

# Original Research Article

## **Pre-harvest salicylic acid spray on shelf life and biochemical changes of litchi during storage**

### **ABSTRACT**

An experiment was conducted on litchi cv. China at Horticulture garden in the Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, to show the shelf life and biochemical changes of litchi during storage. The experiment was laid out in randomized block design with five treatments and four replications. Salicylic acid was sprayed twice i.e. 15 days and 30 days before anticipated harvesting time with different concentrations of salicylic acid (T<sub>1</sub>- 50 ppm, T<sub>2</sub>-100 ppm, T<sub>3</sub>-150 ppm, T<sub>4</sub>-200 ppm and T<sub>5</sub>-control). Different concentrations have different effect on shelf life and biochemical parameters. Salicylic acid with T<sub>3</sub>-150 ppm has increased TSS (20.02 °Brix), total sugar (13.10 %), ascorbic acid (38.21 mg/100 g pulp), anthocyanin (8.06 mg/100g pulp) and shelf life (4 days) on the 6<sup>th</sup> day of storage at ambient condition.

**Keywords:** Litchi, salicylic acid, biochemical parameters, shelf life

### **1. INTRODUCTION**

As India has such a diverse climate, it is ideal for cultivation of different varieties of litchi. Litchi (*Litchi chinensis* Sonn.) belongs to sapindaceae family. It is native of Southern China. Its chromosome no. 2n=30 and type of fruit is one seeded nut and its edible part is fleshy aril. It is highly cross pollinated crop. Its name is derived from Chinese word “lee chee” which means “one who gives the pleasure of life”. It is grown in tropical and sub tropical regions. Due to its bright red peel colour and pleasant flavoured juicy aril this fruit is highly valued in national and international markets. Litchi fruit is very much liked as a table fruit as well as in dried and canned forms. Jam, jelly, squash and cordial are also prepared from this fruit. It is very nutritious and good source of vitamin C (64 mg/100 g pulp). It also contains vitamin E, B complex and trace amount of protein (0.7%), fat (0.3%) and minerals like phosphorous, calcium and iron. It is non climacteric type fruit; it does not ripe after harvesting from plants so it is harvested at ripe stage. Litchi is grown in different countries like China, West Indies, Myanmar, Japan, South Africa, Florida, Hawaii, etc. in the world; India is one among them. China is first and India is second largest producer of litchi fruits in the world. Litchi is very perishable in nature and it has very short shelf life. Litchi being non climacteric in nature it is harvested at ripe stage. Generally, the harvest maturity of the fruit is judged by the development of red colour on epicarp and flattened of the tubercles. After harvesting, the fruit turn brown within a couple of days due to loss of water from the pericarp. (Panwar *et al.* 2018) reported that salicylic acid decreases

38 respiration rate by the closure of stomata. Salicylic acid (SA) is a natural plant hormone and it  
39 acts as signaling molecule. It makes the plants resistance against biotic and abiotic stress (Khan  
40 *et al.* 2012). SA helps in plant growth, ion uptake and nutrient transport in plants. It is phenolic  
41 compound, and in plants it provides systemic resistance to fungal pathogens (Meena *et al.* 2014).  
42 Pre harvest application of various chemicals have been reported to enhance the shelf life of fruits  
43 by reducing physiological loss in weight and decay losses during storage (Gupta and Metha,  
44 1988).

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## 46 **2. MATERIALS AND METHODS**

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48 The present investigation was carried out at the Horticulture Garden under the Department of  
49 Horticulture (Fruit & Fruit Technology), Bihar Agricultural College, Bihar Agricultural  
50 University, Sabour, Bhagalpur during the year of 2021-2022 with a view to study the pre-harvest  
51 application of salicylic acid on shelf life and biochemical changes in litchi during storage.  
52 Variety used for this experiment was “China”. The experiment was laid out with five treatments  
53 (T<sub>1</sub>-50 ppm SA, T<sub>2</sub>- 100 ppm SA, T<sub>3</sub>- 150 ppm SA, T<sub>4</sub>- 200 ppm SA and T<sub>5</sub>- control) and four  
54 replications in randomized block design. Bihar Agricultural College Sabour is situated 25°50' N  
55 latitude and 87°19' E longitude at an altitude of 52.73 m above mean sea level. It has an average  
56 annual rainfall of 1348 mm precipitating mostly in between middle of June to middle of October.

