Physiologically mature, healthy green fruits at an optimum maturity of papaya Cv. Red Lady was collected from local market, Bapatla. Manually harvested fruits were washed with chlorinated water for further investigation. The ripening chamber made up of polyurethane foam panels having a thickness of 60 mm with a dimension of 3.6 x 3.0 x 3.6 m having the capacity to hold 3000 kg of papaya fruits.

2.1 Independent Variables

- Temperatures – 16, 20, 24, 28 ºC
- Ethylene - 60, 80, 100 and 120 ppm

2.2 Dependent Variables

Physiological loss in weight, firmness, total soluble solids, titratable acidity, reducing sugars, ascorbic acid and colour.

The physiological loss in weight (PLW) was measured based on the method described by Pal, 1998 and Doreyappa *et al.*, 1994 and computed as per the formula given below.

$$\text{Physiological loss in weight, \%} = \frac{W_1 - W_2}{W_1} \times 100$$

where, W_1 = Initial weight of the unripe fruits
W_2 = Final weight of ripe fruit

The total soluble solids were determined by a hand held refractometer (0 – 80°, Portable refractometer, 300003 Sper Scientific, China) according to AOAC method, 1995. Ascorbic acid was determined by titration against 2,6-dichlorophenol indophenol following AOAC method 967.21 (AOAC, 1995) [4]. The papaya fruit samples were analyzed for titratable acidity and reducing sugars according to AOAC method, 1995. The fruit firmness was measured with the help of a fruit penetrometer (Model FT- 327, USA) using an 8 mm stainless steel probe. The colour of papaya fruit juice samples was measured using Hunter lab colour flex meter (M/s. Hunter lab, Reston, VA, USA; model CFLX-45). Data were recorded after 2, 4, 6 and 8 days of storage. Sensory evaluation was carried out by ten untrained panelists based on acceptability according to 9 point hedonic scale suggested by Amerine *et al.*, 1965.

2.3 Treatments

Ripening agents like ethylene was used for ripening of papaya fruits for experiment. Investigation was performed at different combinations of temperature and ethylene concentrations at 95% RH as coded below.

T0	Control
T1	Temp. - 16 °C, 60 ppm
T2	Temp. - 20 °C, 60 ppm
T3	Temp. - 24 °C, 60 ppm
T4	Temp. - 28 °C, 60 ppm
T5	Temp. - 16 °C, 80 ppm
T6	Temp. - 20 °C, 80 ppm
T7	Temp. - 24 °C, 80 ppm
T8	Temp. - 28 °C,80 ppm
T9	Temp. - 16 °C, 100 ppm
T10	Temp. - 20 °C, 100 ppm
T11	Temp. - 24 °C, 100 ppm
T12	Temp. - 28 °C, 100 ppm
T13	Temp. - 16 °C, 120 ppm
T14	Temp. - 20 °C, 120 ppm
T15	Temp. - 24 °C, 120 ppm
T16	Temp. - 28 °C, 120 ppm

3. Results and Discussion

3.1 Weight Loss

It was observed that the fruit weight loss increased with increase in temperature, ethylene concentration during the advancement of ripening from second day to eighth day (Fig. 1). The minimum weight loss (12.11%) was observed in control sample and maximum weight loss in fruits treated with ethylene (15.21%). In ethylene treated samples, the maximum increase in weight loss (8.57 to 15.21%) was observed at 120 ppm, 28 °C followed by the samples treated at 24, 20 and 16 °C respectively. The loss in weight during the present investigation was more in the treated fruits than control and it increased with increase in the concentration of ethylene/ethrel. The weight loss may be attributed to the physiological loss in weight due to respiration, surface evaporation through peel tissues and other biological processes taking place in both ethrel treated and untreated fruits. These findings are in full agreements with Kumar and Dhawan, 1995 [10].

