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Pre-harvest Chemical Sprays Extend the Shelf Life and Maintain the Quality of Curry Leaf (*Murraya koenigii* Sprenge)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Curry leaf being perishable commodity and is mostly subjected to excessive post-harvest losses and quantity deterioration in a short span of time. Pre-harvest management system can minimize the losses of curry leaf and by enhancing the shelf life. Thus the present research was conducted to evaluate the effect of chemical spray on shelf life extension and quality of curry leaf. The experimental treatments were comprised of three chemicals (salicylic acid, sodium carbonate and ascorbic acid) at different concentration and the total number of treatments were ten and replicated thrice following completely randomized design (CRD). The results revealed that pre-harvest application of salicylic acid (SA) @ 100 ppm retains the freshness of curry leaf with extended shelf life without any deterioration in quality. On comparison between treatments, salicylic acid @ 100 ppm delayed physiological loss in weight (25.19%), retained chlorophyll content (1.195 mg/g) and ascorbic acid content (3.510 mg/100g). This was followed by ascorbic acid (AA) @ 100 ppm which prevented the degradation of beta-carotene in curry leaf upto seven days of storage at ambient condition. GC-MS analysis of bioactive compounds extracted from essential oil of curry leaf confirmed the presence of limonene compound in salicylic acid treated sample which is related with

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extending the shelf life. Hence individual and combined effect of SA @ 100 ppm followed by AA @ 100 ppm considered to be the best pre-harvest treatment for enhancing shelf life and maintaining the quality of curry leaf.

Keywords: Curry leaf; shelf life; pre-harvest spray.

1. INTRODUCTION

Murraya koenigii Sprenge commonly referred as curry leaf belongs to the Rutaceae family. It is originated in India which is categorized under aromatic tree spices. Curry leaf versatility is seen in its aroma and flavour. Major compounds responsible for its aroma and flavour are sabinene, caryophyllene, pinene, limonene which are known for pharmacological and nutraceutical properties [1]. A 100 gm of fresh curry leaf contains 1g fat, 18.7 g carbohydrate, 6 g protein, 7560 µg beta-carotene, 0.93mg iron and 830 mg calcium [2]. Minerals in curry leaf such as iron, copper, zinc are helpful in maintaining the normal blood glucose level in the body. It also possesses antimicrobial activity, antidiabetic activity, antioxidative property [3]. Therefore curry leaf is considered to be a remarkable plant to mankind. Despite having curative properties, it has been subjected to significant post- harvest losses. The main causes for quality and quantity deterioration in curry leaf are temperature, pest attack, respiration, transpiration and improper handling [4]. Owing to its poor shelf life, export value of this crop got declined. Thus a set of pre-harvest treatments were fixed with different combination of chemicals *i.e.* salicylic acid, ascorbic acid and sodium carbonate at different concentrations. Role of salicylic acid is to control the post- harvest loss by ethylene synthesis and inhibit the fungal growth. It suppresses superoxide radical levels [5]. Ascorbic acid is an antioxidant which scavanges free radicals, retains chlorophyll content and enhance quality and storability of the produce [6]. Sodium carbonate is a disinfectant that improves quality by preventing decay with lower disease incidence [7]. Hence, the present study has been emphasized on the effect of pre-harvest treatments on the quality and shelf life of curry leaf. GC-MS is helpful in the identification of known metabolites and differentiates the novel compound from the sample mixture. Therefore the samples of curry leaf were subjected to GC-MS analysis to identify the volatile compounds responsible for shelf life extension and this type of analysis is gaining more and more importance from both targeted and untargeted analytical perspective [8].