57 Biochemical parameters namely titrable acidity (%) was calculated by the given titration method  
58 (AOAC, 2000), ascorbic acidity (mg/100 g pulp) was estimated by using 2-6-dichlorophenol  
59 indophenols dye method (Jones and Hughes, 1983), TSS (°Brix) was recorded with the help of  
60 digital hand refractometer, TSS: Acid ratio was calculated by dividing TSS with titrable acidity,  
61 total sugar (%) was estimate by Lane and Eyon (1923) copper titration method, anthocyanin  
62 (mg/100 g pulp) was calculated by peel pH- differential method (Wrolstad *et al.* 2005) using two  
63 different buffer systems: potassium chloride buffer (0.025 M, pH 1.0) and sodium acetate buffer  
64 (0.4 M, pH 4.5), antioxidant ( $\mu$  mol Trolox Eq. /g pulp) was determined by cupric reducing  
65 antioxidant capacity (CUPRAC) method (Apak *et al.* 2008).

66

### 67 **Statistical analysis**

68 The experiment was laid out in RBD. Statistical analysis was performed in two way factorial  
69 RBD method. Least significant difference was calculated following significant F-test ( $p \leq 0.05$ ).  
70 Effect of different treatments on various parameters and their interactions were assessed with  
71 ANOVA. Standard errors were computed by MS-Excel. This RBD design was adopted as  
72 suggested by Panse and Sukhatme (1967).

73

## 74 **3. RESULT AND DISCUSSION**

75

### 76 **Total soluble solids (°Brix)**

77 Maximum (20.99 °Brix) TSS was in T<sub>3</sub>-150 ppm while minimum (10.20) in T<sub>5</sub>- control. It was  
78 found that untreated (control) fruits exhibited a rapid increase in total soluble solids (TSS) from  
79 the day of harvest and a sharp decline, thereafter during storage at ambient conditions compared  
80 to the treated ones. The rapid and higher TSS in control fruits might be due to faster ripening  
81 associated with the hydrolysis of starch into simple sugars. The delayed increase of TSS in SA  
82 treated fruits might be due to inhibition of ethylene biosynthesis. A delayed increase in TSS of  
83 SA treated fruits was reported in kiwifruit (Kazemi *et al.* 2011), peach (Khadami and Ershadi,  
84 2013) and persimmon (Khademi *et al.* 2012).

85

#### 86 **Total sugar (%)**

87 Total sugar increased with increase in storage period. Among all the treatments fruits treated  
88 with T<sub>3</sub>-150 ppm salicylic acid recorded highest (18.90 %) sugar as compared to other  
89 treatments, while lowest (9.30 %) in control. The increase in total sugars of fruits with SA may  
90 be due to loss of water from the fruits and conversion of polysaccharides and pectic substances in  
91 sugars. The higher rate of acceleration in SA treated fruits may be due to retardation in the rate  
92 of normal changes of polysaccharides to total sugars because of its low rate of respiration and  
93 oxidation in treated fruits reported by Roe and Brummer (1981) and Yuvraj *et al.* (1999) in  
94 mango fruits.

95

#### 96 **Titration acidity (%)**

97 The highest (0.569 %) titration acidity was observed in treatment T<sub>5</sub>-control whereas lowest  
98 (0.255 %) in T<sub>3</sub>-150 ppm. A continual decrease in titration acidity was noticed during storage at  
99 ambient conditions. SA treated fruits shown a significant slower decline over the untreated fruits.  
100 The reduction in acidity during storage after attainment of maturity and ripening may be due to  
101 utilization of organic acids as a substrate (Islam *et al.* 2013). Similar results of greater titration  
102 acidity in mango fruits were also reported by Barman (2013).