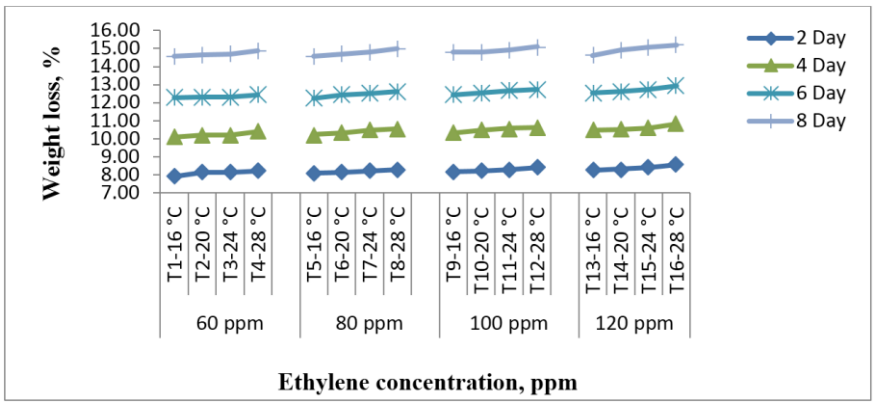

Fig 1: Effect of different concentrations of ethylene at different temperatures on weight loss during ripening of papaya fruits

3.2 Firmness

It was observed that the fruit firmness decreased with increase in temperature, concentration of ethylene during the advancement of ripening from second day to eighth day (Fig. 2). The maximum fruit firmness (6.11 N) was observed in control sample and minimum firmness in fruits treated with ethylene (4.82 N) In ethylene treated samples, the maximum decrease in firmness (14.52 to 4.82 N) was observed at 120 ppm, 28 °C followed by the samples treated at 24, 20 and 16 °C respectively. Similar results were also obtained by Yashoda *et al*., 2006 [20]. The decrease in firmness, during ripening may be due to breakdown of insoluble protopectin into soluble pectin or by cellular disintegration leading to membrane permeability (Brinston *et al*., 1988) [6].

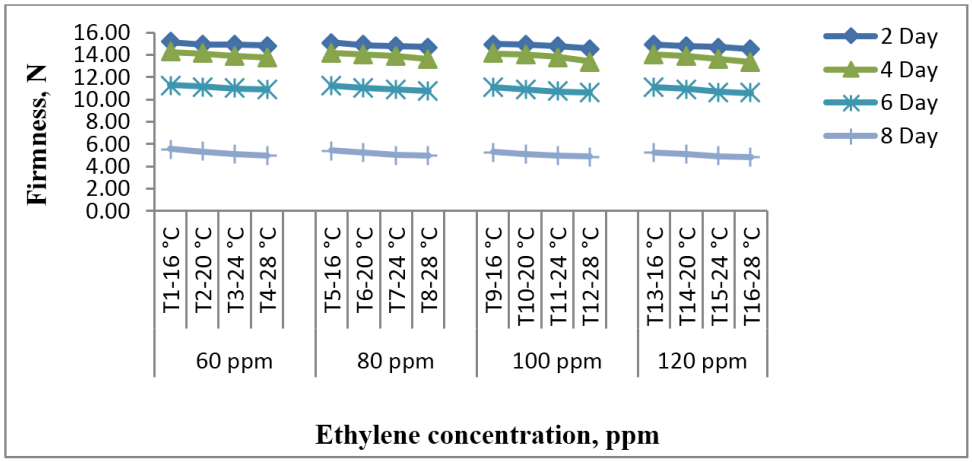

Fig 2: Effect of different concentrations of ethylene at different temperatures on firmness during ripening of papaya fruits

3.3 Total soluble solids (TSS)

It was observed that the fruit TSS increased with increase in temperature, ethylene concentration during the advancement of ripening from second day to eighth day (Fig. 3). The maximum TSS was observed in fruits treated with ethylene (10.78 °Brix) and minimum TSS in control sample (12.11 °Brix). In ethylene treated samples, the maximum increase in TSS (9.49 to 10.78 °Brix) was observed at 120 ppm, 28 °C followed by the samples treated at 24, 20 and 16 °C respectively. Similarly, increased total soluble solids due to post- harvest application of ethylene was also reported by Singh *et al*., 2012 [16] in papaya. The increase in TSS during ripening might be due to the alteration or transformation in cell wall structure and break down of complex carbohydrates, pectic substances, hemicellu-lose or other polysaccharide into simple sugars and dehydration of fruits during storage (Kittur *et al*., 2001) [9].