2. MATERIALS AND METHODS

The field experiment was undertaken at the Department of Spices & Plantation Crops, Horticulture College & Research institute, Coimbatore district of Tamil Nadu State during the growing season of 2021-2022. This experiment was laid out in completely randomized design (CRD) with ten treatments and replicated thrice. 'Senkambu' cultivar was used as planting materials for the study and planted at a spacing of 1m x 1m. The imposed pre-harvest treatments were T_1 – Control (no chemical spray) ; T_2 - Salicylic acid @ 100 ppm; T_3 - Salicylic acid @ 200 ppm; T_4 - Sodium carbonate @ 100 ppm; T_5 - Sodium carbonate @ 200 ppm; T_6 - Ascorbic acid @ 100 ppm; T_7 - Ascorbic acid @ 200 ppm; T_8 - Salicylic acid + Sodium carbonate @ 100 ppm; T_9 - Salicylic acid + Ascorbic acid @ 100 ppm ; T_{10} - Salicylic acid + Sodium Carbonate + Ascorbic acid @ 100 ppm. The chemical were sprayed as per the treatments using hand sprayer before ten days of harvesting. After harvesting, parameters like total chlorophyll content, ascorbic acid, beta-carotene, physiological loss in weight and colour value were measured and recorded.

2.1 Physiological Loss in Weight (%)

Physiological loss in weight was calculated by [9] using the below formula.

$$\text{PLW} = \frac{Initial\ weight\ (g) - Final\ weight\ (g)}{Initial\ weight\ (g)} \text{x } 100 \text{ [9]}$$

2.2 Total Chlorophyll Content (mg/g)

Total chlorophyll content of the sample was estimated by following the procedure described by Yoshida et al. [10]. One gram of leaf sample was taken and it was macerated with 10 ml of 80% acetone. The ground sample was centrifuged at 3000 rpm for 10 minutes. The supernatant was collected and made upto 25ml with 80% acetone in volumetric flask. Optical Density (OD) value of the sample was measured @ 652 nm in spectrophotometer using acetone as a blank. Then the total chlorophyll content of

curry leaf sample was calculated using the following formula;

Total Chlorophyll content = $\frac{\text{OD at 652 nm X V (ml)}}{\text{34.5 X W (g)}}$ [10]

Where,

OD – Optical Density
V- Volume of final supernatant
W- Weight of the leaf sample

2.3 Beta Carotene Content (mg/100g)

Beta carotene content was estimated by following [11] method. One gram of sample was ground with 3:2 ratio of petroleum ether : acetone mixture. The supernatant was collected and made upto 50ml with petroleum ether : acetone mixture. The absorbance of the sample was measured at 450 nm in spectrophotometer using petroleum ether as a blank.

Beta carotene content = $\frac{\text{3.875 X OD at 450 nm X V (ml)}}{\text{W (g)}}$ X 100 [11]

Where,

OD – Optical Density
V- Volume of final supernatant
W- Weight of the leaf sample

2.4 Ascorbic Acid Content (mg/100g)

Ascorbic acid content was estimated by [12] method. A working standard was prepared by diluting 10 ml of ascorbic acid to 100 ml with 4 % ascorbic acid. From the working standard, 5ml was pipetted out into a conical flask and 10 ml of 4 % oxalic acid was added and it was titrated against dye (42 mg of sodium bicarbonate + 52 mg of 2-6 Dichloro indophenols in 200 ml distilled water). The dye consumed was noted as V_1. 5 g extract of leaf sample was made upto 100 ml with 4 % oxalic acid. From 100 ml, 5ml of solution + 10 ml of 4% oxalic acid was taken and titrated against dye (V_2). Then, the ascorbic acid content was calculated using the formula;

Ascorbic acid content = $\frac{\text{0.5 mg X V2 (ml) X 100 ml}}{\text{V1 (ml) X 5 X W (g)}}$ [12]

Where,

V_1– Titre value of standard
V_2 – Titre value of sample
W- Weight of the sample

2.5 Colour Value

The sample colour was assessed using Royal Horticulture Society colour chart 2015 edition (United Kingdom). RHS elaborated a standard colour reference system with which appropriate colour code can be identified.

2.6 GC-MS Analysis

The best pre-harvest treatment was found out based on the results of physiological and biochemical values. Essential oil was extracted from the best performed treatment and control. Then it was subjected to GC-MS analysis to identify and differentiate the compounds present in the samples.

2.6.1 Volatile oil extraction

100 mg of fresh curry leaf was chopped into pieces and it was transferred to round bottom flask and then 500 ml of distilled water was added to it. Oil was extracted using Clevenger apparatus. Oil yield of control and SA 100ppm treated were 0.12 %& 0.15%. After extraction, sample was stored in a closed container at a refrigerated temperature of 4° C.

