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Effect of pre and post harvest applications of salicylic acid on quality attributes and storage behaviour of strawberry cv. Chandler

Sunil Kumar and Gurpinder Kaur

Abstract
The present investigation entitled effect of pre and post harvest application of salicylic acid on the quality attributes and storage behaviour of strawberry cv. Chandler was conducted in the Department of Horticulture, Khalsa College, Amritsar during 2017-2018. The runners of strawberry cv. Chandler were planted in mid October with a spacing of 45 x 30 cm on raised beds. The investigation was conducted under RBD factorial design with ten treatments which replicated thrice and five storage intervals. The results of the study revealed that during storage, treatment T_8 (SA 2 mM as pre and post harvest) also found to be effective in prolonging the storage life of strawberry fruits by reducing the PLW (35.81%), spoilage (35.33%) and fungal decay to significant extent upto 16 days of storage. Hence, SA 2 mM considered to be best when applied at both pre and post harvest to the strawberry runners in enhancing the quality attributes as well as to maintain the storage life of fruits upto 16 days of storage at 4 ^{0}C.

Keywords: Chandler, salicylic acid, quality and storage life

Introduction
Strawberry (*Fragaria x ananassa* Duch.) is one of the most popular fruit in the world which belonging to family Rosaceae and sub family Rosoidae. The name "strawberry" may have derived from the practice of using straw mulch for cultivation, or it may have come from the Anglo-Saxon word "strew" meaning "to spread" (Kaur 2010) [13]. India is the second largest producer of strawberry fruits in the world after China. In India, strawberry was initially grown in temperate zones of the country but now it has become possible in the subtropical zones (Asrey and Singh 2004) [1]. Strawberries are very rich in nutrients, amino acids vitamins and anthocyanins. It contains relatively high qualities of Ellagic acid, which has a wide range of biological activity (Meyers *et al* 2003) [19]. Strawberries have a very short shelf life due to its highly perishable nature and sensitivity to fungal attack. Its fruit quality deteriorates rapidly after harvesting because of quick metabolic activity. Hence the proper fruit storage is an effective way to maintain its quality of even fruit after harvest (Cordenunsi *et al* 2005) [9]. Strawberries are very sensitive against fungal attack because of their perishable structure, so attempts have been made for maintenance of fruit quality and extension of shelf life by the use of natural compounds. Salicylic acid (SA) is a simple phenolic compound and it is recognized as a plant growth regulators, because of its foliar effects on many plant growth physiological processes (Zavala *et al* 2004) [27]. Influence of Salicylic acid on the fruit softening, fruit ripening and senescence are accompanied by changes in several quality aspects such as decrease in total acidity and increase in sugar contents, colour development and aroma production. Salicylic acid and its derivatives are widely used to enhance fruits postharvest life by controlling their firmness (Kazemi *et al* 2011) [14]. Exogenous application of Salicylic acid at nontoxic concentrations to susceptible plants could enhance their resistance to fungal pathogens. It also act as a potential non-enzymatic antioxidant as well as plant growth regulator and play an important role in regulating a number of plant physiological processes including heat production or thermogenesis, ion uptake and transport, disease resistance, seed germination, sex polarisation, crop yield and glycolysis (Zhang *et al* 2003) [28].

Materials and methods
The present study entitled the effect of pre and post harvest application of salicylic acid on the quality attributes and storage behaviour of strawberry cv. Chandler was carried out in the Department of Horticulture, Khalsa College, Amritsar during the year 2017-2018**.** The runners of strawberry cv. Chandler were planted in mid October with a spacing of 45 × 30 cm on raised beds. The investigation was conducted under RBD factorial design with ten treatments

which replicated thrice and five storage intervals. The Pre harvest application of salicylic acid (SA) was done at flowering stage, fruit setting, 30, 20 and 10 days before fruit harvest. For storage work, fruits was harvested from the plants planted on raised beds with three replications. For post harvest application of salicylic acid, 20-25 fruits per replication were selected and dipped in a solution of given concentrations for 15 minutes. The fruits were stored at 4 ^{0}C for 16 days and samples were evaluated for physio-chemical characteristics at 4 days interval.