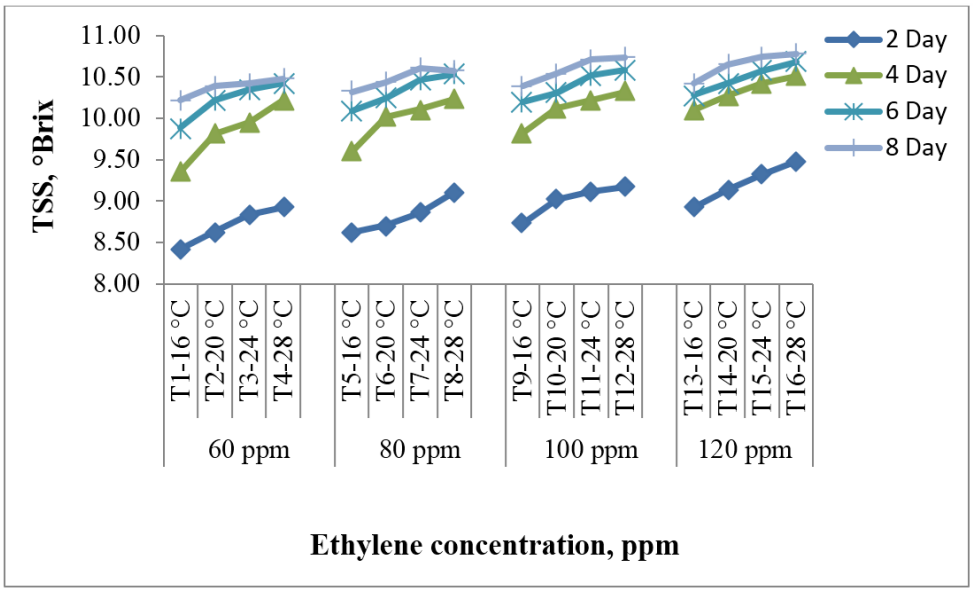

Fig 3: Effect of different concentrations of ethylene at different temperatures on total soluble solids (TSS) during ripening of papaya fruits

3.4 Titratable acidity (TA)

It was observed that the fruit TA decreased with increase in temperature, ethylene concentration during the advancement of ripening from second day to eighth day (Fig. 4). The maximum TA (0.19%) was observed in control sample and minimum TA in fruits treated with ethylene (0.11%). In ethylene treated samples, the maximum increase in TA (0.38-0.22%) was observed at 60 ppm, 16 °C followed by the samples treated at 20, 24 and 28 °C respectively. Similar finding was also noted in papaya (Singh *et al*., 2012) [16]. Riberau-Gayon (1968) suggested that transformation of organic acids into sugars was one of the reasons for decreasing organic acids during fruit ripening.

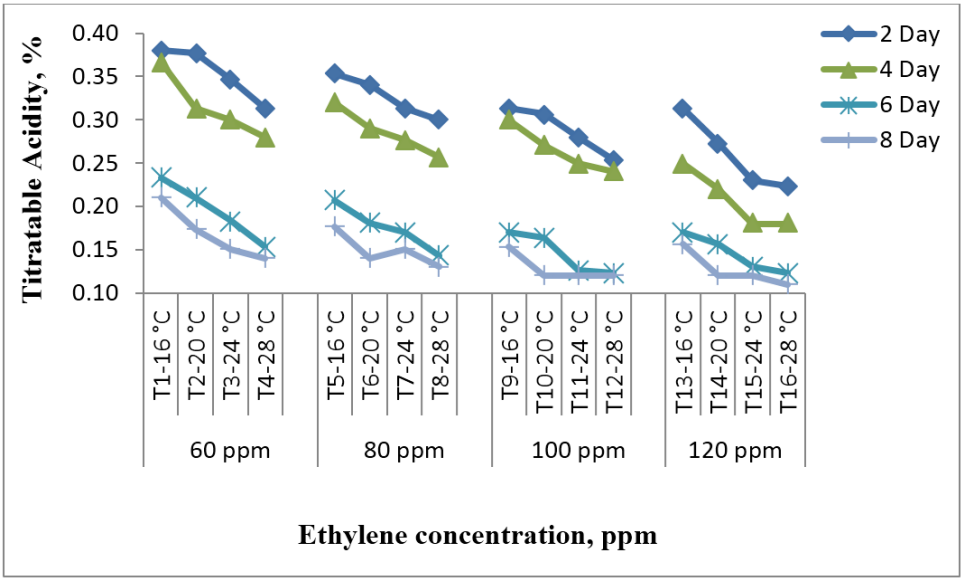

Fig 4: Effect of different concentrations of ethylene at different temperatures on titratable acidity (TA) during ripening of papaya fruits