2.6.2 Instrumentation

A Perkin Elmer GC Claurus SQ8C system was used to analyse curry leaf extract, which was connected to a Mass Spectrometer with a DB-5 capillary standard non polar column fused silica capillary column (30m x 0.25mm x 0.25m df) made of 5% Diphenyl and 95% Dimethyl poly siloxane. An electron ionization device with a70 eV ionization energy was employed for GC-MS detection. The carrier gas was helium (99.99 percent) with a constant flow rate of 1 ml/minute and an injection volume of 1 µl (split ratio of 10:1). The oven temperature was set to 110°C (isothermal for 2 minutes), then increased at a rate of 10°C/minute to 200°C, then 5°C/minute to 280°C, ending at 280°C culminating in a 9-minutes. Mass spectra were collected at 70 eV with a 0.5 second scan interval with fragments ranging from 45 to 450 Da. The GC took 30 minutes to complete. By comparing the average peak area of each component to the total areas, the relative percentage quantity of each component was computed. By comparing spectra from curry leaf extract to spectra from a reference library, compounds were found (NIST 08 Mass Spectra Library, National Institute of Standards and Technology).

2.7 Statistical Analysis

The collected and measured data were compiled and analyzed following analysis of variance (One way ANOVA) using AGRES software. Least significant difference among the means were calculated at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Physiological Loss in Weight (%)

Significant variation physiological loss in weight (PLW) among the storage time (days) was noticed. The PLW was gradually increased with the increased of storage time i.e. the more the storage duration (days) the more the PLW of curry leaf. Among the treatments (chemicals and its concentration), T_2 (25.9%) followed by T_9 (30.75%) significantly reduced the PLW than other treatments while the highest PLW was found in control treatment (40.21 %) which is indicated in Table 1. This might be due to the fact that Salicylic acid has tendency to scavenge free radicals by donating electrons. Tareen et al. [13] reported in peach that the treatment of SA could facilitate closure of stomata which inturn controls respiration and transpiration rate resulting in reduced weight loss. Similar findings were reported by [14-16]. Followed by salicylic acid , combined spray of salicylic acid and ascorbic acid @ 100 ppm was also perfomed well. Ascorbic acid is a antioxidant which is used to retain the quality without any deterioration by activating the natural defense mechanism [17].

3.2 Total Chlorophyll Content (mg/100g)

Chlorophyll is the essential component in photosynthesis process. Total chlorophyll content starts declining on the subsequent days of storage. Chlorophyll degradation was rapid in untreated sample (0.395 mg/g) which might have been due to the reduction of RUBISCO activity indicated in Table 2. The chlorophyll content was significantly higher in T_2 (1.195 mg/g) and T_6 (1.073 mg/100 g) treatments. Both salicylic acid and ascorbic acid had significant effect on photosynthetic pigments compared to control. Miri et al. [18] reported that lower concentration of Salicylic acid influences the photosynthetic efficiency by altering the abaxial and adaxial side of the mesophyll tissue of leaf anatomy. It also helps in the transmission of nitrates which favours internal chlorophyll synthesis and it enhances RUBISCO enzyme activity [19,20].

Table 1. Effect of pre-harvest chemical sprays on physiological loss in weight of curry leaf under ambient storage

Treatment	Physiological Loss in Weight (%)				
	Day - 1	Day - 3	Day - 5	Day - 7	Mean
T_1	35.35	40.21	-	-	18.89
T_2	13.02	18.43	22.47	25.19	19.78
T_3	24.00	27.43	29.26	35.33	29.01
T_4	27.12	32.36	37.82	45.12	35.61
T_5	29.31	35.53	42.12	-	26.74
T_6	18.23	23.07	28.12	34.26	25.92
T_7	21.34	26.30	30.12	-	19.44
T_8	25.12	32.20	37.30	42.12	34.19
T_9	17.30	22.18	25.37	30.75	23.90
T_{10}	19.12	22.32	26.25	32.97	25.17
Mean	22.991	28.000	30.980	35.105	
SEd	0.5190	0.6116	0.4505	0.5295	
CD (*P* =0.05)	1.0826	1.2758	0.9397	1.1045	
CV (%)	2.76	2.68	1.97	2.64	