Results and Discussion

The minimum mean PLW (17.47%) was recorded in fruits obtained from plants applied with pre and post harvest application of SA 2 mM (T_8), While maximum mean PLW (31.37%) was recorded under treatment T_1 (control). The significant reduction in PLW might be due to the superiority of salicylic acid in minimizing weight loss may be because it acts as electron donor and produces free radical which prevents normal respiration and can also decrease respiration rate and fruit loss by closing stomata (Zhang and Zhang 2004) [26]. Similar findings are also reported by Salari *et al* (2012) [20] and Lolaei *et al* (2012) [18] in strawberry fruits. The minimum mean PLW (8.38%) was recorded after 4 days of storage which was found to be dramatically increased to 51.18 percent after 16 days of storage. The loss of weight of fresh fruits and vegetables at storage intervals is mainly due to the loss of water caused by transpiration process (Zhu *et al* 2008) [29]. The minimum PLW (5.16%) was found under treatment T_8: SA 2mM (pre + post harvest) after 4 days of storage, whereas the maximum PLW (61.66%) was recorded in fruits under treatment T_1 (control) after 16 days of storage at 4 ^{0}C.

Table 1: Effect of pre and post harvest application of salicylic acid on PLW (%) of strawberry fruits cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	0	11.49	31.55	52.15	61.66	31.37
T_2 : SA 2 mM (pre harvest)	0	8.56	26.34	40.19	52.20	25.45
T_3 : SA 4 mM (pre harvest)	0	9.0	27.15	42.1	55.82	26.81
T_4 : SA 6 mM (pre harvest)	0	10.61	28.0	49.33	58.12	29.21
T_5 : SA 2 mM (post harvest)	0	7.55	25.11	36.15	49.13	23.58
T_6 : SA 4 mM (post harvest)	0	7.30	22.45	35.0	46.14	22.17
T_7 : SA 6 mM (post harvest)	0	10.53	27.50	47.60	56.0	28.32
T_8 : SA 2 mM (pre + post harvest)	0	5.16	19.07	27.33	35.81	17.47
T_9 : SA 4 mM (pre + post harvest)	0	5.33	22.37	33.81	45.46	21.39
T_{10} : SA 6 mM (pre + post harvest)	0	8.34	25.46	40.0	51.46	25.05
Mean	0	8.38	25.61	40.88	51.18	

CD (p = 0.05%)
Treatments - 0.95
Days - 0.60
Interaction - 1.90

Mean minimum spoilage (15.19%) was recorded in fruits treated with SA 2 mM (pre + post harvest) and was found to be significant over the other treatments. Maximum mean spoilage (49.32%) was recorded under treatment T_1 (control). Salicylic acid mediated prevention of ACO activity which is a precursor of ethylene and decrease the ROS (reactive oxygen species) with increase enzyme antioxidant activity which significantly reduced the spoilage (Abbasi *et al* 2010) [2]. Our results are lined with Samra *et al* (2015), Shafiee *et al* (2010) [22, 21] in strawberry fruits. From the data, it was observed that mean minimum spoilage percentage (10.47%) was recorded after 4 days of storage. However the mean maximum spoilage percentage (81.15%) was recorded after 16 days of storage. However, minimum spoilage percentage (4.98%) was recorded in fruits treated with treatment T_8: SA 2 mM (pre + post harvest) after 4 days of storage. On the other hand, maximum spoilage percentage (100%) was found in T_1, T_2, T_3 and T_4 after 16 days of storage at 4 ^{0}C.

