

Original Research Article

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## Effect of Post-harvest Degreening on Vitamin-C Content of Acid Lime Cv. Balaji

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### ABSTRACT

#### Keywords

Acid lime, Cv. Balaji, Degreening, Vitamin- C

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Aim of present investigation was analyse the effect of post-harvest degreening with ethylene on Vitamin C content of Acid lime Cv. Balaji. The present research was conducted at Post-harvest laboratory, college of horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad, during the year 2018-2019. Degreening experiment was designated with factorial completely randomized design with two factors viz., (A) Ethylene concentrations, (B) Number of pulsings. Vitamin C is most important among the quality parameters of citrus fruits. This investigation concluded that the Vitamin-C content of Acid lime Cv. Balaji declined with ethylene treatment but, the effect of ethylene was not directly on Vitamin-C, which decreases with ripening. 10-15ppm ethylene with shortest exposure times gives the uniform degreening and good levels of Vitamin C.

### Introduction

Vitamin-C is required for a range of essential metabolic reactions in all animals and plants. Deficiency of this vitamin causes the disease scurvy. As Vitamin-C is needed for the growth and repair of tissues in all parts of our body and it is used to form an important protein used to make skin, tendons, ligaments and blood vessels, heal wounds and form scar tissues, repair and maintaining cartilage, bones and teeth. It is one of the many antioxidants, which removes free radicals and stimulate the immune system and prevents and treat cancers. The body is not able to

make Vitamin- C on its own, and it does not store Vitamin-C. Citrus fruits are good source of Vitamin-C. One lime can provide 32% of the vitamin-C needed in a day.

Green colored lime fruits are considered unripe and fetch lower prices. Hence the degreening of the lime is the most important factor determining marketability. But degreening with high doses of ethylene reduces the vitamin- C levels so the present study aims at investigating the effect of post-harvest degreening on vitamin-C content of Acid lime Cv. Balaji.

## Materials and Methods

### Acid lime Cv. Balaji fruits

Acid lime Cv. Balaji (*Citrus aurantifolia* S.) fruits were collected from citrus orchard. Matured fruits are harvested manually and immediately transported to degreening chamber and subjected to the ethylene treatments at room temperature 27-28 °C. Treated fruits were stored up to 16 days. Some treatments were spoiled after 12 days of storage. Their mean values were recorded.

### Ethylene cylinder

Ethylene release canisters named Ripylene, manufactured by Chemtron science laboratories, Mumbai were used in the research. 15 grams of ethylene gas was filled in a cylinder with adjustable gauge. This was approved by National Horticulture Board, Food Safety and Standards Authority of India and Food and Drug Administration as a gas for ripening.

### Low-cost ripening chamber

The low-cost ripening chamber consists of 40mm PUF (Polyurethane Foam) insulated panels with PPGI Sheets (Pre painted Galvanised Iron) lamination on either side, with flashings and swing door - 300 x 600 mm with the capacity of 5 crates (100 kg).

### Experimental Details

Experiment was designated with two factorial completely randomized design and executed with the objective: effect of post-harvest degreening on Vitamin-C content of Acid lime Cv. Balaji. Acid lime Cv. Balaji fruits were allowed to degreen in Low Cost Ripening Chamber with ethylene treatment with different levels of ethylene concentrations *i.e.* (A<sub>1</sub>) 5ppm (A<sub>2</sub>) 10ppm

(A<sub>3</sub>) 15ppm and (A<sub>4</sub>) 20ppm were given four levels of number of pulsings *viz.*, (B<sub>1</sub>) 6 pulsings in 24 hrs @ 4 hrs. interval (B<sub>2</sub>) 4 pulsings in 24 hrs @ 6 hrs. interval (B<sub>3</sub>) 2 pulsings in 24 hrs @ 12 hrs. interval and (B<sub>4</sub>) 1 pulsing in 24 hrs @ 24 hrs. interval. The combination of 2 factors gives 16 treatments *viz.*,

