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Effect of Pre-Treatments on the Shelf Life of Banana Leaves

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ABSTRACT: Longer shelf life of banana leaves is one of preferable quality traits in marketing for growers, retailers and consumers. Several compounds, like ascorbic acid, benzyl amino purine have been reported to prolong the shelf-life of banana leaves. Thus, the experiment was conducted at Horticultural Research Station, Kovvur during 2021-22 to study the effect of pre-treatments on the shelf life of banana leaves with factorial concept. Two factors involved are cultivars and pre-treatments. Cultivars include C_1: Karpura Chakkerakeli, C_2: Grand Naine and pre-treatments comprised of D_1: BAP@25ppm, D_2: Ascorbic acid @ 0.5%, D_3: Water, D_4: Control (Without pre-treatment). Banana cultivar Grand Naine recorded minimum physiological loss in weight (20.64%), yellowing score (4.47) and maximum freshness score (2.43), shelf life (5.83) compared to Karpura Chakkerakeli. Among the pre-treatments, ascorbic acid @ 0.5% recorded minimum physiological loss in weight (16.26%), yellowing score (4.47) and maximum freshness score (2.50), shelf life (5.17), over the other pre-treatments on 7thday. The results showed that banana leaves treated with ascorbic acid @ 0.5%inbanana cultivar Grand Naine suitable for long distance transport with better shelf life.

Keywords: Banana leaves, pre-treatment, Ascorbic acid, Shelf life**,** Grand Naine.

INTRODUCTION

Banana is the most popular fruit in India and is valued for its flavour, nutritional value and availability throughout the year. The plant is called Kalpataru (Plant of all virtues) owing to versatile use of all parts. Apart from fruit, banana leaves though themselves are not edible, being used for a range of purposes like wrapping, cooking, food serving, decorative and symbolic purposes. Banana leaves are waterproof, flexible, biodegradable and large enough to useas food packaging. Compared to synthetic food packaging materials like plastics which are derived from fossil fuel, banana leaf is a renewable resource which can contribute to the reduction of carbon footprint (Gautam *et al.,* 2020). However, banana leaves have poor durability as it contains high water content.

The shelf life of banana leaves varies with the cultivar. Uma *et al.* (2003) studied different accessions of banana for leaf purpose. Among these accessions, Elavazhai registered the highest shelf life (13.33 days) followed by Kunnan (12.33 days) and Borkal Baista (11.67 days). Besides cultivars, many treatments have been investigated to preserve the postharvest quality of banana leaves. Pre-treatments with chemicals, hormones (Zheng *et al.,* 2019), antioxidants (Ascorbic acid) were tested in banana leaves for storage, and it was reported that the treatments preserve the visual quality of leaves, prevent chlorophyll breakdown and delay senescence. It is of great importance that the materials applied for pre-treating the banana leaves are safe for consumption as well as extend the storage period which have short term storage period. The temperature of banana leaves at the time of harvest is high, resulting in low shelf life. Therefore, removal of field heat from banana leaves in shortest possible time immediately after harvest which may greatly reduce metabolic rates and prolong its storage life. Such a rapid reduction in temperature can be achieved by precooling. Submerging the leaves in water reduced the loss of fresh weight from the leaves during storage and maintained the relative water content at a high level. Treatment of Poovan and Udhayam leaves with cold water at 20°C for 30 minutes recorded eight days of shelf life against three days at room temperature without any pre-treatment. Treatment at 25°C for 30

minutes registered a shelf-life of seven days when compared to five days at room temperature alone (control-without any pre-treatment) (NRCB Annual report 2014).