Table 2: Effect of pre and post harvest application of salicylic acid on spoilage (%) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	0	17.83	40.07	88.73	100	49.32
T2 : SA 2 mM (pre harvest)	0	12.21	16.52	47.43	100	35.23
T_3 : SA 4 mM (pre harvest)	0	12.33	19.11	50.94	100	36.47
T_4 :-SA 6 mM (pre harvest)	0	17.55	26.24	61.86	100	41.13
T_5 : SA 2 mM (post harvest)	0	6.25	10.0	43.14	80.94	28.06
T_6 : SA 4 mM (post harvest)	0	5.25	7.16	33.63	66.40	22.48
T_7 : SA 6 mM (post harvest)	0	12.93	25.61	54.54	100	38.61
T_8 : SA 2 mM (pre + post harvest)	0	4.98	6.75	28.93	35.33	15.19
T_9 : SA 4 mM (pre + post harvest)	0	5.08	7.06	32.74	44.35	17.84
T_{10} : SA 6 mM (pre + post harvest)	0	10.30	14.92	45.31	84.49	31.0
Mean	0	10.47	17.34	48.72	81.15	

CD (p = 0.05)
Treatments - 0.65
Days - 0.41
Interaction - 1.31

The results revealed that the fruits treated with treatments T_8: SA 2mM (pre + post harvest), T_6: SA 4mM (post harvest) and T_5: SA 2mM (post harvest) exhibited no fungal decay. However the mean maximum fungal decay (11.05%) was recorded under control fruits. This might be due to the fact that salicylic acid leads to plant defence system against pathogens by rapidly increasing H_2O_2 (Hydrogen peroxide) production in plants, that behaves as a signal molecule and thereby activates the plants systemic resistance against pathogen (Cai and Zheng 1999) [8]. The data revealed that the minimum mean fungal decay (1.68%) was recorded after 4 days of storage while the maximum percentage of fungal decay (10.46%) was found after 12 days of storage. However, no decay was found in treatments T_8: SA 2mM (pre + post harvest), T_5: SA 2 mM (post harvest) and T_6: SA 4 mM (post harvest) after 4, 8, 12 and 16 days of storage at 4 ^{0}C. On the other hand, the maximum fungal decay (28.52%) was found in control fruits after 12 days of storage. The present results are in accordance with the findings of Xu and tian (2008) in sweet cheery fruits, Babular *et al* (2007) [7] in strawberry fruits.

Table 3: Effect of pre and post harvest application of salicylic acid on fungal decay (%) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 ; Control	0	10.63	16.12	28.52	-	11.05
T_2 : SA 2 mM (pre harvest)	0	0	5.85	14.39	-	4.04
T_3 : SA 4 mM (pre harvest)	0	0	5.0	12.56	-	3.51
T_4 : SA 6 mM (pre harvest)	0	6.25	8.0	24.0	-	7.65
T_5 : SA 2 mM (post harvest)	0	0	0	0	0	0
T_6 : SA 4 mM (post harvest)	0	0	0	0	0	0
T_7 : SA 6 mM (post harvest)	0	0	10.0	14.09	-	4.81
T_8 : SA 2 mM (pre + post harvest)	0	0	0	0	0	0
T_9 : SA 4 mM (pre + post harvest)	0	0	0	0	5.0	1.0
T_{10} : SA 6 mM (pre + post harvest)	0	0	5.0	11.03	18.46	6.89
Mean	0	1.68	4.49	10.46	2.34	

CD (p = 0.05)
Treatments - 0.61
Days - 0.39
Interaction - 1.23

The data revealed that mean maximum fruit acceptability (7.76) was recorded under treatment T_8: SA 2 mM (pre + post harvest). However, the minimum mean fruit acceptability (4.61) was recorded under untreated control fruits. The increase in fruit acceptability by the application of SA might be due to adverse effect on ethylene production (Babular *et al* 2007) [7]. The results of present study are related to the findings of Ali *et al* (2013) [4] in apricot fruits, Krishna *et al* (2011) [16] in apple fruits. From the data, it was observed that the mean maximum fruit acceptability (8.84) was found before storage which was declined during the increment in storage intervals with minimum mean fruit acceptability (2.17) was recorded after 16 days of storage. From the data, it has been found that treatment T_8: SA 2 mM (pre + post harvest) significantly retained the fruit acceptability after 12 days of storage at 4 ^{0}C. The higher acceptability in salicylic acid treated fruits at the end of storage could be due to retardation of ripening and softening process of fruit that led to the development of better juice, texture, flavour and sweetness (Kaundal *et al* 2000) [17].

