The effect of coting peach (*Prunus persica* L.) on increasing shelf life after harvesting

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Research Article

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Abstract

Considering the high waste after peach harvest, it is very important to provide suitable solutions to increase the shelf life of this fruit after harvest. One of the ways to increase the shelf life of fruits after harvesting is to use nature-friendly substances such as vegetation and the use of hormones. For this purpose, an experiment was conducted to investigate the effect of vegetation cover in a factorial form in a completely randomized design in four replications on peach (*Prunus persica* L.). Research treatments included salicylic acid at three levels: control (no consumption), 1 mM and 2 mM, aloe vera gel at three levels control (no consumption), 20% and 30%, clove extract (*Syzygium aromaticum*) at three levels of no consumption (control), 150 ppm and 300 ppm. The results of this research showed that the use of coating fruits with plant extracts and salicylic acid increased the shelf life and quality of peaches after harvesting compared to the control (no consumption), so the highest fruit weight 24.65 g was seen in salicylic acid 2 mM, 73.68 g aloe vera gel 30%, and 62.75 g clove extract 300 ppm. The lowest this index was observed in control. The highest total antioxidant 509.75 m mol.l^{-1}, was observed in the interaction of salicylic acid 2 mM + aloe vera gel 30% + clove extract 300 ppm. The lowest of this index 320.53 m mol.l^{-1} was seen in control.

Introduction

After harvesting, fruits continue metabolic activity despite the lack of supply of carbohydrates, nutrients and water by the plant. Hence, the post-harvest period involves proper stress management that minimizes metabolic rate or increases in harmful metabolic processes. To be storage in fruit freezer is suggested as a suitable solution to slow down the rotting process and maintain the quality of the fruit (Zhao et al. 2021; Leng et al. 2021). Peach (*Prunus persica* L.), is one of the most popular fruits in the world due to its nutritional value and delicious flavor, which has a high nutritional value that is used fresh and processed. In addition, this fruit contains significant amounts of bioactive pigments such as anthocyanins, carotenoids, lutein and beta cryptoxanthin (Awad 2013). Peach progress in the ripening cycle, they lose their water and wither quickly. Therefore, the short storage life after harvesting of peach, makes it unsellable due to severe decomposition of internal tissues along with microbial infections (Gayed et al. 2017). Decomposition of the internal tissue of peach, which is characterized by the browning of the flesh, is characterized by an increase in neutral sugar and low amounts of cellulose and pectin, as well as a decrease in the activity of pectin hydrolyzing enzymes and the binding of cations, mainly calcium, in the cell wall (Zhao et al. 2021). However, peach is sensitive to low storage temperature, which limits their storage period. Therefore, coating the peach fruit is one of the appropriate strategies to increase the storage life of this fruit (Leng et al. 2021; Silva et al. 2017; Hong et al. 2012).

Edible coatings of fruits can act as a suitable substitute for synthesized chemicals in delaying physiological processes and biochemical degradation in fruits and thus maintaining the quality of fruits (Ncama et al. 2018; Silva et al. 2017). Aloe vera gel is a polysaccharide plant cover and a protective layer that has features such as reducing the loss of juice and reducing the amount of gas in relation to the skin of the fruit and reducing the production of ethylene in the raw fruit. Aloe vera gel has approximately

99.5% water and 0.5% solid matter, which includes compounds such as polysaccharides, vitamins, minerals, phenolic compounds and organic acids (Guillen et al. 2013). The researchers reported that the decay process was slower in grapes treated with aloe vera gel, and the lowest rate of decay was observed in the 2% chitosan with aloe vera gel treatment on the 14th day (Ehtesham Nia et al. 2022). The amount of total phenol and antioxidant capacity were higher in kiwi (*Actinidia deliciosa*(in aloevera coating. In the samples with higher concentration of aloe vera, the destruction of ascorbic acid was less. In general, modified atmosphere and aloe vera gel coating improved the quality of stored kiwi (Mansour gorgani et al. 2018). The use of plant extracts, including clove extract (*Syzygium aromaticum*), is a useful and environmentally friendly method that increases the storage of fruits. Plant extracts increase the plant's defense system and significantly reduce fungal diseases. It has been reported that coating with clove extract increased the shelf life of oranges compared to the control (without coating) (Baran Zehi et al. 2019).