The shelf life of banana leaves can be improved by techniques like pre-treating the leaves with chemicals. In this study, the effects of ascorbic acid and BAP treatments on storage of banana leaves were investigated. Ascorbic acid (AA) is a water-soluble vitamin that plays an important physiological role in suppressing reactive oxygen species (ROS) that occur in plants under stress conditions. In recent years, it has been noted that exogenous ascorbic acid treatments had greater role in the preservation of horticultural crops and is a biologically safe molecule that can be used to maintain postharvest quality. Bilgin (2021) at the end of the storage period, the lowest weight loss (2.74%), total soluble solids (8.07%), pH value (7.14) and the highest amount of titratable acidity (0.12%) were found in the heads treated with ascorbic acid (2 mM). Betelvine treated with ascorbic acid @ 100 ppm extended the shelf for 11 days as against 6 days in control (Priya *et al.,* 2017). Venkatram *et al*. (2013) observed that application of ascorbic acid @1000 ppm was helpful to enhance shelf life up to 10 days whereas the control fruits recorded a shelf life 8.50 days.

In leafy vegetables, 6-benzylaminopurine (BAP), a cytokine also extensively used to extend the shelf life. Prasad *et al*. (2021) suggested that the most pronounced effect was under 6-BAP treatments (*i.e.* 0.0025 and 0.005%) which reduced the respiration rate and aided to increase in shelf life up to 5.5 days and 23.5 days in treated broccoli heads under ambient and refrigerated storage respectively compared to other chemical treatments.On comparing with control of four days, shelf life of banana leaves was high in 6-BAP treated leaves (9 days) at room temperature (NRCB Annual report, 2020).

Therefore, it is necessary to find out the suitable cultivar and pre- treatment chemical for extending the shelf life of leaves.

MATERIAL AND METHODS

The present investigation was carried out at Horticultural Research Station, Kovvur during 2021-22. The experiment was laid out in Factorial Completely Randomized Design with 4 pre-treatments and 2 cultivars and replicated thrice. The8 treatment combinations were C_1D_1: Karpura Chakkerakeli + BAP @25ppm, C_1D_2: Karpura Chakkerakeli + Ascorbic acid @0.5%, C_1D_3: Karpura Chakkerakeli + Water, C_1D_4: Karpura Chakkerakeli + Without pre-treatment (Control), C_2D_1: Grand Naine + BAP @25ppm, C_2D_2: Grand Naine + Ascorbic acid @0.5%, C_2D_3: Grand Naine + Water, C_2D_4: Grand Naine + Without pre-treatment (Control). Banana leaves were harvested early in the morning at 6.00 am and sized to 45 cm for uniformity. Ten banana leaves from each cultivar Karpura Chakkerakeli and Grand Nainewere taken per treatment per replication and were dipped in the respective solutions for 30 minutes. After pre-treatment the leaves were stacked and folded in to one bundle and kept for storage study under laboratory conditions (27±2^{o}C and R.H 75±5%). Parameters on physiological loss in weight, freshness, yellowing and shelf life were recorded. With the help of digital weighing balance of capacity 0.01gm to 1 kg **(**Infra Instruments Pvt. Ltd), ten leaves were weighed at one day interval from the initiation of the experiment. Weight loss percentage was calculated with the following formula and expressed in per cent (Koraddi *et al*., 2009).

$$\text{Weight loss percentage (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Among the visual observations, freshness score and yellowing score given by Kwanhong *et al.* (2018), which were based on 5point rating scale was adopted.

Score	Freshness of banana leaf
5	Extremely fresh/excellent
4	Fresh/good quality, minor defects
3	Fairish/slightly to moderately objectionable defects
2	Un fresh/poor quality, excessive defects
1	Declined/extremely poor quality

Yellowing Score	Colour of banana leaf
1	Dark green
2	Light green
3	Yellowish-green
4	Greenish-yellow
5	Yellow

Shelf life was arrived based on the number of days at which, freshness scores were over 3 points and leaf yellowing scores were less than 3 points in 50% of the leaves under study.

RESULTS AND DISCUSSION

Physiological loss in weight. Cultivars and pre-treatment dipping had significant effect on physiological loss in weight (Table 1 a&b). Weight loss increased continuously till the end of storage period irrespective of pre-treatments and cultivars. The mean physiological loss in weight in various treatment combinations was found to enhance from 1st day after pre-treatment to 7th day after pre-treatment.

