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Effect of pre harvest elicitor sprays on post harvest biochemical parameters of dragon fruit (*Selenicereus monacanthus*)

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Abstract
The research entitled "Effect of pre harvest elicitor sprays on post harvest biochemical parameters of dragon fruit (*Selenicereus monacanthus*)" was carried out in farmer's field, Nabipeta, West Godavari district of Andhra Pradesh during the year 2023-24. The pre harvest sprays was laid out in Randomized Block Design (RBD) with seven treatments and three replications. Red fleshed dragon fruits were sprayed with different elicitors i.e., T_1: Salicylic acid 500 ppm, T_2 : Salicylic acid 1000 ppm, T_3: Methyl jasmonate 500 ppm, T_4 : Methyl jasmonate 1000 ppm T_5 : Chitosan 500 ppm, T_6 : Chitosan 1000 ppm, T_7 was taken as control. Spraying was given once, 15 days after flowering (DAF). Salicylic acid 1000 ppm (T_2) treated fruits recorded significantly highest TSS (13.67°Brix), total sugars (10.32%) and reducing sugars (7.12%) at 9th day of storage. Hence, the research findings concluded that salicylic acid 1000 ppm (T_2) found to be best in retaining biochemical parameters of dragon fruit at ambient temperature.

Keywords: Dragon fruit, pre harvest sprays, elicitors, biochemical parameters

Introduction
Dragon fruit is a tropical fruit belonging to the cactus family and is widely admired for its striking appearance, particularly the red-fleshed variety. Originally native to Central America, dragon fruit is now cultivated across many tropical and subtropical regions, including Southeast Asia, Australia, and parts of the Middle East. The plant is a climbing cactus that grows well in well-drained sandy soils and requires abundant sunlight. Once established, it is highly tolerant to dry conditions and requires minimal maintenance, making it a hardy and adaptable crop suitable for a range of farming systems.

In addition to its attractive appearance, dragon fruit is highly valued for its nutritional benefits. It is rich in vitamin C, dietary fiber, antioxidants, and essential minerals, which has contributed to its growing popularity among health-conscious consumers worldwide. However, despite the increasing demand and expanding cultivation, the commercial and export potential of dragon fruit is limited by its high perishability. The fruit deteriorates rapidly after harvest, resulting in a short shelf life and significant post-harvest losses, especially during storage and transportation for export markets. Therefore, there is a pressing need to adopt effective post-harvest management strategies to reduce losses, maintain fruit quality, extend shelf life, and enhance the economic value of dragon fruit in both domestic and international trade.

The initial quality and post-harvest behavior of dragon fruit are strongly affected by pre-harvest management practices. Integrating pre-harvest elicitor treatments with conventional cultivation methods can enhance fruit quality, reduce reliance on chemical pesticides, and improve the fruit's tolerance to post-harvest stresses. Synthetic elicitors used as pre-harvest sprays, induce fruit resistance against pathogens by eliciting systemic acquired resistance (SAR), which could partially replace the use of synthetic fungicides (Romanazzi *et al*., 2016) [16]. They mainly include salicylic acid, jasmonic acid and chitosan and their analogs or derivatives (Gong *et al*., 2022) [5].

It has also been discovered that the elicitors support increased antioxidant activity, decreased chilling injury, and preserved fruit quality after harvest (Ahmad *et al*., 2013) [1].

Materials and Methods

The experiment was conducted at in farmer's field, Nabipeta, West Godavari district, Andhra Pradesh during the year 2023-24. The design adopted for the experiment was Randomized Block Design (RBD), with 7 treatments each having 3 replicates as per the procedure out lined by Panse and Sukhatme (1967) [11].

Preparation of pre-harvest solutions

Aqueous solutions of salicylic acid (500 and 1000 ppm) were prepared by dissolving required amount of product in a small amount of ethanol and bringing to the final volume with distilled water. A surfactant Tween 20® at the rate of 0.1% was added to obtain better retention and penetration as followed by Champa *et al.* (2015) [2]. Two different concentrations, 500 and 1000 ppm of methyl jamonate solution were prepared by dissolving required amount of product in distilled water. Tween 20® @ 0.5% was used as a surfactant as followed by Dhami *et al.* (2021) [4]. Two different concentrations, 500 and 1000 ppm of chitosan solution were prepared by measuring required amount of product followed by dissolving in 0.1 N HCl and diluting with distilled water with pH adjusted at 6.5 by 0.1 N NaOH as followed by Rahman *et al*. (2018) [13].