Acid salicylic is natural plant hormones, belongs to the phenolic group of compounds with strong antioxidant properties that activate the systemic acquired resistance system, synthesis of metabolites and antioxidant enzymes. Also, salicylic acid as a natural compound has a high potential in preventing the production and effect of ethylene (Haider et al. 2020; Kumari et al. 2015). It was reported that coating fruit with salicylic acid increased the shelf life of fruits such as pistachios (*Pistacia vera*) (Molamohammadi et al. 2020), pear (*pyrus communis*) (Sinha et al. 2021), peach (Yang et al. 2020). Therefore, the present study was conducted with the aim of investigating the effects of vegetation and salicylic acid and also comparing the effect of vegetation with salicylic acid on increasing shelf life and preserving the quality of peach fruit after harvest.

Materials and methods

Research plan and treatments

This research was carried out as a factorial in the form of a completely randomized design in four replications on peach (*Persica pronus* L.). Treatments included salicylic acid in three levels: control (no consumption), 1 mM and 2 mM, the second factor was aloe vera gel in three levels: control (no consumption), 20% and 30%. The third factor was clove extract (*Syzygium aromaticum*) in three levels: control (no consumption), 150 ppm and 300 ppm.

Plant materials and sampling

The variety of peach was Zafarani and after determining the harvest time, it was collected from one of the orchards located in the central province of Arak city, Iran. Efforts were made to ensure that the selected fruits were uniform and of the same size, completely healthy and free from any scratches, wounds and diseases. Aloe vera leaves for the use of its gel were obtained from a commercial farm located in Arak. To prepare clove extract, first the samples were powdered and then extracted. The oral coating of aloe vera gel in different concentrations was prepared from the gel diluted with distilled water (20–30% w/w) (Boudreau and Beland 2006).

Plan methods and traits

The coating operation was carried out by spray method and the samples were completely coated by sprayed, then coded and dried in the vicinity of air. The control sample did not have any coating. Each sample contained 5 peaches. The duration of fruit storage was one week. In this research, traits such as total acidity, total phenol, fruit weight (g), vitamin C, weight loss, juice pH, decay, fruit flesh percentage, and total antioxidants were measured.

Traits measurement method

Total weight and amount of weight loss

To measure weight changes, five fruits in each repetition were randomly measured with a digital scale with an accuracy of 0.001 grams at the beginning of the weighing experiment and after storage every week immediately after leaving the cold storage. The said changes were expressed as a percentage of weight loss using the following relationship.

Weight loss percentage = (fruit weight before storage - fruit weight after storage) / fruit weight before storage x 100

Measurement of vitamin C

For measuring vitamin C, a spectrophotometer (Spectrophotometer 2601 UV, Double Beam) made in China with visible light and a 1 cm tube was used. The extraction solution of 0.4% oxalic acid contained 20% acetone. 4 grams of oxalic acid was dissolved in 500 ml of water, 200 ml of acetone was added to it, and it was diluted to the volume of 1 liter with distilled water. Then the pH was adjusted to 1.1 with the help of concentrated H_2SO_4. The stock solution of 2,6-dichloroindophenol (DCIP) was prepared by dissolving 100 mg of dye in 100 ml of hot water and adding 84 mg of $NAHCO_3$ to 500 ml, diluted with water and filtered. The stock solution of DCIP diluted with water was mixed with 9 ml of DCIP in the ratio of 1 ml of the extraction solution and its absorbance at 520 nm was read between 0.35 – 0.3. The standard ascorbic acid stock solution is 100 mg of ascorbic acid in 100 ml of extraction solution. The mashed peach sample was immediately placed in a bed of powdered dry ice to prevent the oxidation of ascorbic acid. After 30 to 60 minutes, a part of this frozen mass was placed in glass molds (at a pressure of less than 100 microns); After 3 days, the samples were ground (powdered) and passed through a sieve and kept in a freezer at -16°C for analysis. The moisture content was determined by drying the samples to a constant weight in an oven under vacuum at 70°C for 16 to 18 hours (Egoville et al. 1988).