Throughout the experiment during storage, from 1st day to 7th day after treatment (Fig 1), banana leaves of Karpura Chakkerakeli recorded highest weight loss of 3.40% to 23.02%, while lowest weight loss of 2.32% to 20.64% was recorded in Grand Naine.

Weight loss increased markedly in all treatments from 5th day after pre-treatment and differences among the treatments were significant (Fig 2). Among the pre-treatment chemicals, on 1st day after pre-treatment, ascorbic acid @0.5% treated leaves recorded lowest weight loss of 1.93% which was on par with dipping leaves in BAP @25 ppm and water (2.43% and 2.87% respectively), while highest weight loss (4.21%) was found in control (without any pre-treatment). Later from 2nd day to 7th day after treatment, lowest weight loss was recorded in ascorbic acid @0.5% treated leaves (3.92% to 16.26% respectively), whereas highest weight loss of 8.50% was observed on 2nd day after

treatment and 26.56% on 7th day after treatment in control.

Irrespective of the treatments, with increase in storage period, the physiological weight loss increased as the leaves are living entities which respire, transpire and due to those process, there is loss of nutrients and moisture. It could be inferred that, leaves lost water rapidly because of their greater surface-to-volume ratio (Kays, 1991). Out of various chemicals tested, banana leaves pre-treated with ascorbic acid showed least weight loss throughout the storage period from 1st DAP to 7th DAP.

The leaves with ascorbic acid were effective in conferring a physical barrier to moisture loss and therefore retarded dehydration. The rate at which water is lost depends on the water pressure gradient between the leaves and the surrounding atmosphere. The weight loss takes place due to higher metabolic activity and increased postharvest senescence (because rapid senescence generally leads to reduced membrane integrity or higher tissue permeability) of fresh leaves (Koyuncu *et al.*, 2019). This is also ascribed to the fact that ascorbic acid probably reduced metabolic activity, delayed senescence, and maintained better cellular integrity, thereby worked in an integrated manner to reduce fresh weight loss of banana leaves. The results were supported by Puthmee *et al*. (2009) in mango, Gill *et al*. (2014); Kaur (2016) in guava and Bilgin (2021) in broccoli.

Freshness. There was a significant difference from 1st day after pre-treatment to 7th day after pre-treatment in both the cultivars for freshness (Table 2 a&b). Grand Naine cultivar recorded maximum freshness on 1st day and 7th day after pre-treatment with the corresponding values 4.83 to 2.43, while in Karpura Chakkerakeli cultivar minimum freshness score (4.72 to 2.25 respectively) was registered. Freshness (>3) retained only up to 5 days in Karpura Chakkerakeli and 6 days in Grand Naine leaves.

The freshness of pre-treated banana leaves went on decreasing with the advancement of storage period. Among the treatments, maximum score (5.00 on 1st DAP and 2.50 on 7th DAP) was recorded in leaves treated with ascorbic acid @0.5%, whereas in untreated leaves (control) recorded minimum score (4.50 on 1st DAP and 2.07 on 7th DAP). However, acceptable freshness score (>3) was observed in ascorbic acid @0.5% treated leaves (3.20) which was on par with BAP @25 ppm treated leaves (3.13) on 6th DAP, while acceptable score of 3.27 was recorded on 5th DAP.

Interaction effect between cultivars and pre-treatments for freshness score showed significant difference on 1st and 6th DAP. Grand Naine leaves pre-treated with 0.5% ascorbic acid showed maximum freshness score (5.00 and 3.53 on 1st and 6th DAP respectively) which was on par with BAP@ 25 ppm (5.00 and 3.47 on 1st and 6th DAP respectively) treated leaves.