T<sub>1</sub>. 5 ppm ethylene with 6 pulsings in 24 hrs @ 4 hrs interval

T<sub>2</sub>. 5 ppm ethylene with 4 pulsings in 24 hrs @ 6 hrs interval

T<sub>3</sub>. 5 ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval

T<sub>4</sub>. 5 ppm ethylene with 1 pulsing in 24 hrs @ 24 hrs interval

T<sub>5</sub>. 10 ppm ethylene with 6 pulsings in 24 hrs @ 4 hrs interval

T<sub>6</sub>. 10 ppm ethylene with 4 pulsings in 24 hrs @ 6 hrs interval

T<sub>7</sub>. 10 ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval

T<sub>8</sub>. 10 ppm ethylene with 1 pulsing in 24 hrs @ 24 hrs interval

T<sub>9</sub>. 15 ppm ethylene with 6 pulsings in 24 hrs @ 4 hrs interval

T<sub>10</sub>. 15 ppm ethylene with 4 pulsings in 24 hrs @ 6 hrs interval

T<sub>11</sub>. 15 ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval

T<sub>12</sub>. 15 ppm ethylene with 1 pulsing in 24 hrs @ 24 hrs interval

T<sub>13</sub>. 20 ppm ethylene with 6 pulsings in 24 hrs

@ 4 hrs interval

T<sub>14</sub>. 20 ppm ethylene with 4 pulsings in 24 hrs  
@ 6 hrs interval

T<sub>15</sub>. 20 ppm ethylene with 2 pulsings in 24 hrs  
@ 12 hrs interval

T<sub>16</sub>. 20 ppm ethylene with 1 pulsing in 24 hrs  
@ 24 hrs interval

### Details of control

Vitamin C (mg/100g) values of Acid lime Cv. Balaji fruits after harvest without subjecting to ethylene (control) were recorded. The values were 49.99, 49.92 and 42.88 on 1<sup>st</sup>, 4<sup>th</sup> and 8<sup>th</sup> day respectively.

### Vitamin-C (mg/100g): Ascorbic acid (mg/100g)

Ascorbic acid was estimated by the procedure elicited by Ranganna (1987). Ten grams of fruit tissue was blended in 3 % meta-phosphoric acid and the volume was made up to 100 ml of H<sub>3</sub>PO<sub>4</sub>. The contents were filtered through Whatman No.1 filter paper and 10 ml of the aliquot was taken and titrated with standard dye (2, 6-dichlorophenol-indophenol dye) to a pink end point. The ascorbic acid was expressed as mg ascorbic acid/100 g. Ascorbic acid was calculated by using following formula.

$$\text{Ascorbic Acid} := \frac{\text{Titre Value} \times \text{Dye Factor} \times \text{Volume Made Up} \times 100}{\text{Aliquot Taken for Estimation} \times \text{Weight of Sample for Estimation}}$$

### Statistical analysis

The design adopted was completely randomized design with 2 factors (ethylene dose and number of pulsings). All the analysis was performed in 3 replicates of samples and the results were presented as critical difference (CD) and standard deviation. The experimental data were subjected to (ANOVA) using module of ICAR CCARI WASP. Least significance difference

(Fisher's protected LSD) were calculated following significant F test (p=0.05). All assumptions of analysis were checked to ensure validity.

### Results and Discussion

The data pertaining to Vitamin-C (mg/100g) of Acid lime Cv. Balaji at ambient temperature as influenced by ethylene concentrations and number of pulsings in tables 1 to 4 and Figs. 1 and 2.

### Effect of ethylene concentrations on Vitamin-C in acid lime Cv. Balaji

On 4<sup>th</sup> day (Table 1.) among the ethylene concentrations significantly maximum level of Vitamin-C was recorded with ethylene @ 5 ppm (49.89 mg/100g) followed by ethylene @ 10 ppm (47.63 mg/100g) while, lowest with 20 ppm (44.53 mg/100g). On 8<sup>th</sup> day (Table 2.) among the ethylene concentrations significantly maximum level of Vitamin-C was recorded with ethylene @ 5 ppm (42.50 mg/100g) followed by 10 ppm (41.78 mg/100g) while, lowest with 20 ppm (38.69 mg/100g).

### Effect of number of pulsings on Vitamin-C in acid lime Cv. Balaji

On 4<sup>th</sup> day (Table 1.) among the time of pulsing significantly maximum level of Vitamin-C was recorded with 1 pulsing in 24 hrs @ 24 hrs interval (47.59 mg/100g), followed by 2 pulsings in 24 hrs @ 12 hrs interval (47.01 mg/100g) while, lowest with 6 pulsings in 24 hrs @ 4 hrs interval (46.55 mg/100g). On 8<sup>th</sup> day (Table 2.) among the time of pulsing significantly maximum level of Vitamin-C was recorded with 1 pulsing in 24 hrs @ 24 hrs interval (41.24 mg/100g), followed by 2 pulsings in 24 hrs @ 12 hrs interval (40.98 mg/100g) while, lowest with 6 pulsings in 24 hrs @ 4 hrs interval (40.26 mg/100g).