3.5 Reducing sugars

It was observed that the fruit reducing sugars increased with increase in temperature, concentration of ethylene during the advancement of ripening from second day to eighth day (Fig. 5). The minimum reducing sugars (5.11%) was observed in control sample and maximum reducing sugars in fruits treated with ethylene (5.78%). In ethylene treated samples, the maximum increase in reducing sugars (4.92 to 5.78%) was observed at 120 ppm, 28 °C followed by the samples treated at 24, 20 and 16 °C respectively. Also, observed that the reducing sugars of papaya fruits were lowest for samples stored at 16 °C and highest for samples stored at 28 °C in ethylene concentrations. Similarly, high percentage of sugar with ethylene application was observed by Singh *et al*., 2012 in papaya. It was due to faster rate of respiration and formation of sugar content with oxidation of carbohydrate.

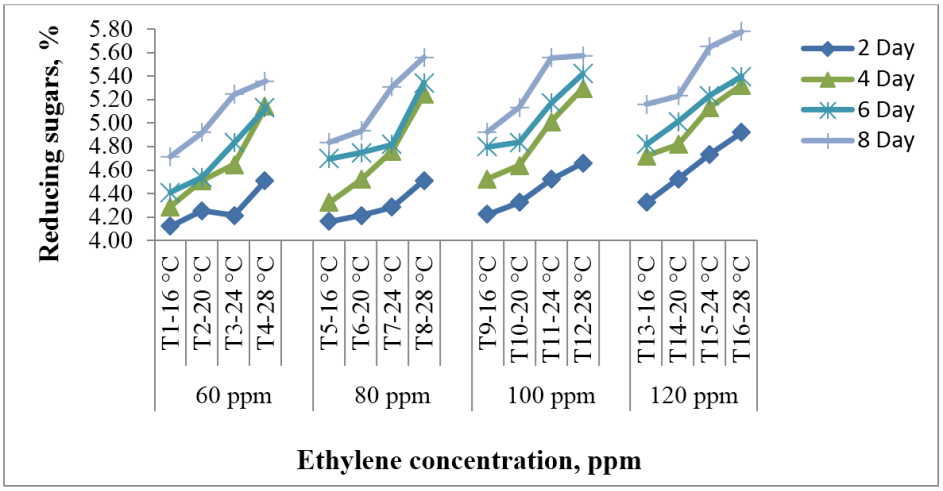

Fig 5: Effect of different concentrations of ethylene at different temperatures on reducing sugars during ripening of papaya fruits

3.6 Ascorbic acid

It was observed that the fruit ascorbic acid increased with increase in temperature, concentration of ethylene during the advancement of ripening from second day to sixth day (Fig. 6). After 6 days ripening period, ascorbic acid decreased with increase in temperature, concentration of ethylene up to ripening period of 8 days. The maximum ascorbic acid (40.12 mg/100 g) was observed in control sample and minimum ascorbic acid in fruits treated with ethylene (34.35 mg/100 g). In ethylene treated samples, the maximum decrease in ascorbic acid (49.68 to 34.35 mg/100 g) was observed at 120 ppm, 28 °C followed by the samples treated at 24, 20 and 16 °C respectively up to 6 days ripening period. A decline in ascorbic acid content of the fruits might be due to utilization of ascorbic acid in respiration process during ripening. Similar trend was also observed by Sakhale *et al*., 2006 [17].

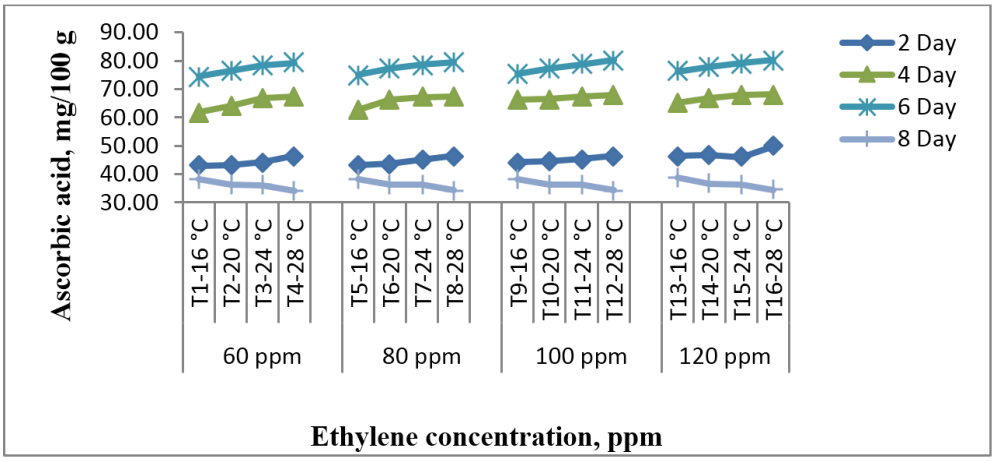

Fig 6: Effect of different concentrations of ethylene at different temperatures on ascorbic acid during ripening of papaya fruits