Leaves in all treatments showed acceptable freshness score (>3) up to 5th DAP. Later, on 6th DAP, acceptable freshness score was observed in ascorbic acid and BAP treated leaves only. Fresh leaves have an optimal cell turgor. Termination of leaf freshness were characterized by the irreversible loss of cell turgor resulted in wilting of leaves. The loss of moisture results in a reduction in the fresh weight of leaves, often accompanied by loss of freshness, appearance and texture (Roura *et al.*, 2000). Ascorbic acid treated leaves recorded maximum freshness index due to the shelf life enhancing properties of ascorbic acid like delayed senescence, increased respiratory sugar substrates. During storage, ascorbic acid prevents leaf wilting, thus maintain the water balance and photosynthetic activities (Forti and Elli 1995; Kobayakawa and Imai 2012). This mechanism is predicted to have relation with ascorbic acid which prolonged leaves freshness. Similar results were reported by Budiarto (2019) in chrysanthemum gaillardia. Ascorbic acid was followed by BAP, which might be due to the delayed cell wall degradation and decreased dehydration by BAP as explained by Massolo *et al*. (2014) in summer squash.

Yellowing. Changes in the colour scores are one of the important factors affecting visual quality. The yellowing of banana leaves progressed with the advancement of storage period (Table 3 a&b). Banana cultivar Grand Naine recorded lowest yellowing score (1.30 on 1st DAP and 4.47 on 7th DAP), whereas highest yellowing score (1.41 on 1st DAP and 4.77 on 7th DAP) was observed in Karpura Chakkerakeli.

Among the pre-treatments, lowest yellowing score (1.28 on 1st DAP and 4.47 on 7th DAP) was recorded in leaves treated with ascorbic acid @0.5% and maximum yellowing score (1.43 on 1st DAP and 4.77 on 7th DAP) was observed in control. However, among all treatments, acceptable yellowing score (<3) was noticed in ascorbic acid @0.5% treated leaves up to 5th DAP while it was 2.37 up to 4th DAP in BAP @ 25 ppm treated leaves.

Interaction effect between cultivars and pre-treatment for yellowing score was significant on 2nd, 3rd and 5th DAP. Significantly minimum yellowing score (1.27, 1.47 and 2.53 respectively) was observed in Grand Naine leaves treated with ascorbic acid@0.5% and maximum yellowing score (1.67, 2.20 and 3.53 respectively) was noticed in Karpura Chakkerakeli leaves without any pre-treatment.

More green colour retention *i.e.,* less yellowing was observed in ascorbic acid treated leaves. Ascorbic acid is the most widely used post-harvest chemical to enhance the storage life and delayed in colour change of harvested produce by inhibition of oxidation and improvement of shelf life in leaves. This might be ascribed to the fact that ascorbic acid proved beneficial to reverse the reduction in chlorophyll pigments that may have been due to the enhanced activities of chlorophyllase and peroxidase involved in the breakdown of chlorophyll while BAP resulted in slow rate of colour change than control which resulted in delaying in senescence and maintenance of chloroplast activity (Rivera *et al*., 2006). Moreover, it could be inferred that ascorbic acid might retard senescence by inhibiting ethylene production (Leamtim *et al*., 2008) which in turn reduced the chlorophyll degradation. Similar results on delay in yellowing activity was found by Kaur (2016) in guava.

Application of the synthetic cytokinin N6-benzylaminopurine (BAP) reduced the expression of chlorophyll degrading genes (Gomez-Lobato *et al.*, 2012) and delayed chloroplast dismantling and yellowing in leaves. Similar findings were reported by Budiarto (2019) in chrysanthemum and Massolo (2014) in summer squash.

Shelf life. Perusal of the data illustrated in fig 3it is revealed that shelf life differed significantly among different cultivars and pre-treatments. However, the interaction effect between cultivars and pre-treatment showed non-significant results.

Grand Naine had significantly maximum shelf life of 5.17 days, while Karpura Chakkerakeli cultivar had minimum shelf life of 4.75 days. Maximum storage life of 5.83 days was recorded in leaves treated with ascorbic acid @0.5%, whereas minimum storage life of 4.33 days was recorded in control which was on par (4.50 days) with leaves dipped in water.

Among the two banana cultivars under study, Grand Naine recorded highest shelf life compared to Karpura Chakkerakeli. This might be due to the presence of lower number of stomata which were responsible for low transpiration loss of water from leaves resulted in the highest shelf life. The better shelf life of leaves in Grand Naine is also ascribed due to its thinner leaves, which are less likely to tear during handling and transit.