(T_1– Control (no chemical spray) ; T_2 - Salicylic acid @ 100 ppm ; T_3 - Salicylic acid @ 200 ppm ; T_4 - Sodium carbonate @ 100 ppm ; T_5 - Sodium carbonate @ 200 ppm ; T_6 - Ascorbic acid @ 100 ppm ; T_7 - Ascorbic acid @ 200 ppm ; T_8 - Salicylic acid + Sodium carbonate @ 100 ppm ; T_9 - Salicylic acid + Ascorbic acid @ 100 ppm ; T_{10} - Salicylic acid + Sodium Carbonate + Ascorbic acid @ 100 ppm)

Table 2. Effect of pre-harvest chemical sprays on total chlorophyll content of curry leaf under ambient storage

Treatment	Total Chlorophyll Content (mg/g)				
	Day - 1	Day - 3	Day - 5	Day - 7	Mean
T_1	0.523	0.395	-	-	0.22
T_2	1.376	1.302	1.253	1.195	1.28
T_3	1.19	1.031	0.972	0.913	1.03
T_4	0.982	0.926	0.843	0.789	0.89
T_5	0.726	0.654	0.597	-	0.49
T_6	1.217	1.173	1.131	1.073	1.15
T_7	0.821	0.783	0.625	-	0.56
T_8	0.96	0.917	0.874	0.816	0.89
T_9	0.898	0.845	0.79	0.738	0.82
T_{10}	1.121	1.098	1.042	0.996	1.06
Mean	0.9814	0.9124	0.8127	0.652	
SEd	0.0241	0.0194	0.0159	0.0142	
CD (*P* = 0.05)	0.0504	0.0405	0.0332	0.0296	
CV (%)	3.01	2.61	2.40	2.66	

(T_1– Control (no chemical spray) ; T_2 - Salicylic acid @ 100 ppm ; T_3 - Salicylic acid @ 200 ppm ; T_4 - Sodium carbonate @ 100 ppm ; T_5 - Sodium carbonate @ 200 ppm ; T_6 - Ascorbic acid @ 100 ppm ; T_7 - Ascorbic acid @ 200 ppm ; T_8 - Salicylic acid + Sodium carbonate @ 100 ppm ; T_9 - Salicylic acid + Ascorbic acid @ 100 ppm ; T_{10} - Salicylic acid + Sodium Carbonate + Ascorbic acid @ 100 ppm)

Table 3. Effect of pre-harvest chemical sprays on beta-carotene content of curry leaf under ambient storage

Treatment	Betacarotene (mg/100g)				
	Day - 1	Day - 3	Day - 5	Day - 7	Mean
T_1	7.100	7.006	-	-	3.53
T_2	7.682	7.640	7.608	7.559	7.62
T_3	7.210	7.156	7.102	6.952	7.11
T_4	7.142	7.107	6.958	6.896	7.03
T_5	7.256	7.203	7.182	-	5.41
T_6	7.705	7.675	7.650	7.616	7.66
T_7	7.180	7.109	7.008	-	5.32
T_8	7.297	7.236	7.191	7.097	7.21
T_9	7.306	7.271	7.202	7.176	7.24
T_{10}	7.300	7.252	7.195	7.123	7.22
Mean	7.317	7.265	7.232	5.602	
SEd	0.1330	0.1526	0.1325	0.1596	
CD (*P*= 0.05)	0.2775	0.3183	0.2764	0.3328	
CV (%)	2.23	2.57	2.49	3.88	

(T_1– Control (no chemical spray) ; T_2 - Salicylic acid @ 100 ppm ; T_3 - Salicylic acid @ 200 ppm ; T_4 - Sodium carbonate @ 100 ppm ; T_5 - Sodium carbonate @ 200 ppm ; T_6 - Ascorbic acid @ 100 ppm ; T_7 - Ascorbic acid @ 200 ppm ; T_8 - Salicylic acid + Sodium carbonate @ 100 ppm ; T_9 - Salicylic acid + Ascorbic acid @ 100 ppm ; T_{10} - Salicylic acid + Sodium Carbonate + Ascorbic acid @ 100 ppm)

3.3 Beta-carotene Content (mg/100g)

Retention of beta-carotene is higher in curry leaf treated with ascorbic acid @100 ppm (7.616 mg/g) followed by salicylic acid @ 100 ppm treatment (7.559 mg/g) at the end of the storage (Table 3). Ascorbic acid decelerated beta-carotene degradation due to slow oxidation reaction [21]. Salicylic acid 100 ppm treated curry leaf also performed well. This might be due to the fact that SA enhances biosynthetic pathway by controlling the gene encoding the enzymes responsible for carotenoids. It is a growth regulator, which inhibits catalase activity and increases hydrogen peroxide concentration followed by elevated antioxidative enzymes.