Table 4: Effect of pre and post harvest application of salicylic acid on fruit acceptability of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	8.5	7.3	5.41	1.87	-	4.61
T_2 : SA 2 mM (pre harvest)	8.9	8.4	7.6	4.8	-	5.94
T_3 : SA 4 mM (pre harvest)	8.8	8.3	7.3	4.5	-	5.78
T_4 : SA 6 mM (pre harvest)	8.6	7.8	7.0	4.0	-	5.54
T_5 : SA 2 mM (post harvest)	9.0	8.5	8.0	6.8	3.9	7.24
T_6 : SA 4 mM (post harvest)	9.0	8.6	8.2	7.3	4.2	7.46
T_7 : SA 6 mM (post harvest)	8.7	7.9	7.2	4.4	-	5.64
T_8 : SA 2 mM (pre + post harvest)	9.0	8.9	8.5	7.8	4.6	7.76
T_9 : SA 4 mM (pre + post harvest)	9.0	8.82	8.35	7.6	4.4	7.63
T_{10} : SA 6 mM (pre + post harvest)	8.95	8.46	7.96	6.3	3.8	7.09
Mean	8.84	8.29	7.55	5.53	2.09	

CD (p = 0.05)
Treatments - 0.043
Days - 0.031
Interaction - 0.098

The maximum mean TSS (7.56 ^{0}Brix) was observed under treatment T_6: SA 4 mM (pre + post harvest), while the minimum mean TSS (4.67 ^{0}Brix) was found in treatment T_1 control fruits. Abbasi *et al* (2010) [2] supported the present results with the application of salicylic acid in peach fruits. From the given data, it was observed that the TSS contents first increased significantly from 7.41 to 7.70 ^{0}Brix after 8 days of storage, then after TSS content showed a sudden decline to 3.11 ^{0}Brix after 16 days of storage through 6.22 ^{0}Brix TSS after 12 days of storage. The increase in TSS with

the advancement of storage period could be attributed to the water loss and hydrolysis of starch and other polysaccharides to soluble form of sugar (Wills *et al* 1980) [24], whereas decrease in TSS content after storage may be due to fermentation of sugars into ethyl alcohol, carbondioxide and water (Hussain *et al* 2011) [12]. Maximum TSS (8.12 ^{0}Brix) was found under treatment T_7: SA 6 mM (post harvest) after 8 days of storage Whereas minimum TSS (5.10 ^{0}Brix) was found in treatment T_{10}: SA 6 mM (pre + post harvest) after 16 days of storage at 4 ^{0}C.

Table 5: Effect of pre and post harvest application of salicylic acid on TSS (^{0}Brix) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	7.86	8.03	7.46	-	-	4.67
T_2 : SA 2 mM (pre harvest)	7.20	7.39	7.58	6.43	-	5.72
T_3 : SA 4 mM (pre harvest)	7.24	7.42	7.60	6.28	-	5.71
T_4 :-SA 6 mM (pre harvest)	7.31	7.50	7.66	6.04	-	5.70
T_5 : SA 2 mM (post harvest)	7.70	7.88	8.06	7.45	6.32	7.48
T_6 : SA 4 mM (post harvest)	7.68	7.85	8.04	7.68	6.58	7.56
T_7 : SA 6 mM (post harvest)	7.77	7.95	8.12	6.80	-	6.12
T_8 : SA 2 mM (pre + post harvest)	7.11	7.29	7.47	7.38	6.76	7.20
T_9 : SA 4 mM (pre + post harvest)	7.13	7.32	7.50	7.28	6.38	7.12
T_{10} : SA 6 mM (pre + post harvest)	7.18	7.38	7.57	6.92	5.10	6.82
Mean	7.41	7.60	7.70	6.22	3.11	