Ascorbic acid pre-treatment proved effective by registering higher values of freshness score and lower physiological weight loss and yellowing score. The highest shelf life recorded in ascorbic acid treated leaves could be ascribed to the fact that it acts as moisture and gas semipermeable barrier, which resulted in restriction of microbial growth and lead to increase in shelf life. It has been opined that ascorbic acid may retard senescence either by inhibiting ethylene production and decreasing respiration Leamtim *et al.* (2008). Similar results were found by Venkatram *et al.* (2013) in custard apple and Priya *et al.* (2017) in betel vine leaves.

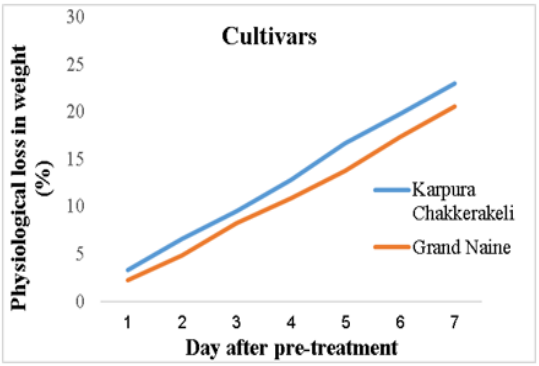

Fig. 1. Effect of cultivars on physiological loss in weight of banana leaves at different intervals of storage.

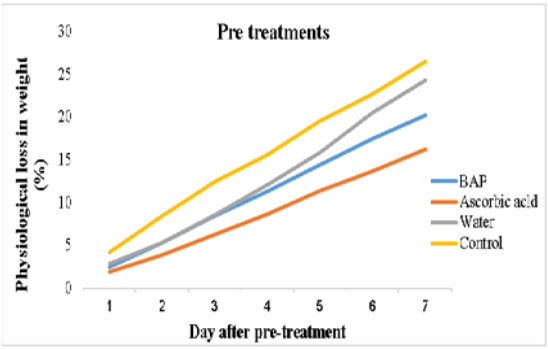

Fig. 2. Effect of cultivars on physiological loss in weight of banana leaves at different intervals of storage.

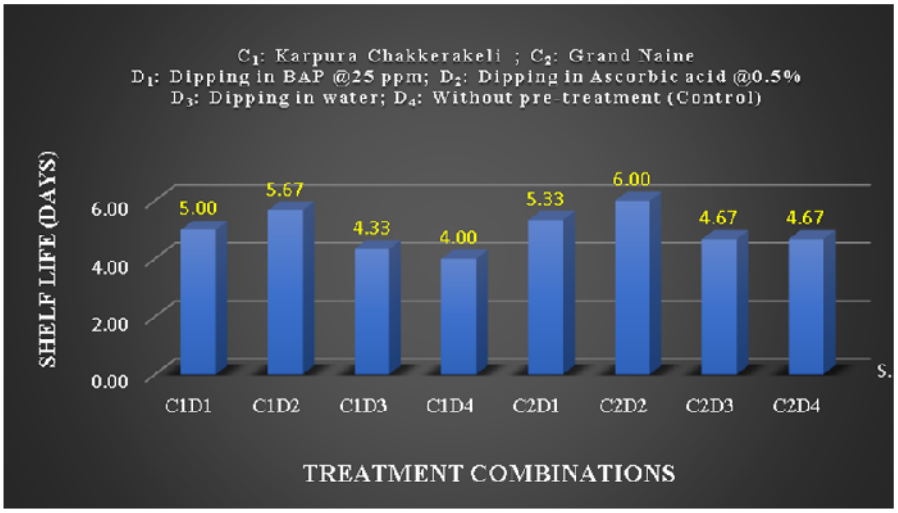

Fig. 3. Effect of cultivars and pre-treatments on shelf life of banana leaves.