103

#### 104 **Ascorbic acid (mg/100g pulp)**

105 Highest (10.10 mg/100g pulp) ascorbic acid was in treatment T<sub>3</sub>-150 ppm salicylic acid whereas  
106 lowest in T<sub>5</sub>-control. Ascorbic acid was decreased with advancement of storage period. It was  
107 revealed that decrease in ascorbic acid was significantly higher throughout the storage period  
108 in the fruits treated with SA compared to untreated ones. It could be possible due to retardation  
109 of oxidation process and slow rate of conversion of L-ascorbic acid into dehydroascorbic acid  
110 (DHA) by ascorbic acid oxidase. DHA concentration was maintained at higher levels in salicylic  
111 acid treated fruits than in controls, leading to higher concentration in ascorbic acid throughout  
112 the storage period (Garcia-Pastor *et al.* 2020).

113

#### 114 **Anthocyanin (µmol Trolox Eq. /g pulp)**

115 Highest (8.06 µmol Trolox Eq. /g pulp) anthocyanin was found in treatment T<sub>4</sub>-200 ppm salicylic  
116 acid treated fruits whereas lowest (1.50 µmol Trolox Eq. /g pulp) was found in untreated fruits.  
117 SA maintained fruit colour by retarding the degradation of chlorophyll that declined skin colour

118 changes throughout the storage and retarding senescence rate in table grapes (Champa *et al.*  
119 2015). Similar results were recorded by Ullah and Jawandha (2013), SA showed a slow rate of  
120 conversion from green to yellow and chlorophyll degradation in peach fruits.

121

#### 122 **PLW (Physiological loss in weight) (%)**

123 The lowest (13.97 %) physiological loss in weight was observed in treatment T<sub>4</sub>-200 ppm while  
124 highest (19.21 %) was in T<sub>5</sub>-control. The higher PLW in untreated fruits might be due to active  
125 metabolism such as respiration and transpiration, which might have led to greater loss of water  
126 during storage in 'Amrapali' mango fruits (Singh and Tiwari, 1994). SA is an electron donar  
127 produces free radicals which prevent normal respiration thus leading to lower weight loss  
128 (Shafiee *et al.* 2010). The lower PLW per cent in SA treated fruits is due to reduced respiration,  
129 transpiration and ethylene production (Srivastava and Dwivedi, 2000).

130

#### 131 **Spoilage (%)**

132 Fruits treated with different concentrations of SA significantly lowered decay incidence than  
133 control. Highest decay (48.02 %) was in T<sub>5</sub>-control whereas lowest (17.20%) in T<sub>3</sub>-150 ppm SA  
134 treated fruits. Salicylic acid helped in enhancement of expression of genes that control the  
135 production of phenolic compounds by activating the phenylalanine ammonialyase enzyme,  
136 increases resistance to infection (Eraslan *et al.* 2007). Dipping of pear fruit in the SA solution,  
137 effectively controlled fruit decay during 5 months of cold storage (Asghari *et al.* 2007). SA  
138 application had a positive effect in reducing berry decay (Samra, 2015).

139

#### 140 **Shelf life (Days)**

141 Different concentrations of SA have different effect on shelf life of litchi. Maximum (4 days)  
142 shelf life of litchi was observed in T<sub>3</sub>-150 ppm concentration over control. This enhancement  
143 effect on shelf life period might be due to the role of SA reducing physiological weight loss of  
144 fruits, the activity of oxidative enzymes and retarding fruit softening. Also, SA increased  
145 phenolic compounds and enhanced resistant against pest and diseases. These results are same as  
146 those of Perez-Vicente *et al.* (2002) who reported that, exogenous polyamines applications  
147 delayed color changes, reduced mechanical damage, chilling injury susceptibility and increase  
148 shelf life in both climacteric and non-climacteric fruits. The maximum shelf life in SA treated  
149 fruits might be due to its ability to serve as a physical barrier around the fruit which reduce  
150 transpiration and respiration activity along with delay in ethylene production. The positive effect  
151 of SA on storage life could probably be due to the modifying the atmosphere. The modified  
152 atmosphere created could, therefore, delay the ripening by delaying ethylene production and by  
153 reducing the level of internal oxygen and consequently prolonging the storage life of fruit (Gol  
154 and Rao, 2011).