CD (p = 0.05)
Treatments - 0.024
Days - 0.017
Interaction - 0.054

The maximum mean titratable acidity (1.22%) was recorded in fruits treated with treatment T_8: SA 2 mM (pre + post harvest) and the minimum mean titratable acidity (0.52%) was found in untreated control fruits. The maintenance of acidity in strawberry fruit with the use of salicylic acid could be due to the reduced hydrolysis of organic acids because of decreased respiration rate. The data revealed that the maximum mean titratable acidity (1.10%) was recorded after harvesting of fruits. However, minimum mean titratable acidity (0.59%) was observed after 16 days of storage. Maximum titratable acidity (1.31%) was registered in fruits under treatment T_{10}: SA 6 mM (pre + post harvest) after 16 days of storage at 4 ^{0}C. However, minimum titratable acidity (0.8%) was found in control fruits 4 days of storage. These findings are in confirmity with the studies of Davarynejad *et al* (2013) [10] in plum fruits, Kezemi (2013), Lolaei *et al* (2012) [15, 18] in strawberry fruits.

Table 6: Effect of pre and post harvest application of salicylic acid on titratable acidity (%) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	0.90	0.8	0.91	-	-	0.52
T_2 : SA 2 mM (pre harvest)	1.20	1.10	1.02	1.20	-	0.90
T_3 : SA 4 mM (pre harvest)	1.18	1.07	1.0	1.21	-	0.89
T_4 : SA 6 mM (pre harvest)	1.12	1.02	0.94	1.22	-	0.86
T_5 : SA 2 mM (post harvest)	0.96	0.85	0.78	0.97	1.02	0.91
T_6 : SA 4 mM (post harvest)	0.98	0.88	0.80	0.96	1.0	0.92
T_7 : SA 6 mM (post harvest)	0.94	0.83	0.75	0.99	-	0.70
T_8 : SA 2 mM (pre + post harvest)	1.28	1.19	1.12	1.25	1.28	1.22
T_9 : SA 4 mM (pre + post harvest)	1.25	1.14	1.06	1.26	1.29	1.20
T_{10} : SA 6 mM (pre + post harvest)	1.22	1.12	1.03	1.27	1.31	1.19
Mean	1.10	1.0	0.94	1.03	0.59	

CD (p = 0.05)
Treatments - 0.015
Days - 0.011
Interaction - 0.035

The maximum mean TSS:acid ratio (8.31) was registered in fruits under treatment T_6: SA 4 mM (post harvest). However, the minimum mean TSS:acid ratio (5.11) was recorded in fruits treated with treatment T_2: SA 2 mM (pre harvest). The present findings are in accordance with Salari *et al* (2012) [20] in strawberry fruits, Shirzadeh and Kazemi (2012) [23] in apple fruits. While going through the study, it was found that at first TSS:acid ratio significantly increase from 6.86 after 4 days of storage to 8.36 after 8 days of storage, which then sharply decreased to 2.70 after 16 days of storage. The increase in TSS:acid ratio with the advancement of storage period might be attributed to increase in TSS and reduction in acidity in fruits. Maximum TSS:acid ratio (10.82) was observed in the fruits under treatment T_7: SA 6 mM (pre + post harvest) after 8 days of storage Whereas minimum TSS:acid ratio (3.89) was recorded in fruits under treatment T_{10}: SA 6 mM (pre + post harvest) after 16 days of storage at 4 ^{0}C.

Table 7: Effect of pre and post harvest application of salicylic acid on TSS: acid ratio of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	8.73	10.03	8.19	-	-	5.39
T_2 : SA 2 mM (pre harvest)	6.06	6.71	7.43	5.35	-	5.11
T_3 : SA 4 mM (pre harvest)	6.13	6.93	7.60	5.19	-	5.17
T_4 :-SA 6 mM (pre harvest)	6.52	7.35	8.14	4.95	-	5.39
T_5 : SA 2 mM (post harvest)	8.02	9.27	10.33	7.68	6.19	8.29
T_6 : SA 4 mM (post harvest)	7.83	8.92	10.05	8.0	6.76	8.31
T_7 : SA 6 mM (post harvest)	8.26	9.57	10.82	6.86	-	7.10
T_8 : SA 2 mM (pre + post harvest)	5.55	6.12	6.66	5.90	5.28	5.90
T_9 : SA 4 mM (pre + post harvest)	5.70	6.42	7.07	5.77	4.94	5.98
T_{10} : SA 6 mM (pre + post harvest)	5.88	6.58	7.34	5.36	3.89	5.81
Mean	6.86	7.79	8.36	5.50	2.70	