These enzymes are accountable for the increased synthesis of carotenoids [22-24].

3.4 Ascorbic Acid Content (mg/100g)

Pre-harvest spray of salicylic acid @ 100 ppm in curry leaf retained 3.510 mg/100g ascorbic acid till the end of 7th day of storage compared to other treatments (Table 4). Minimum retention of ascorbic acid (2.890 mg/100g) was noted in control at third day of storage. As ascorbic acid is sensitive to oxidation, it degrades rapidly. Kumar et al. [25] reported in strawberry that salicylic acid played a effective role on mitigating ascorbic acid oxidase enzyme activity that oxidize ascorbic acid to dehydroascorbic acid which hastened the ascorbate peroxidase and glutathione reductase activity and also accumulates reducing sugars. This statement is in accordance with [26-28].

3.5 Colour Value

Colour code and colour was noted from Royal Horticulture Society colour chart. The leaves of all the treatment belonged to green group. Colour changed from strong and brilliant green to moderate olive green. There was a significant difference between control and other treatments. Colour got faded on the third day of storage in control whereas in other treatments colour retention was higher.

3.6 GC-MS Analysis

Forty major and minor volatile compounds present in curry leaf essential oil was determined by GC-MS. Major compounds like Caryophyllene, á-Pinene and ç-Terpinene were identified. Minor compounds like à-Terpineol, Limonene, Cubenene,ç-Elemene,Humulene, Neointermedeol were also recognized. Caryophyllene compound has maximum retention time (11.512) in the salicylic acid (SA) treated sample. The other compounds like á-Pinene, á-Ocimene and ç-Terpinene were found to be highest in SA treated sample. In the present study, limonene is a monoterpene compound with maximum peak area (15.120 %) was observed to be present only in SA @100ppm treated sample which was completely absent in control. Limonene possess insecticidal property. Hollingsworth et al. [29] reported role of limonene in controlling mealy bug and scale insect. Khalid et al. [30] investigated the interaction between salicylic acid and grape essential oil in which he reported that application of salicylic acid has improved limonene compound. This could be one of the reason that limonene compound present in treated curry leaf would have extended the shelf life. Dhital et al. [31] reported that limonene coating in strawberry has extended shelf with higher anthocyanin content. Therefore limonene might be the reason for prolonging shelf life in salicylic acid treated sample.

Table 4. Effect of pre-harvest chemical sprays on Ascorbic acid content of curry leaf under ambient storage

Treatment	Ascorbic acid (mg/100g)				
	Day - 1	Day - 3	Day - 5	Day - 7	Mean
T_1	3.010	2.890	-	-	1.48
T_2	3.800	3.720	3.650	3.510	3.67
T_3	3.220	3.140	3.020	2.910	3.07
T_4	3.190	3.100	3.000	2.890	3.05
T_5	3.120	3.050	2.980	-	2.29
T_6	3.560	3.420	3.380	3.250	3.40
T_7	3.390	3.270	3.120	-	2.45
T_8	3.250	3.100	2.980	2.900	3.06
T_9	3.590	3.470	3.360	3.290	3.43
T_{10}	3.750	3.680	3.550	3.420	3.60
Mean	3.388	3.284	3.227	3.167	
SEd	0.0940	0.0755	0.0766	0.0527	
CD (*P*=0.05)	0.1960	0.1575	0.1599	0.1100	
CV (%)	3.40	2.82	3.23	2.91	