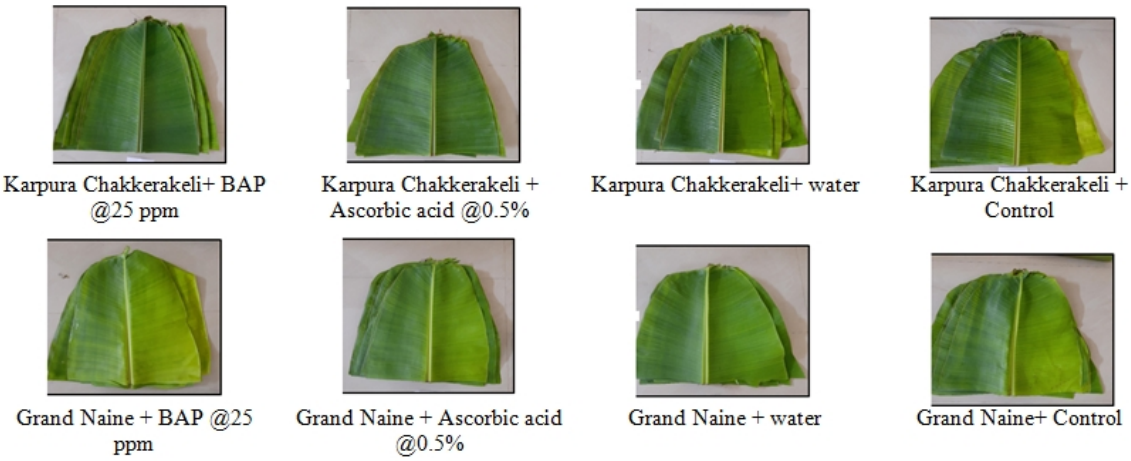

Fig. 4. Effect of pre-treatments and cultivars on banana leaves at 1st day.

Fig. 5. Effect of pre-treatments and cultivars on banana leaves at 5th day.

Table 1a: Effect of cultivars and pre-treatments on physiological loss in weight of banana leaves at different intervals of storage.

Cultivar (C)	Physiological loss in weight (%)																			
	Pre-treatment (D)																			
	1st DAP					2nd DAP					3rdDAP					4th DAP				
	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean	D_1	D_2	D_3	D_4	Mean
C_1	3.35 (10.5)	1.89 (7.84)	2.96 (9.80)	5.41 (13.40)	**3.40 (10.39)**	6.20 (14.40)	4.13 (11.72)	6.46 (14.52)	9.99 18.40)	**6.69 (14.76)**	9.39 (17.82)	6.63 (14.90)	8.91 (17.33)	13.37 (21.43)	**9.57 (17.87)**	12.35 (20.57)	9.45 (17.87)	13.69 (21.69)	16.14 (23.67)	**12.90 (20.95)**
C_2	1.51 (6.92)	1.97 (8.03)	2.78 (9.48)	3.01 (9.83)	**2.32 (8.57)**	4.56 (12.30)	3.70 (11.08)	4.29 (11.91)	7.02 (15.30)	**4.89 (12.65)**	7.58 (15.96)	5.96 (14.09)	8.12 (16.53)	11.45 (19.76)	**8.28 (16.59)**	10.32 (18.73)	7.91 (16.31)	10.46 (18.84)	15.00 (20.27)	**10.92 (23.22)**
Mean	**2.43 (8.71)**	**1.93 (7.94)**	**2.87 (9.64)**	**4.21 (11.62)**		**5.38 (13.35)**	**3.92 (11.40)**	**5.37 (13.21)**	**8.50 (16.85)**		**8.48 (16.89)**	**6.30 (14.50)**	**8.52 (16.93)**	**12.41 (20.60)**		**11.34 (19.65)**	**8.68 (17.09)**	**12.08 (20.27)**	**15.57 (23.22)**	
Factor	SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%		
C	0.46		1.38			0.42		1.27			0.29		0.86			0.26		0.79		
D	0.65		1.95			0.59		1.79			0.40		1.22			0.37		1.12		
C × D	0.91		NS			0.84		NS			0.57		NS			0.53		NS		

Table 1b: Effect of cultivars and pre-treatments on physiological loss in weight of banana leaves at different intervals of storage.