3.7 Colour (L*, a* and b*)

It was observed that the fruit L* values increased with increase in temperature, ethylene concentrations during the advancement of ripening from second day to eighth day (Fig. 7). The minimum L* value (50.32) was observed in control sample and maximum L* value in fruits treated with ethylene (59.71). Also, observed that the fruit a* and b* values increased with increase in temperature, ethylene concentrations during the advancement of ripening from second day to eighth day (Fig. 8 & 9). The minimum a* value (18.34) was observed in control sample and maximum a* value in fruits treated with ethylene (24.39). The minimum b* value (37.15) was observed in control sample and maximum b* value in fruits treated with ethylene (43.24). The colour development was better due to rapid degradation of chlorophyll and higher synthesis of carotenoids and other pigments in applied treatments. The findings of the present study confirm with the findings of Singh and Janes, 2001 and Singh *et al.*, 2012 [12] in mango. Exposures of fruits to ethylene gas have been reported to improve their colour and quality during storage and marketing (Kulkarni *et al.*, 2004) [11].

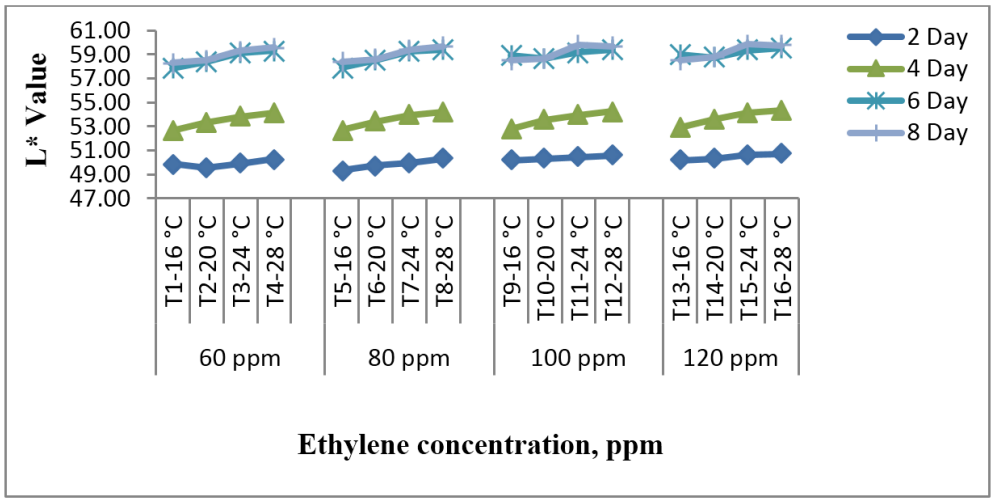

Fig 7: Effect of different concentrations of ethylene at different temperatures on L* value during ripening of papaya fruits