155

#### 156 **4. CONCLUSION**

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158 From the above findings it may be concluded that pre-harvest spray of salicylic acid on litchi  
159 plant can enhance the shelf life and biochemical properties of fruits. Spray of salicylic acid T<sub>3</sub>-  
160 150 ppm concentration was found superior in biochemical parameters and shelf life during  
161 storage at ambient condition. Biochemical parameters such as total soluble solids, total sugar,  
162 titrable acidity, ascorbic acid, anthocyanin and shelf life, physiological loss in weight (PLW) and  
163 spoilage.

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229

230 **Table 1. Effect of pre harvest spray of salicylic acid on TSS (°Brix) during storage at**  
 231 **ambient condition**

Treatment	Days of observation				Mean
	Day 0	Day 2	Day 4	Day 6	
T <sub>1</sub> -SA 50 ppm	19.21	19.31	19.88	18.61	19.25
T <sub>2</sub> -SA100 ppm	19.56	19.68	20.16	20.00	19.85
T <sub>3</sub> -150 ppm	20.02	20.16	20.78	20.99	20.49
T <sub>4</sub> -200 ppm	19.85	19.98	20.69	20.64	20.29
T <sub>5</sub> -Control	18.75	18.86	16.11	10.20	15.98
Mean	19.49	19.60	19.52	18.09	19.17
CD(p≤0.05)	T				0.50
	D				0.45
	T*D				0.99
CV (%)					7.35

232

233 **Table 2. Effect of pre harvest spray of salicylic acid on Total sugar (%) during storage at**  
 234 **ambient condition**

Treatment	Days of observation				Mean
	Day 0	Day 2	Day 4	Day 6	
T <sub>1</sub> -SA 50 ppm	11.66	12.92	13.59	17.98	14.03
T <sub>2</sub> -SA100 ppm	12.75	13.36	14.72	18.06	14.72
T <sub>3</sub> - SA150 ppm	13.10	14.46	16.01	18.90	15.62
T <sub>4</sub> - SA 200 ppm	12.86	13.85	15.26	18.10	15.02
T <sub>5</sub> -Control	10.84	11.91	10.22	9.30	10.57
Mean	12.24	13.30	13.96	16.47	13.99
CD(p≤0.05)	T				0.26
	D				0.24

	T*D				0.53
CV (%)					5.34

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236 **Table 3. Effect of pre harvest spray of salicylic acid on Titrable acidity (%) during storage**237 **at ambient condition**

Treatment	Days of observation				238
	Day 0	Day 2	Day 4	Day 6	Mean
T <sub>1</sub> -SA 50 ppm	0.605	0.533	0.449	0.317	0.476
T <sub>2</sub> -SA100 ppm	0.580	0.512	0.435	0.310	0.459
T <sub>3</sub> -150 ppm	0.440	0.428	0.324	0.255	0.362
T <sub>4</sub> -200 ppm	0.520	0.493	0.356	0.312	0.420
T <sub>5</sub> -Control	0.760	0.682	0.568	0.569	0.645
Mean	0.581	0.530	0.427	0.352	0.472
CD (p≤0.05)	T				0.011
	D				0.010
	T*D				0.022
CV (%)					6.70

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240 **Table 4. Effect of pre harvest spray of salicylic acid on Ascorbic Acid (mg/100 g) during**241 **storage at ambient condition**

Treatment	Days of observation				
	Day 0	Day 2	Day 4	Day 6	Mean
T <sub>1</sub> -SA 50 ppm	34.86	27.26	22.51	8.44	23.27
T <sub>2</sub> -SA100 ppm	35.44	28.55	22.91	8.73	23.91
T <sub>3</sub> -150 ppm	38.21	31.90	24.52	10.10	26.18
T <sub>4</sub> -200 ppm	36.15	30.16	23.30	8.81	24.61
T <sub>5</sub> -Control	33.01	26.00	19.00	0.00	19.50
Mean	35.54	28.77	22.45	7.22	23.49
CD (p≤0.05)	T				0.50
	D				0.45
	TxD				1.00
CV (%)					6.07