**Interaction effect of ethylene concentrations and number of pulsings on Vitamin-C in Acid lime Cv. Balaji**

Among the storage days 4<sup>th</sup> and 8<sup>th</sup> day interaction between ethylene concentration and number of pulsings were significantly differed. On 4<sup>th</sup> day significantly maximum level of Vitamin-C was noticed in 5ppm ethylene with 1 pulsing in 24 hrs@ 24 hrs interval (49.98 mg/100g). 5ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval (49.92 mg/100g), 5ppm ethylene with 4 pulsings in 24 hrs@ 6 hrs interval (49.86 mg/100g) and 5ppm ethylene with 6 pulsings in 24 hrs@ 4 hrs interval (49.81 mg/100g) were at par with 5ppm ethylene with 1 pulsing in 24 hrs@ 24 hrs interval (49.98 mg/100g) while, minimum in 20ppm ethylene with 6 pulsings in 24 hrs@ 4 hrs interval (43.73 mg/100g). On 8<sup>th</sup> day significantly maximum level of Vitamin-C was noticed in 5ppm ethylene with 1 pulsing in 24 hrs@ 24 hrs interval (42.86 mg/100g) followed by 5ppm ethylene with 2 pulsings in 24 hrs@ 12 hrs interval (42.64 mg/100g). 10ppm ethylene with 1 pulsing in 24 hrs@ 24

hrs interval (42.03 mg/100mg) was at par with 5ppm ethylene with 6 pulsings in 24 hrs @ 4 hrs interval (42.17 mg/100mg) while, lowest in 20ppm ethylene with 6 pulsings in 24 hrs@ 4 hrs interval (38.24 mg/100g). The mean values recorded in the Vitamin-C of Acid lime Cv. Balaji fruits at 12<sup>th</sup> day and 16<sup>th</sup> day during storage tabulated at Table 3 and 4 respectively. A similar decreasing trend in respect of Vitamin-C was observed.

Vitamin C is among the most important quality parameters for fruits. In present investigation, vitamin C content was decreased with an increase in storage time. Degreening process promotes the conversion of acids to sugars leads to decrease in the Vitamin-C content (Bisen *et al.*, 2012).

With the advancement of storage period, total soluble solids were increased while Vitamin-C and acidity of fruits decreased in Kagzi lime (Piyush and Dashora, 2000). It is evident from the data that, Vitamin-C content of lime fruits was gradually decreased with the time (Ayesha *et al.*, 2014).

**Table.1** Ascorbic acid (mg/100g): of Acid lime Cv. Balaji as influenced by ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature on 4<sup>th</sup> day

Ethylene concentrations	Number of pulsings per 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
Ethylene @5ppm	49.81	49.86	49.92	49.98	49.89 <sup>A</sup>
Ethylene @ 10ppm	47.18	47.22	47.46	48.64	47.63 <sup>B</sup>
Ethylene @ 15ppm	45.49	45.62	45.93	46.42	45.87 <sup>C</sup>
Ethylene @ 20ppm	43.73	44.33	44.74	45.33	44.53 <sup>D</sup>
Mean	46.55 <sup>d</sup>	46.76 <sup>c</sup>	47.01 <sup>b</sup>	47.59 <sup>a</sup>	
<b>Factors</b>	<b>CD (5%)</b>		<b>SEm±</b>		
Ethylene concentrations (A)	0.07		0.03		
Number of pulsings (B)	0.07		0.03		
Factor A × B	0.15		0.05		

**Table.2** Ascorbic acid (mg/100g) of Acid lime Cv. Balaji as influenced by ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature on 8<sup>th</sup> day

Ethylene concentrations	Number of pulsings per 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
<b>Ethylene @5ppm</b>	42.17	42.32	42.64	42.86	42.50 <sup>A</sup>
<b>Ethylene @ 10ppm</b>	41.32	41.86	41.91	42.03	41.78 <sup>B</sup>
<b>Ethylene @ 15ppm</b>	39.32	39.62	40.64	40.86	40.11 <sup>C</sup>
<b>Ethylene @ 20ppm</b>	38.24	38.59	38.71	39.22	38.69 <sup>D</sup>
<b>Mean</b>	40.26 <sup>d</sup>	40.59 <sup>c</sup>	40.98 <sup>b</sup>	41.24 <sup>a</sup>	
<b>Factors</b>	<b>CD (5%)</b>		<b>SEm±</b>		
<b>Ethylene concentrations (A)</b>	0.14		0.05		
<b>Number of pulsings (B)</b>	0.14		0.05		
<b>Factor A × B</b>	0.28		0.10		