CD (p = 0.05)
Treatments - 0.019
Days - 0.013
Interaction - 0.043

The mean maximum total sugars (6.49%), reducing sugars (5.22%) and non reducing sugars (1.28%) were recorded in fruits treated with post harvest application of SA 4 mM (T_6). However, the minimum mean total sugars (3.90%), reducing sugars (3.05%) and non reducing sugars (0.84%) was found in fruits under treatment T_1 (control). From the given data, it was noted that sugars percentage first increased significantly after 8 days of storage then after sugars content showed a sudden decline after 16 days of storage. The maximum sugars content was found in fruits under treatment T_7: SA 6 mM (post harvest) after 8 days of storage. Whereas the minimum total sugars content (4.84%) was registered in fruits treated with treatment T_{10}: SA 6 mM (pre + post harvest) after 16 days of storage period. The reason for increase in sugars may be due to the hydrolysis of starch into sugars whereas decline in sugars may be attributed to the fact that after the completion of hydrolysis of starch, no further increase in sugar content occur and subsequently a decline in sugars is predictable as they along with other organic acids are primary substrates for respiration (Wills *et al* 1980) [24]. These results are confirmed by Abbasi *et al* (2010) [2] in peach fruits, Amanullah *et al* (2017) [5] in guava fruits.

Table 8: Effect of pre and post harvest application of salicylic acid on total sugars (%) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	6.80	6.96	5.77	-	-	3.90
T_2 : SA 2 mM (pre harvest)	6.52	6.68	6.82	5.42	-	5.08
T_3 : SA 4 mM (pre harvest)	6.55	6.73	6.87	5.20	-	5.07
T_4 : SA 6 mM (pre harvest)	6.60	6.77	6.91	5.0	-	5.05
T_5 : SA 2 mM (post harvest)	6.72	6.88	7.02	6.64	5.10	6.47
T_6 : SA 4 mM (post harvest)	6.70	6.87	7.0	6.69	5.23	6.49
T_7 : SA 6 mM (post harvest)	6.75	6.93	7.06	5.52	-	5.25
T_8 : SA 2 mM (pre + post harvest)	6.40	6.57	6.71	6.58	5.46	6.34
T_9 : SA 4 mM (pre + post harvest)	6.44	6.62	6.75	6.44	5.14	6.27
T_{10} : SA 6 mM (pre + post harvest)	6.49	6.65	6.79	6.28	4.84	6.21
Mean	6.59	6.76	6.77	5.37	2.57	

CD (p = 0.05)
Treatments - 0.015
Days - 0.010
Interaction - 0.034

Table 9: Effect of pre and post harvest application of salicylic acid on reducing sugars (%) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	5.40	5.51	4.38	-	-	3.05
T_2 : SA 2 mM (pre harvest)	5.22	5.33	5.42	4.94	-	4.18
T_3 : SA 4 mM (pre harvest)	5.24	5.35	5.44	4.82	-	4.17
T_4 :-SA 6 mM (pre harvest)	5.28	5.39	5.49	4.66	-	4.16
T_5 : SA 2 mM (post harvest)	5.35	5.45	5.54	5.24	4.40	5.19
T_6 : SA 4 mM (post harvest)	5.32	5.43	5.53	5.30	4.52	5.22
T_7 : SA 6 mM (post harvest)	5.38	5.49	5.58	4.98	-	4.28
T_8 : SA 2 mM (pre + post harvest)	5.12	5.23	5.32	5.20	4.70	5.11
T_9 : SA 4 mM (pre + post harvest)	5.14	5.25	5.33	5.10	4.44	5.05
T_{10} :SA 6 mM (pre + post harvest)	5.18	5.27	5.36	5.04	4.20	5.01
Mean	5.26	5.37	5.33	4.52	2.22	