Application of pre harvest sprays

Red fleshed dragon fruits were sprayed with different elicitors i.e., T_1: Salicylic acid 500 ppm, T_2 : Salicylic acid 1000 ppm, T_3: Methyl jasmonate 500 ppm, T_4 : Methyl jasmonate 1000 ppm T_5 : Chitosan 500 ppm, T_6 : Chitosan 1000 ppm, T_7 was taken as control. Spraying was given once, 15 days after flowering (DAF). Spraying was done with the help of a sprayer. The sprayer was rinsed thoroughly with water before the application of each treatment.

Procurement of dragon fruits

Mature red fleshed dragon fruits of uniform size, firm, free from blemishes, disease incidence and injuries were harvested. Maturity index of dragon fruit is colour break stage from bright green to red colour or minimum of 31 days after flowering (DAF). Fruits after harvesting were carefully brought to laboratory, College of Horticulture, Venkataramannagudem and sorted.

Observations recorded

The fruits were stored at ambient condition and were evaluated for biochemical parameters at three days interval during storage.

Total soluble solids (°Brix)

Fruits were cut and pulp was crushed for juice extraction. The total soluble solids in juice were determined by using digital refractometer with range 0-32 and expressed as °Brix (Ranganna, 1986) [14].

Total sugars (%)

Total sugars were determined following the method described by Lane and Eyon (AOAC, 1965) [10]. Fifty ml lead free filtrate was taken in a 100 ml volumetric flask and to it 5 ml of concentrate HCL was added, mixed well and then kept for 24 hours at room temperature. Acid was then neutralized with NaOH using a drop of phenolphthalein as an indicator till the pink colour persisted for at least few seconds. Then volume is made up to 100 ml. Total sugars were then estimated by taking this solution in a burette and titrating it against standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator till brick red colour is formed and noted as an end point.

$$\text{Total sugars (\%)} = \frac{\text{Factor} \times \text{Volume made up}}{\text{Titre value} \times \text{Weight of sample}} \times 100$$

Reducing sugars (%)

Reducing sugars were determined by the method of Lane and Eyon (AOAC, 1965) [10]. Ten grams of fruit pulp was taken, ground well and transferred to 250 ml volumetric flask. To this, 100 ml of distilled water was added. Two ml of lead acetate solution (45%) was added to flask for precipitation of colloidal matter and two ml of potassium oxalate (22%) was added in this solution to precipitate the lead and volume was made up to 250 ml using distilled water.

The contents were then filtered through Whatmann No. 1 filter paper after testing a little of filtrate for its freedom from lead by adding a drop of potassium oxalate. The lead free solution was taken in a burette and titrated against 10 ml of standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator till brick red colour is formed and noted as an end point. The titration was carried out by keeping the Fehling's solution boiling on the heating mantle.

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{Volume made up}}{\text{Titre value} \times \text{Weight of sample}} \times 100$$

Results and discussion

Total Soluble Solids (TSS)

The results regarding total soluble solids as influenced by different pre harvest treatments during ambient storage (Table 1 and Figure 1) revealed significant differences.

The TSS was gradually increased from 3rd day of storage to 6th day of storage and it was decreased on 9th day of storage in all the treatments except in salicylic acid @ 500 ppm (T_1) and 1000 ppm (T_2) treatments.

On 3rd day of storage, the highest total soluble solids of 13.47°Brix was recorded in control (T_7) and lowest of 12.07 °Brix was recorded in fruits sprayed with salicylic acid @ 1000 ppm (T_2). Similar trend was noticed on 6th day of storage. On 9th day of storage, significantly the highest total soluble solids of 13.67 °Brix was recorded in fruits sprayed with salicylic acid @ 1000 ppm (T_2), followed by salicylic acid @ 500 ppm (T_1) (13.50 °Brix) and the lowest of 11.07 °Brix was recorded in control treatment (T_7).

The increase in TSS during early storage is mainly due to the conversion of starches to sugars and the breakdown of organic acids. Decrease in TSS during later storage stages occurs as fruits begin to lose water, or enter the senescence phase, which involves the breakdown of sugars and the degradation of cellular structures. Additionally, microbial activity, excessive moisture loss, and enzymatic processes contribute to the decline in soluble solids. Similar trend was observed in dragon fruit by Prashanth *et al.* (2022) [12].