(T_1– Control (no chemical spray) ; T_2 - Salicylic acid @ 100 ppm ; T_3 - Salicylic acid @ 200 ppm ; T_4 - Sodium carbonate @ 100 ppm ; T_5 - Sodium carbonate @ 200 ppm ; T_6 - Ascorbic acid @ 100 ppm ; T_7 - Ascorbic acid @ 200 ppm ; T_8 - Salicylic acid + Sodium carbonate @ 100 ppm ; T_9 - Salicylic acid + Ascorbic acid @ 100 ppm ; T_{10} - Salicylic acid + Sodium Carbonate + Ascorbic acid @ 100 ppm

Table 5. Effect of pre-harvest chemical sprays on colour value of curry leaf under ambient storage

Treatment	Colour Value							
	Day 1		Day 3		Day 5		Day 7	
	Colour code	Colour	Colour code	Colour	Colour code	Colour	Colour Code	Colour
T_1	N134C	Strong Green	NN 137C	Greyish Olive Green	-	-	-	-
T_2	N134C	Strong Green	N134D	Brilliant Green	135A	Dark Green	137A	Moderate Olive Green
T_3	N134D	Brilliant Green	135A	Dark Green	135B	Moderate Green	137C	Moderate Yellow Green
T_4	N134C	Strong Green	135B	Moderate Green	137 B	Moderate Olive Green	137C	Moderate Yellow Green
T_5	N134D	Brilliant Green	135A	Dark Green	NN137 A	Greyish Olive Green	-	-
T_6	N134C	Strong Green	N134D	Brilliant Green	135 B	Moderate Green	NN137A	Greyish Olive Green
T_7	135A	Dark Green	136 B	Dark Yellowish Green	NN137 C	Greyish Olive Green	-	-
T_8	N134C	Strong Green	135A	Dark Green	137 A	Moderate Olive Green	NN137A	Greyish Olive Green
T_9	N134C	Strong Green	135A	Dark Green	135 A	Dark Green	NN137C	Greyish Olive Green
T_{10}	N134C	Strong Green	N134D	Moderate Green	135 A	Dark Green	NN137B	Greyish Olive Green

(T_1– Control (no chemical spray) ; T_2 - Salicylic acid @ 100 ppm ; T_3 - Salicylic acid @ 200 ppm ; T_4 - Sodium carbonate @ 100 ppm ; T_5 - Sodium carbonate @ 200 ppm ; T_6 - Ascorbic acid @ 100 ppm ; T_7 - Ascorbic acid @ 200 ppm ; T_8 - Salicylic acid + Sodium carbonate @ 100 ppm ; T_9 - Salicylic acid + Ascorbic acid @ 100 ppm ; T_{10} - Salicylic acid + Sodium Carbonate + Ascorbic acid @ 100 ppm)

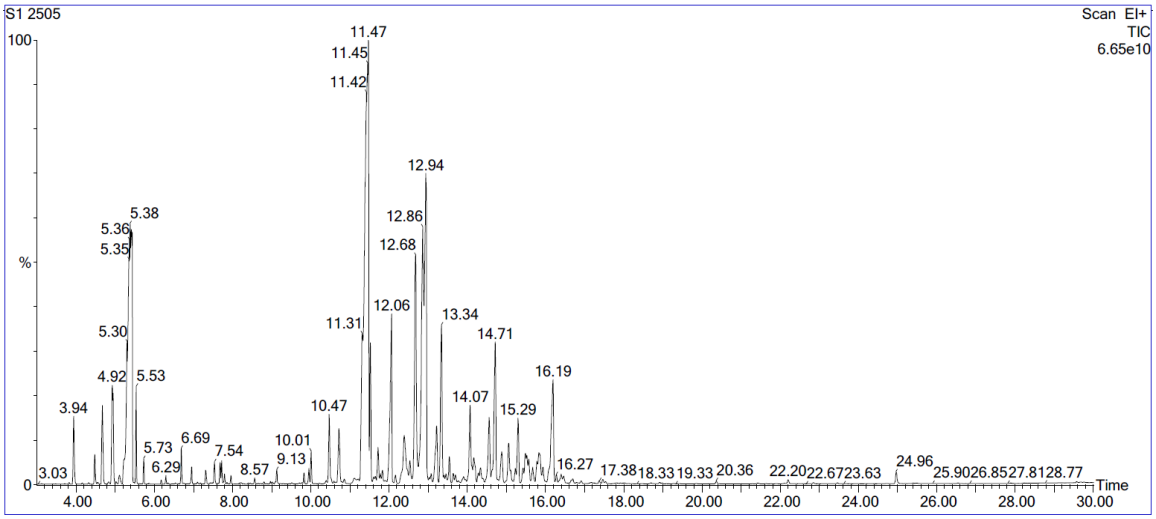

Fig. 1. Chemical constituents of essential oil extracted from curry leaf (control)