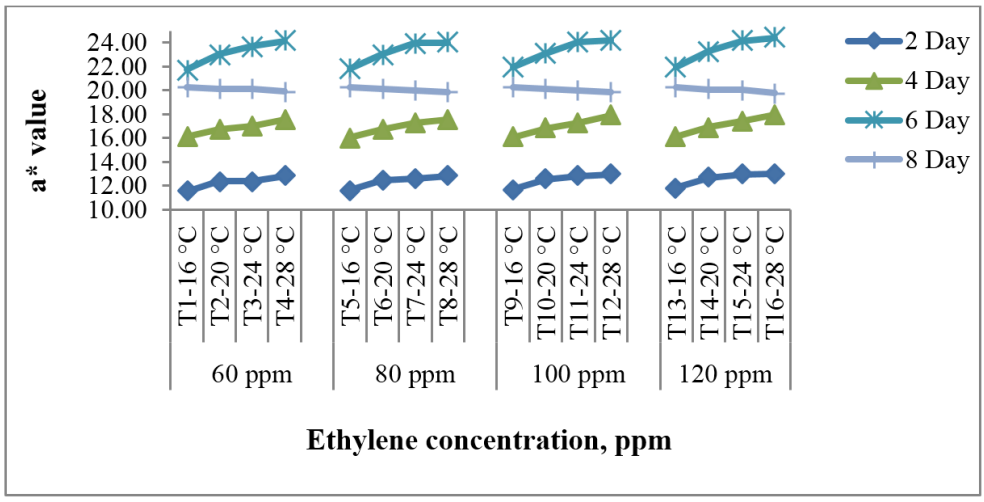

Fig 8: Effect of different concentrations of ethylene at different temperatures on a* value during ripening of papaya fruits

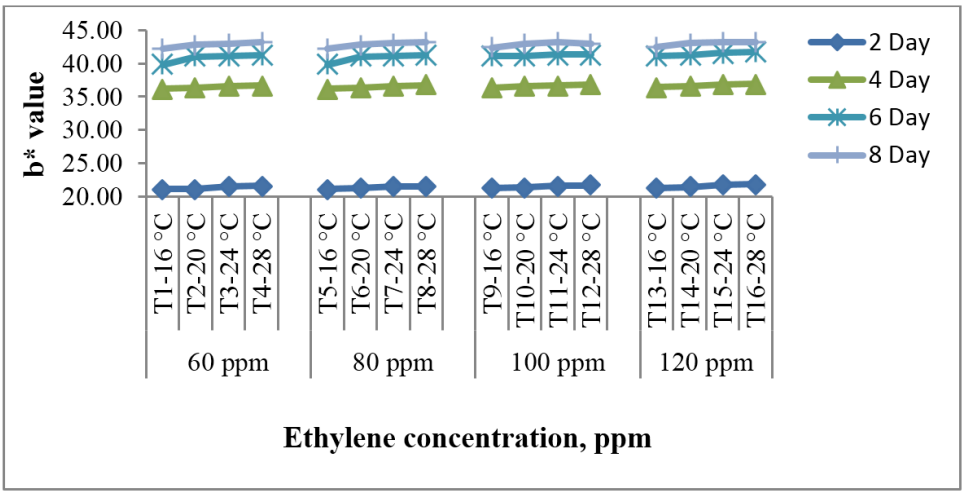

Fig 9: Effect of different concentrations of ethylene at different temperatures on b* value during ripening of papaya fruits

3.8 Effect of ethylene treatments in ripening chamber at different temperatures on sensory quality of Papaya Cv. Red Lady fruits

The data regarding the sensory qualities at fully ripened stage of papaya fruit Cv. Red Lady due to post-harvest treatments of ethylene gas are presented in Table 1. It is evident from the data that all the ethylene treated papaya fruits Cv. Red Lady recorded higher score for overall acceptability (8.63) was observed at 100 ppm, 24 °C during the period of 6 days whereas in control sample the overall acceptability was 6.88.

Table 1: Effect of different ethylene treatments and temperatures at 95% RH in ripening chamber on sensory quality of papaya Cv. Red Lady during 6 days

Treatments	Colour	Flavour	Taste	Texture	Overall acceptability
Control	6.00	7.00	7.50	7.00	6.88
T1	7.50	7.65	7.65	7.50	7.58
T2	7.50	7.50	8.25	8.25	7.88
T3	8.00	8.00	7.50	8.25	7.94
T4	8.00	8.25	7.50	8.50	8.06
T5	7.50	8.25	8.00	7.65	7.85
T6	8.00	8.25	8.00	8.25	8.13
T7	8.25	8.00	8.25	8.50	8.25
T8	8.25	8.25	8.50	8.25	8.31
T9	8.00	8.25	8.00	8.00	8.06
T10	8.25	8.00	8.00	8.25	8.13
T11	8.75	8.75	8.50	8.50	8.63
T12	8.75	8.50	8.50	8.50	8.56
T13	8.00	8.45	8.25	8.00	8.18
T14	8.00	8.25	8.25	8.25	8.19
T15	8.50	8.50	8.25	8.25	8.38
T16	8.50	8.25	8.50	8.25	8.38

4. Conclusion

The excellent flavour with deep yellow fruit colour, organoleptic taste and highly acceptable marketability was observed at 100 ppm ethylene treatment, 24 °C during ripening period of 6 days as compared to the other treatments. It was concluded that the papaya cultivar Red Lady treated with 100 ppm of ethylene for five minutes and ripened in ripening chamber at 24 °C exhibited best post-harvest quality attributes during ripening period.