Cultivar (C)	Physiological loss in weight (%)														
	Pre-treatment (D)														
	5th DAP					6th DAP					7th DAP				
	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**
C_1	16.54 (23.96)	12.93 (21.01)	18.12 (25.17)	19.29 (26.04)	**16.72 (24.04)**	19.89 (26.43)	14.95 (22.71)	22.41 (28.24)	22.03 (27.98)	**19.82 (26.34)**	22.90 (28.50)	17.23 (24.50)	25.74 (30.47)	26.22 (30.78)	**23.02 (28.56)**
C_2	12.33 (20.55)	9.81 (18.22)	13.59 (21.61)	19.80 (26.41)	**13.88 (21.70)**	15.14 (22.89)	12.45 (20.64)	18.61 (25.49)	23.36 (28.88)	**17.39 (24.48)**	17.53 (24.74)	15.28 (22.98)	22.84 (28.46)	26.90 (31.23)	**20.64 (26.85)**
Mean	**14.44 (22.25)**	**11.37 (19.61)**	**15.85 (23.39)**	**19.54 (26.22)**		**17.51 (24.66)**	**13.70 (21.67)**	**20.51 (26.86)**	**22.70 (28.43)**		**20.22 (26.62)**	**16.26 (23.74)**	**24.29 (29.47)**	**26.56 (31.01)**	
Factor	SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%		
C	0.37		1.11			0.42		1.26			0.52		1.58		
D	0.52		1.57			0.59		1.79			0.74		2.23		
C×D	0.74		NS			0.84		NS			1.04		NS		

Table 2a: Effect of cultivars and pre-treatments on freshness in banana leaves at different intervals of storage.

Cultivar (C)	Freshness score																			
	Pre-treatment (D)																			
	1st DAP					2nd DAP					3rd DAP					4th DAP				
	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**
C_1	4.73	5.00	4.67	4.47	**4.72**	4.60	4.67	4.60	4.00	**4.47**	4.00	4.13	4.07	3.93	**4.03**	3.67	3.73	3.60	3.40	**3.60**
C_2	5.00	5.00	4.80	4.53	**4.83**	4.67	4.67	4.47	4.13	**4.48**	4.20	4.53	4.00	3.67	**4.10**	3.87	4.00	3.80	3.67	**3.83**
Mean	**4.87**	**5.00**	**4.73**	**4.50**		**4.63**	**4.67**	**4.53**	**4.07**		**4.10**	**4.33**	**4.03**	**3.80**		**3.77**	**3.87**	**3.70**	**3.53**	
Factor	SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%		
C	0.02		0.06			0.06		NS			0.06		NS			0.05		0.09		
D	0.03		0.08			0.09		0.26			0.08		0.24			0.07		0.13		
C × D	0.04		0.11			0.12		NS			0.11		0.34			0.09		NS		

Table 2a: Effect of cultivars and pre-treatments on freshness in banana leaves at different intervals of storage.

Cultivar (C)	Freshness score														
	Pre-treatment (D)														
	5th DAP					6th DAP					7th DAP				
	D_1	D_2	D_1	D_1	D_1	D_1	D_1	D_3	D_4	**Mean**	D_1	D_1	D_3	D_4	**Mean**
C_1	3.47	3.53	3.33	3.20	**3.38**	2.80	2.87	2.80	2.60	**2.77**	2.27	2.40	2.33	2.00	**2.25**
C_2	3.60	3.73	3.53	3.33	**3.55**	3.47	3.53	2.93	2.47	**3.10**	2.53	2.60	2.47	2.13	**2.43**
Mean	**3.53**	**3.63**	**3.43**	**3.27**		**3.13**	**3.20**	**2.87**	**2.53**		**2.40**	**2.50**	**2.40**	**2.07**	
Factor	SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%		
C	0.03		0.10			0.08		0.23			0.06		0.17		
D	0.05		0.14			0.11		0.32			0.08		0.24		
C × D	0.07		NS			0.15		0.46			0.11		NS		

C_1: KarpuraChakkerakeli
C_2: Grand Naine
DAP: Day after pre-treatment

D_1: Dipping in BAP @25 ppm
D_2: Dipping in Ascorbic acid @0.5%
D_3: Dipping in water
D_4: Without pre-treatment (Control)

Table 3a: Effect of cultivars and pre-treatments on yellowing of banana leaves at different intervals of storage.