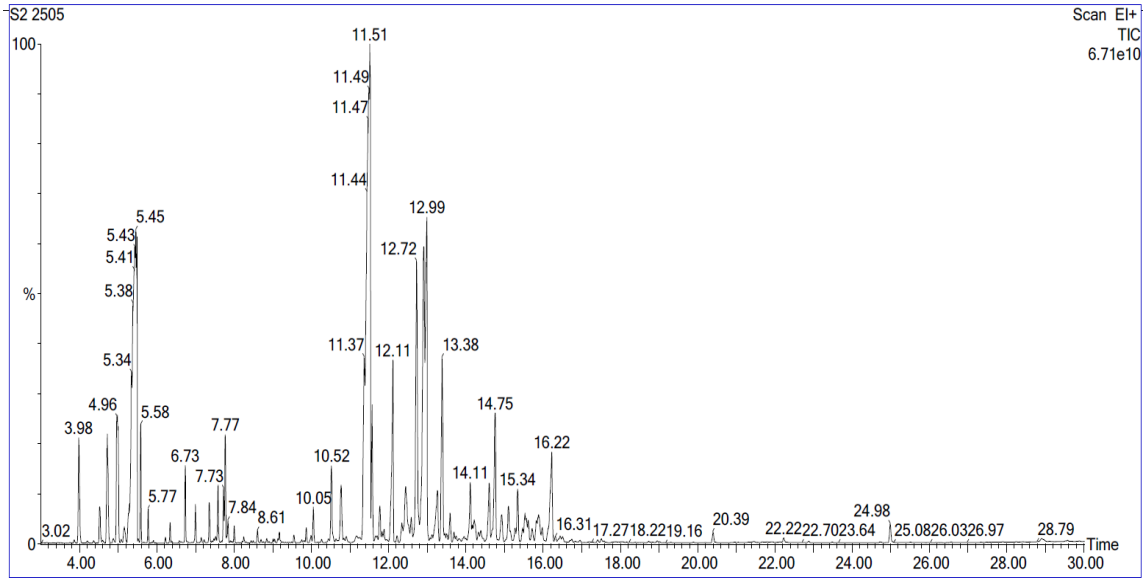

Fig. 2. Chemical constituents of essential oil extracted from curry leaf (SA treated sample)

Table 6. Chemical constituents of essential oil in curry leaf

Compound name	Control		Salicylic acid treated sample (100 ppm)	
	RT	Peak area (%)	RT	Peak area (%)
(1R)-2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene	3.939	0.991	3.979	1.493
Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	4.479	0.402	4.519	0.516
á-Pinene	4.669	1.306	4.719	1.807
Limonene	-	-	5.379	15.120
á-Ocimene	5.534	0.955	5.584	1.025
ç-Terpinene	5.729	0.253	5.775	0.308
1,3-Cyclohexadiene, 1-methyl-4-(1-methylethyl)-	-	-	5.159	0.301