5. References

1. Akamine EK. Respiration of fruits of papaya *(Carica papaya* L., var. Solo) with reference to the effect of quarantine disinfestations treatments. Proceedings of the American Society for Horticultural Science. 1966; 89:231-236.
2. Akamine EK. Hastening the ripening of papayas for processing. Proc. 13th Annu. Hawaii Papaya Indian Association Conference. 1977, 32-38.
3. Amerine MA, Pangborn RM, Roessler EB. Principles of Sensory evaluation of Food. *Academic Press*, London. 5, 1965.
4. AOAC. Official Methods of Analysis 16th edition.. Association of Official Analytical Chemists Washington D C, 1995
5. Barry CS, Giovannoni JJ. Ethylene and fruit ripening. Journal of Plant Growth Regulation. 2007; 26(2):143-159.
6. Brinston K, Dey PM, John MA, Pridhan JB. Post-harvest changes in *Mangifera indica* mesocarp walls and cytoplasmic polysaccharides. Phytochemistry. 1988; 27:719-723.
7. Broughton WJ, Hashim AM, Shen TC, Tan IKP. Maturation of Malaysian fruits. I. Storage conditions and ripening of papaya *(Carica papaya* L. Cv. Sunrise Solo). Malaysian Agricultural Research and Development Institute. 1977; 5:59-72.

8. Doreyappy-Gowda IND, Huddar AG. Studies on ripening changes in mango (Mangifera indica L.) fruits. Journal of Food Science and Technology. 2001; 38:135-137.
9. Kittur FS, Saroja N, Habibunnisa N, Tharanathan RN. Polysaccharide-based composite coating formulations for shelf-life extension of fresh banana and mango. European Food Research and Technology. 2001; 213:306-311.
10. Kumar A, Dhawan SS. Effect of post-harvest treatments on the enhancement of ripening of mango (*Mangifera indica* L) fruit cv. Dashehari. Haryana Journal of Horticultural Sciences. 1995; 24(2):109-115.
11. Kulkarni SG, Kudachikar VB, Vasanta MS, Prakash MNK, Prasad BA, Ramana KVR. Studies on effect of ethrel dip treatment on ripening behaviour of mango variety Neelum. Mysore Journal of Food Science and Technology. 2004; 41:216-220.
12. Montalvo E, Garcia HS, Tovar B, Mata M. Application of exogenous ethylene on postharvest ripening of refrigerated Ataulfo mangoes. Food Science and Technology. 2007; 40:1466-1472.
13. Nazeeb M, Broughton WJ. Storage conditions and ripening of papaya Bentong and Taiping. *Scientia Horticulture.* 1978; 9:265-277.
14. Pal RK. Ripening and rheological properties of mango as influenced by ethrel and carbide. Journal of Food Science and Technology. 1998; 35(4):358-360.
15. Ribereau Gayon G. Etudedes mechanisms synthese at de transformation delacide mailique,de l‟acide tartique at de I‟acide mailique, chaz *Vitis vinifera* L. *Phytochemistry*, 1968; 7:1471-1482.
16. Singh P, Kumar S, Maji S. Effect of ethrel on postharvest changes in papaya. Horticulture Flora Research Spectrum. 2012; 1(3):225-230.
17. Sakhale BK, Pawar VN, BMK. Effect of Ethrel on Hastening of Onset of Ripening in Kesar Mango (*Mangifera indica* L.). In Proceedings of 8th International Mango Symposium, February 2006; 820:635-642.
18. Siddiqui MW, Dhua RS. Standardization of ethrel treatment for inducing ripening of mango var. Himsagar. International Congerence on Horticulture-2009, Horticulture for Livelihood Security and Economic Growth, November 09-12, 2009, Bangalore, India, 2009, 325.
19. Selvaraj Y, Pal DK, Subramanyam, Iyer CPA. Changes in the chemical composition of four cultivars of papaya during growth and development. Journal of Horticultural Science. 1982; 57(1):135-143.
20. Yashoda HM, Prabha TN, Tharanathan RN. Mango ripening: changes in cell wall constituents in relation to textural softening. Journal of the Science Food and Agriculture. 2006; 86(5):713-721.