CD (p = 0.05)
Treatments - 0.014
Days - 0.010
Interaction - 0.032

Table 10: Effect of pre and post harvest and post harvest application of salicylic acid on non reducing sugars (%) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	1.40	1.45	1.39	-	-	0.84
T_2 : SA 2 mM (pre harvest)	1.30	1.35	1.40	0.48	-	0.91
T_3 : SA 4 mM (pre harvest)	1.31	1.38	1.43	0.38	-	0.90
T_4 : SA 6 mM (pre harvest)	1.32	1.39	1.42	0.34	-	0.89
T_5 : SA 2 mM (post harvest)	1.37	1.43	1.48	1.40	0.68	1.27
T_6 : SA 4 mM (post harvest)	1.38	1.44	1.49	1.39	0.71	1.28
T_7 : SA 6 mM (post harvest)	1.37	1.44	1.48	0.54	-	0.96
T_8 : SA 2 mM (pre + post harvest)	1.28	1.34	1.39	1.38	0.76	1.23
T_9 : SA 4 mM (pre + post harvest)	1.3	1.37	1.42	1.34	0.70	1.22
T_{10} : SA 6 mM (pre + post harvest)	1.31	1.38	1.43	1.24	0.60	1.19
Mean	1.33	1.39	1.43	0.84	0.34	

CD (p = 0.05)
Treatments - 0.011
Days - 0.008
Interaction - 0.025

Maximum mean ascorbic acid (68.5 mg/100g) was registered in fruits treated with treatment T_8: SA 2 mM (pre + post harvest) Whereas the minimum mean ascorbic acid (28.46 mg/100g) was registered under control fruits. The higher ascorbic content in the fruits with SA may result from an acceleration of biosynthetic pathways or a decrease in catabolism through an accumulation of dehydroascorbate (Hung *et al* (2007) [11]. The data showed that the ascorbic acid content first increased significantly after 8 days of storage, then after ascorbic acid content showed a sudden decline after 12 and 16 days of storage. Maximum ascorbic acid content (79.2 mg/100g) was registered in fruits under treatment T_8: SA 2 mM (pre + post harvest) after 8 days of storage. While the minimum ascorbic acid content (38.5 mg/100g) was registered in fruits under treatment T_1 (control) after 8 days of storage at 4 ^{0}C. The findings of present study are similar with the findings of Aghaeifard *et al* (2014) [3] in strawberry fruits and Awad (2013) [6] in peach fruits.

Table 11: Effect of pre and post harvest application of salicylic acid on the ascorbic acid (mg/100 g) of strawberry cv. Chandler

Treatments	Storage Interval (Days)					
	0 days	4 days	8 days	12 days	16 days	Mean
T_1 : Control	48.66	55.16	38.50	-	-	28.46
T_2 : SA 2 mM (pre harvest)	58.12	64.50	72.60	52.10	-	49.46
T_3 : SA 4 mM (pre harvest)	56.18	63.20	71.30	49.20	-	47.97
T_4 :SA 6 mM (pre harvest)	54.36	61.40	68.60	46.30	-	46.13
T_5 : SA 2 mM (post harvest)	50.34	57.42	66.80	58.60	44.24	55.48
T_6 : SA 4 mM (post harvest)	52.60	59.20	68.50	61.80	47.30	57.88
T_7 : SA 6 mM (post harvest)	49.24	56.80	64.70	47.20	-	43.58
T_8 : SA 2 mM (pre + post harvest)	62.16	70.70	79.20	72.12	58.32	68.5
T_9 : SA 4 mM (pre + post harvest)	60.12	68.20	77.50	69.40	54.24	65.89
T_{10} : SA 6 mM (pre + post harvest)	59.14	66.80	74.2	65.28	49.2	62.92
Mean	55.09	62.33	68.19	52.2	25.33	

CD (p = 0.05)
Treatments - 0.062
Days - 0.044
Interaction - 0.140

Conclusion

Results of the present study revealed that pre and post harvest application of SA @ 2 mM proved to be the best treatment in prolonging the storage life of strawberry fruits by reducing the PLW, spoilage and fungal decays as well as retaining the quality attributes upto 16 days of storage at 4 ^{0}C.

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