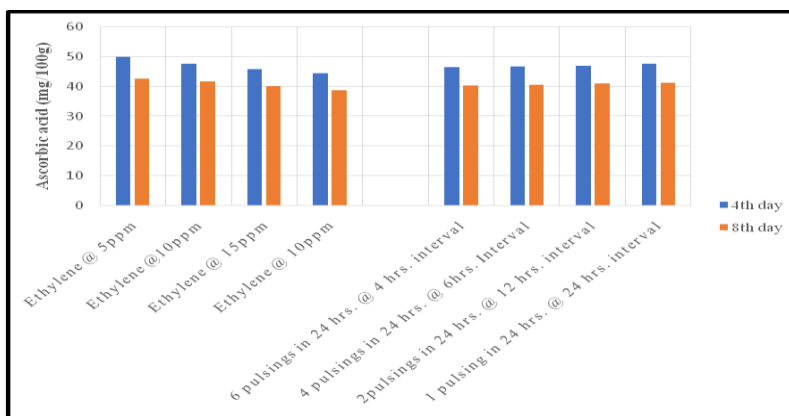
**Table.3** Ascorbic acid (mg/100g) of Acid lime Cv. Balaji as influenced by ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature on 12<sup>th</sup> day

Ethylene concentrations	Number of pulsings per 24 hrs.			
	6 pulsings	4 pulsings	2 pulsings	1 pulsing
<b>Ethylene @5ppm</b>	-	-	-	-
<b>Ethylene @ 10ppm</b>	39.35	40.55	-	-
<b>Ethylene @ 15ppm</b>	38.47	38.95	39.28	39.85
<b>Ethylene @ 20ppm</b>	-	-	38.68	39.73

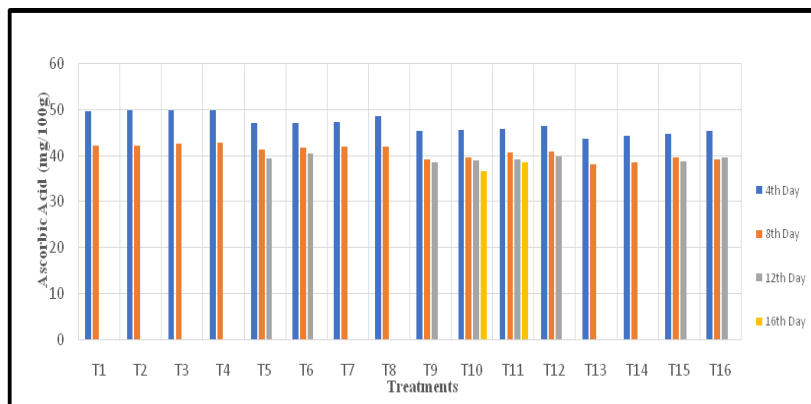
**Table.4** Ascorbic acid (mg/100g) of Acid lime Cv. Balaji as influenced by ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature on 16<sup>th</sup> day

Ethylene concentrations	Number of pulsings per 24 hrs.			
	6 pulsings	4 pulsings	2 pulsings	1 pulsing
<b>Ethylene @5ppm</b>	-	-	-	-
<b>Ethylene @ 10ppm</b>	-	-	-	-
<b>Ethylene @ 15ppm</b>	-	36.61	38.56	-
<b>Ethylene @ 20ppm</b>	-	-	-	-

**Fig.1** Ascorbic Acid (mg/100g) of Acid lime Cv. Balaji as influenced by different ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature



**Fig.2** Ascorbic Acid (mg/100g) of Acid lime Cv. Balaji as influenced by interaction between ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature on 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup> and 16<sup>th</sup> day



In the present investigation among the ethylene concentrations 15ppm and 20ppm show good degreening but, 20ppm ethylene drastically reduces the vitamin-C content due the high rate of respiration. Among the time of pulsings 1 pulsing in 24 hrs. and 2 pulsings in 24 hrs. were better regarding the Vitamin-C content. So, 15ppm ethylene with 1pulsing in 24 hrs. and 2 pulsings in 24 hrs. were best treatments. They give uniform degreening and no effect on recovery of vitamin-C. The present investigation was agreement with Ladaniya and Shyam (2001). They were reported that the Vitamin-C content of sweet orange declined with ethylene treatment but,

the effect of ethylene was not directly on Vitamin-C, which decreases with ripening.

Similar results were reported by Jadhao *et al.*, (2008) and Bisen *et al.*, (2012). Where vitamin C content was slightly reduced during the storage. the decline in vitamin C content seems to be caused by the oxidation of Vitamin-C by enzymes.

In conclusion the degreening process promotes the conversion of acids to sugars leads to decrease in the Vitamin-C content. Therefore, degreening must be performed under appropriate conditions, using the lowest



possible levels of ethylene *i.e.*, 10ppm and 15ppm and shortest possible exposure times *i.e.*, 1 pulsing in 24hrs. @ 24hrs. interval and 2 pulsings in 24hrs. @ 12hrs. interval. Finally, to conclude 15ppm ethylene with 1 pulsing in 24 hrs. @ 24 hrs. interval and 15ppm ethylene with 2 pulsings in 24 hrs. @ 12 hrs. interval were best treatments. They give uniform degreening and no effect on recovery of vitamin-C.

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