Cultivar (C)	Yellowing score																			
	Pre-treatment (D)																			
	1st DAP					2nd DAP					3rd DAP					4th DAP				
	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**	D_1	D_2	D_3	D_4	**Mean**
C_1	1.40	1.37	1.40	1.47	**1.41**	1.53	1.40	1.60	1.67	1.55	1.87	1.87	1.93	2.20	**1.97**	2.40	2.13	2.60	2.67	**2.45**
C_2	1.27	1.20	1.34	1.40	**1.30**	1.33	1.27	1.53	1.60	1.43	1.53	1.47	1.60	2.07	**1.67**	2.33	2.20	2.47	2.53	**2.38**
Mean	**1.33**	**1.28**	**1.37**	**1.43**		1.43	1.33	1.57	1.63		**1.70**	**1.67**	**1.77**	**2.13**		**2.37**	**2.17**	**2.53**	**2.60**	
Factor	SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%		
C	0.01		0.02			0.01		0.03			0.01		0.04			0.02		0.06		
D	0.01		0.03			0.02		0.05			0.02		0.06			0.03		0.08		
C × D	0.01		0.04			0.02		0.07			0.03		0.09			0.04		NS		

Table 3b: Effect of cultivars and pre-treatments on yellowing of banana leaves at different intervals of storage.

Cultivar (C)	Yellowing score														
	Pre-treatment (D)														
	5th DAP					6th DAP					7th DAP				
	D_1	D_2	D_1	D_1	D_1	D_1	D_1	D_3	D_4	**Mean**	D_1	D_1	D_3	D_4	**Mean**
C_1	3.13	3.13	3.20	3.53	**3.25**	3.80	3.73	4.00	4.00	**3.88**	4.73	4.66	4.80	4.87	**4.77**
C_2	2.87	2.53	3.13	3.27	**2.95**	3.47	3.47	3.67	3.73	**3.58**	4.40	4.27	4.53	4.66	**4.47**
Mean	**3.00**	**2.83**	**3.17**	**3.40**		**3.64**	**3.60**	**3.83**	**3.87**		**4.57**	**4.47**	**4.67**	**4.77**	
Factor	SE(m)		C.D. at 5%			SE(m)		C.D. at 5%			SE(m)		C.D. at 5%		
C	0.02		0.05			0.03		0.09			0.02		0.07		
D	0.02		0.07			0.04		0.12			0.03		0.10		
C x D	0.03		0.09			0.06		NS			0.05		NS		

C_1: KarpuraChakkerakeli
C_2: Grand Naine
DAP: Day after pre-treatment

D_1: Dipping in BAP @25 ppm
D_2: Dipping in Ascorbic acid @0.5%
D_3: Dipping in water
D_4: Without pre-treatment (Control)

CONCLUSION

It could be inferred that banana leaves treated with ascorbic acid @0.5% prolong the shelf life by 5.17 days over the leaves without any pre-treatment (4.33 days). Among the cultivars, Grand Naine recorded highest shelf life of 5.17 days over Karpura Chakkerakeli with 4.75 days shelf life.

FUTURE SCOPE

Eco-friendly technologies should to be studied to enhance shelf life of banana leaves. Owing to great demand for banana leaves, studies to enhance the storability of banana leaves for export purpose has to be conducted. Trials on development of holistic module to enhance the shelf life of banana leaves from the time of harvest, handling, transport and storage should be carried out.

Conflicts of Interest. None.

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