The amylases responsible for conversion of starch into sugars, are regulated by salicylic acid. Salicylic acid prevents an early and rapid buildup of sugars by delaying the action of these enzymes, leading to a more gradual increase in sugar content. Salicylic acid helps to reduce the rate of respiration and metabolic degradation of sugars by regulating the fruit's hormonal balance, thereby slowing down the conversion of sugars into energy. The reduced rate of sugar metabolism means that more soluble sugars are preserved in the fruit, helping to retain higher TSS at the end of storage. Similar results were reported by Karlidag *et al.* (2009) [8] in strawberry, Shaaban *et al.* (2011) [17] in apple, Kassem *et al.* (2011) [9] in jujube, Reddy and Sharma (2016) [15] in mango, Hanif *et al.* (2020) [6] in papaya, Shrivastva *et al.* (2020) [18] and Kanwal *et al.* (2021) [7] in ber.

Total sugars (%)

The data (Table 2) pertaining to total sugars (%) content due to influence of pre harvest treatments showed a significant influence during storage. Total sugars increased with increase in storage period and later decreased. However, the increase had been at a slower rate in all the treated fruits except in control.

On 3rd day of storage, highest total sugars content of 10.23% was recorded in control (T_7) and lowest of 9.41% was recorded in fruits sprayed with salicylic acid @ 1000 ppm (T_2). Similar trend was noticed on 6th day of storage. On 9th day of storage, significantly the highest total sugars content of 10.32% was recorded in fruits sprayed with salicylic acid @ 1000 ppm (T_2), followed by salicylic acid @ 500 ppm (T_1) (10.20%) and lowest of 7.12% was recorded in control (T_7).

Reducing sugars (%)

The data showed significant differences in reducing sugars (%) as influenced by pre harvest treatments in dragon fruit (Table 3). Like total sugars, reducing sugars were also increased during initial periods of storage and decreased later.

On 3rd day of storage, highest reducing sugars content of 7.02% was recorded in control (T_7) and lowest of 6.40% was found in fruits sprayed with salicylic acid @ 1000 ppm (T_2). Similar trend was noticed on 6th day of storage. On 9th day of storage, significantly the highest reducing sugars content of 7.12% was found in fruits sprayed with salicylic acid @ 1000 ppm (T_2), followed by salicylic acid @ 500 ppm (T_1) (7.02%) and lowest of 5.12% was recorded in control (T_7).

The per cent increase in sugars during early storage period is mainly due to conversion of starches to simple sugars (glucose, fructose and sucrose) and breakdown of organic acids through an enhanced enzymatic process. Decrease in sugars during later stages of storage occurs as they are used in respiration, converted to other compounds (e.g., alcohol during fermentation), or metabolized by deteriorating cells. Additionally, microbial activity and the breakdown of fruit tissues also contribute to the reduction in sugar levels. Similar trend was observed in dragon fruit by Prashanth *et al.* (2022) [12].

It could be evident from the data recorded that salicylic acid @ 1000 ppm sprayed fruits showed a gradual increase in sugars and also retained higher sugar content by the end of storage. Salicylic acid might help in gradual increase of sugars and retain higher sugar content in fruit pulp by regulating carbohydrate metabolism, delaying ripening and senescence process, reduction of ethylene production and reducing the breakdown of sugars. Similar results were also reported by Shaaban *et al.* (2011) [17] in apple, Kassem *et al.* (2011) [9] in jujube, Shrivastva *et al.* (2020) [18] in ber, Devarkonda *et al.* (2020) [3] and Hanif *et al.* (2020) [6] in papaya.

Table 1: Effect of pre harvest elicitor sprays on total soluble solids (ºBrix) in dragon fruit pulp during storage.

Treatment	Total soluble solids (ºBrix)			
	3rd day	6th day	9th day	12th day
T_1: Salicylic acid 500 ppm	12.27	13.13	13.50	12.77
T_2: Salicylic acid 1000 ppm	12.07	12.93	13.67	13.27
T_3: Methyl jasmonate 500 ppm	12.53	13.33	12.57	*
T_4: Methyl jasmonate 1000 ppm	12.47	13.27	12.83	*
T_5: Chitosan 500 ppm	12.87	13.40	11.40	*
T_6: Chitosan 1000 ppm	12.73	13.37	11.63	*
T_7: Control	13.47	13.60	11.07	*
Mean	12.63	13.29	12.38	13.02
SE m±	0.04	0.03	0.05	
CD at 5%	0.13	0.08	0.16	