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246 **Table 5. Effect of pre harvest spray of salicylic acid on Anthocyanin of peel (mg/100 g pulp)**247 **during storage at ambient condition**

Treatment	Days of observation				Mean
	Day 0	Day 2	Day 4	Day 6	
T <sub>1</sub> -SA 50 ppm	19.54	18.74	14.61	6.76	14.91
T <sub>2</sub> -SA100 ppm	19.96	18.93	14.70	7.66	15.31
T <sub>3</sub> - SA150 ppm	20.88	19.66	15.11	8.06	15.92
T <sub>4</sub> - SA 200 ppm	21.54	20.33	16.07	7.75	16.42
T <sub>5</sub> -Control	18.72	16.58	6.07	1.50	10.72
Mean	20.12	18.85	13.31	6.35	14.66
CD (p≤0.05)	T				0.30
	D				0.26
	TxD				0.59
CV (%)					5.70

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250 **Table 6. Effect of pre harvest spray of salicylic acid on PLW (%) during storage at ambient**251 **condition**

Treatment	Days of observation				Mean
	Day 0	Day 2	Day 4	Day 6	
T <sub>1</sub> -SA 50 ppm	-	5.35 (21.41)	10.70 (42.81)	15.52 (62.08)	10.53
T <sub>2</sub> -SA100 ppm	-	4.99 (19.95)	10.35 (41.40)	14.07 (56.26)	9.80
T <sub>3</sub> - SA150 ppm	-	4.42 (17.67)	9.80 (39.18)	14.29 (57.16)	9.50
T <sub>4</sub> - SA 200 ppm	-	4.10 (16.40)	9.64 (38.57)	13.97 (55.86)	9.24
T <sub>5</sub> -Control	-	7.92 (31.67)	13.85 (55.40)	19.21 (76.84)	13.66
Mean	-	5.36	10.87	15.41	10.54
CD(p≤0.05)	T				0.26
	D				0.24
	TxD				0.53
CV (%)					7.06

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258 **Table 7. Effect of pre harvest spray of salicylic acid on Spoilage (%) during storage at**259 **ambient condition**

Treatment	Days of observation	
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	<b>Day 0</b>	<b>Day 2</b>	<b>Day 4</b>	<b>Day 6</b>	<b>Mean<sup>260</sup></b>
T <sub>1</sub> -SA 50 ppm	-	-	18.43 (73.72)	29.16 (116.64)	23.80
T <sub>2</sub> -SA100 ppm	-	-	17.20 (68.81)	24.72 (98.90)	20.96
T <sub>3</sub> - SA150 ppm	-	-	14.47 (57.90)	17.20 (68.81)	15.84
T <sub>4</sub> - SA 200 ppm	-	-	15.17 (60.68)	21.76 (87.04)	18.46
T <sub>5</sub> -Control	-	-	45.72 (182.87)	48.02 (192.07)	46.87
Mean	-	-	22.20	28.17	25.19
CD(p ≤0.05)	T				0.44
	D				0.28
	TxD				0.62
CV(%)					3.49

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262 **Table 8. Effect of pre harvest spray of salicylic acid on shelf life during storage at ambient**  
 263 **condition**

<b>Treatment</b>	<b>Shelf life enhanced</b>	<b>Shelf life extended over control</b>
T <sub>1</sub> -SA 50 ppm	<b>4</b>	<b>2</b>
T <sub>2</sub> -SA100 ppm	<b>4</b>	<b>2</b>
T <sub>3</sub> - SA150 ppm	<b>6</b>	<b>4</b>
T <sub>4</sub> - SA 200 ppm	<b>4</b>	<b>2</b>
T <sub>5</sub> -Control	<b>2</b>	<b>-</b>

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