Compound name	Control		Salicylic acid treated sample (100 ppm)	
	RT	Peak area (%)	RT	Peak area (%)
Cyclohexene, 4-methyl-1-(1-methylethenyl)-	-	-	5.454	16.038
2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis-	6.690	0.390	7.000	0.380
3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-, (R)-	7.535	0.275	7.585	0.600
2-Cyclohexen-1-one, 4-(1-methylethyl)-	-	-	7.730	0.493
à-Terpineol	-	-	7.770	1.081
à-Cubebene	10.006	0.388	10.051	0.390
.alfa.-Copaene	10.466	1.074	10.516	1.107
Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-, [1S-(1à,2á,4á)]-	10.716	1.101	10.767	1.069
Caryophyllene	11.472	20.843	11.512	19.015
ç-Muurolene	11.522	1.556	11.572	1.358
Aromandendrene	11.717	0.584	11.772	0.517
Humulene	12.062	3.619	12.112	2.889
1H-Cyclopropa[a]naphthalene, decahydro-1,1,3a-trimethyl-7-methylene-, [1aS-(1aà,3aà,7aá,7bà)]-	12.387	1.635	12.437	1.421
Germacrene D	12.532	0.256	-	-
Naphthalene, decahydro-4a-methyl-1-methylene-7-(1-methylethenyl)-, [4aR-(4aà,7à,8aá)]-	12.857	6.276	12.722	4.894
Longifolene-(V4)	-	-	12.907	6.373
ç-Elemene	-	-	12.987	5.945
1H-Benzocycloheptene, 2,4a,5,6,7,8,9,9a-octahydro-3,5,5-trimethyl-9-methylene-, (4aS-cis)-	12.937	7.653	-	-
(3S,3aR,3bR,4S,7R,7aR)-4-Isopropyl-3,7-dimethyloctahydro-1Hcyclopenta[1,3]cyclopropa[1,2]benzen-3-ol	13.217	1.416	13.263	1.384
Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-, (1S-cis)-	13.338	3.222	-	-
1-Isopropyl-4,7-dimethyl-1,2,3,5,6,8a-hexahydronaphthalene	-	-	13.383	16.62
Cubenene	13.538	0.412	13.588	0.400
1,6,10-Dodecatrien-3-ol, 3,7,11-trimethyl-, (E)-	14.073	1.709	14.113	0.916
(1aR,4S,4aR,7R,7aS,7bS)-1,1,4,7-Tetramethyldecahydro-1Hcyclopropa[e]azulen-4-ol	14.163	0.618	14.218	0.451
(1S,4aS,7R,8aS)-1,4a-Dimethyl-7-(prop-1-en-2-yl)decahydronaphthalen-1-ol	14.338	0.346	-	-
1H-Cycloprop[e]azulen-7-ol, decahydro-1,1,7-trimethyl-4-methylene-, [1ar-(1aà,4aà,7á,7aá,7bà)]-	14.553	1.300	14.603	0.980
Globulol	14.713	2.874	14.753	2.249
Guaiol	14.878	0.740	-	-
2-Naphthalenemethanol, 2,3,4,4a,5,6,7,8-	15.058	1.038	15.098	0.788

Compound name	Control		Salicylic acid treated sample (100 ppm)	
	RT	Peak area (%)	RT	Peak area (%)
octahydro-à,à,4a,8-tetramethyl-, [2R-(2à,4aá,8á)]-Neointermedeol	15.293	1.246	15.338	0.855
(2E,4S,7E)-4-Isopropyl-1,7-dimethylcyclodeca-2,7-dienol	15.423	0.246	-	-
.tau.-Muurolol	-	-	15.884	0.713
1H-Indene, 1-ethylideneoctahydro-7a-methyl-, (1E,3aà,7aá)-	15.488	0.979	15.529	0.736
Di-epi-1,10-cubenol	15.568	0.351	-	-
Epicubenol	15.668	0.278	-	-
(-)-Spathulenol	15.779	0.327	-	-
.tau.-Cadinol	15.829	0.977	-	-
1-Naphthalenol, 1,2,3,4,4a,7,8,8a-octahydro-1,6-dimethyl-4-(1-methylethyl)-, [1R-(1à,4á,4aá,8aá)]-	15.934	0.288	-	-

4. CONCLUSION

The results of present study revealed that individual or combined effect of salicylic acid @ 100 ppm and ascorbic acid @ 100 ppm could be an effective pre-harvest spray. It prolonged the shelf life of curry leaf without much deterioration in quality by stimulating defense mechanism and inhibiting ethylene synthesis. It slowed down the degradation of chlorophyll, ascorbic acid, beta carotene content upto seven days at ambient condition. From the finding of this study it should be concluded that pre-harvest spray of salicylic acid @ 100 ppm could be the better option for the shelf life extension with the maintaining of quality components of curry leaf. As curry leaf is bestowed with numerous benefits, further research has to be carried out utilizing different plant growth promoters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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