*Indicates termination of storage

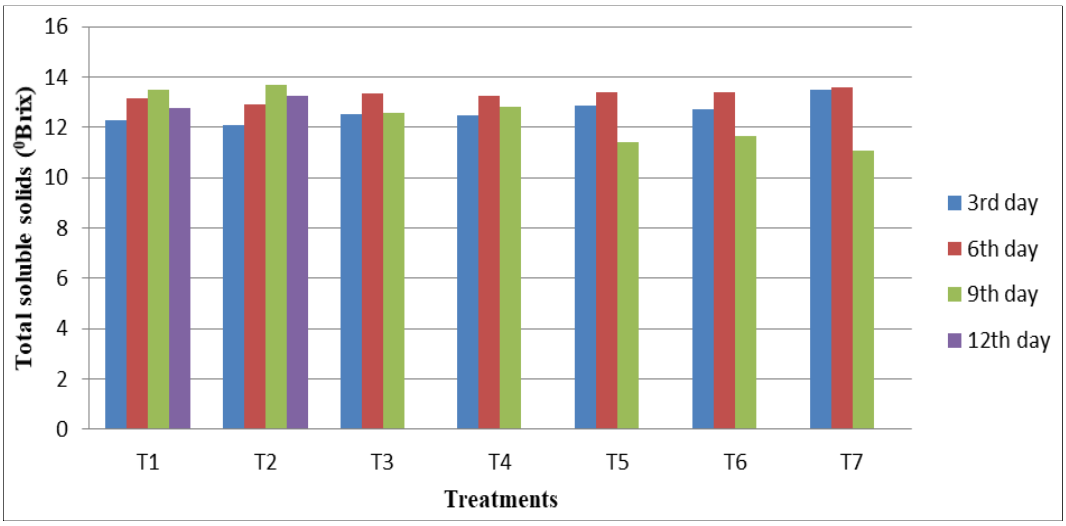

Fig 1: Effect of pre harvest elicitor sprays on total soluble solids (ºBrix) in dragon fruit pulp during storage. T_1: Salicylic acid 500 ppm, T_2: Salicylic acid 1000 ppm, T_3: Methyl jasmonate 500 ppm, T_4: Methyl jasmonate 1000 ppm, T_5: Chitosan 500 ppm, T_6: Chitosan 1000 ppm, T_7: Control

Table 2: Effect of pre harvest elicitor sprays on total sugars (%) in dragon fruit pulp during storage.

Treatment	Total sugars (%)			
	3rd day	6th day	9th day	12th day
T_1: Salicylic acid 500 ppm	9.57	9.93	10.20	9.08
T_2: Salicylic acid 1000 ppm	9.41	9.79	10.32	9.60
T_3: Methyl jasmonate 500 ppm	9.73	10.05	8.71	*
T_4: Methyl jasmonate 1000 ppm	9.66	9.99	8.95	*
T_5: Chitosan 500 ppm	9.87	10.16	8.45	*
T_6: Chitosan 1000 ppm	9.82	10.13	8.56	*
T_7: Control	10.23	10.32	7.12	*
Mean	9.75	10.05	8.90	9.34
SE m±	0.02	0.02	0.03	
CD at 5%	0.05	0.06	0.09	

*Indicates termination of storage

Table 3: Effect of pre harvest elicitor sprays on reducing sugars (%) in dragon fruit pulp during storage.

Treatment	Reducing sugars (%)			
	3rd day	6th day	9th day	12th day
T_1: Salicylic acid 500 ppm	6.45	6.81	7.02	6.25
T_2: Salicylic acid 1000 ppm	6.40	6.74	7.12	6.66
T_3: Methyl jasmonate 500 ppm	6.58	6.87	6.39	*
T_4: Methyl jasmonate 1000 ppm	6.54	6.83	6.58	*
T_5: Chitosan 500 ppm	6.70	6.96	6.20	*
T_6: Chitosan 1000 ppm	6.65	6.93	6.29	*
T_7: Control	7.02	7.09	5.12	*
Mean	6.62	6.89	6.39	6.45
SE m±	0.01	0.02	0.02	
CD at 5%	0.04	0.06	0.07	

*Indicates termination of storage

Conclusion

Results of the experiment revealed that different pre harvest sprays significantly affected biochemical parameters of dragon fruit. Among them, salicylic acid 1000 ppm was best in terms of maintaining TSS and sugars at end of storage without causing adverse effects, followed by salicylic acid 500 ppm treatment.

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