Total phenol content

The samples were centrifuged at 6000 rpm for 15 minutes at 4°C and then filtered. 0.5 ml of the extract was mixed with 0.5 ml of Folin Ciocaltio reagent and 10 ml of saturated sodium carbonate solution and kept at room temperature for one hour. Then the absorbance of the samples was calculated at 725 nm.

The results were expressed as milligrams of gallic acid per kilogram of fresh weight (Singleton et al. 1999).

Total antioxidant capacity

Since 1996, a method called FRAP has been used to measure the activity of antioxidants. The basis of this method is the ability of the substance in question to reduce ferric ions (Fe^{+3}) to ferric ions (Fe^{+2}) using the introduction called Trypyridyl-S-Triazine (TPTZ). In the presence of antioxidants, ferric ions (Fe^{+3}) are reduced to ferro (Fe^{+2}), and in the presence of TPTZ reagent, the solution turns purple. In relation to the reducing power, the amount of absorption increases depending on the concentration. By using this absorption change, the antioxidant property of different compounds can be measured. The increase in absorption at the wavelength of 595 nm occurs after 10 minutes from the start of the reaction.

Statistical Analysis

The data obtained from different stages of the research were analyzed using SAS software version 4.9 and the averages were compared using Duncan's multi-range test with a probability of 5% error. Excel software was used to draw graphs.

Results

Total acidity

The effect of salicylic acid, aloe Vera gel and clove extract on total acidity was significant ($p < 0.05$) (Table 1). When the concentration of salicylic acid, aloe Vera gel and clove extract was increased total acidity decreased. The highest total acidity 4.64 was for control of salicylic acid, and also 4.56 for control of aloe vera gel, and 4.67 for control of clove extract. The lowest value of this index was related to salicylic acid, aloe vera gel, and clove extract (Table 3). Another main reasons for the increase in total acidity is the breakdown and decomposition of organic acids in the process of respiration. It is very probable that the reduction of total acid is due to the biochemical changes of the organic compounds of the fruit during the respiration process. Therefore, usage any treatments that make slow the metabolism and aging of the product can reduce the rate of treatable acidity changes during storage. It can be said that the use of salicylic acid can lead to a decrease in the use of organic acids as a respiratory substrate due to the decrease in respiration rate and ethylene production. Studies show that the use of salicylic acid reduces the rate of respiration in banana and peach tissues and preserves organic acids compared to control fruits (Srivastava and Dwivedi 2000). Similarly results reported that investigation the effect of pre-harvest salicylic acid spraying along with different wax treatments on maintaining the quality and storage life of red orange)*Citrus × sinensis* 'Blood orange'(and found that the acidity of the oranges decreased with passing the time. Other results were reported on apricot (*Prunus armeniaca* L) (Darvishnia et al., 2013) and peach (El-Shazly et al. 2013), which showed that the application of salicylic acid increased the total acidity in the fruit.

Table 1
Variance analysis of peach quality traits

S.O.V	d.f	Mean of squares				
		Total acidity	Juice pH	Total phenol	Vitamin C	Total antioxidant
salicylic acid (S)	2	28.46*	307.64**	51298.63**	3265.73**	698.53**
aloe vera gel (A)	2	32.97*	411.99**	43676.59**	2986.51**	876.10**
clove extract (D)	2	20.85*	516.28**	27652.78**	3186.93**	698.21**
A×S	4	2.53 ns	25.09 ns	2012.35**	2374.64**	723.44**
D×S	4	1.98 ns	18.21 ns	15686.70**	1826.53**	1059.52**
D×A	4	3.63 ns	31.44 ns	75369.34**	7911.41**	964.38**
D×S×A	8	5.23 ns	42.65 ns	18123.95**	1845.38**	845.21**
Error	81	10.34	21.32	146.32	17.24	52.96
C.V (%)		7.33	8.59	9.49	13.54	10.59

**Significant at $p < 0.01$, * Significant at $p < 0.05$, ns: no significance (at $p < 0.05$).

Table 3
Comparison of the average characteristics of total acidity, fruit weight, amount of weight loss, fruit flesh

treatments	Total acidity	Juice pH	Fruit weight (g)	Amount of weight loss (%)	Fruit flesh (%)
Salicylic acid					
2 mM	b 4.3	4.32 a	65.24 a	9.25 c	87.5 a
1 mM	4.27 b	3.97 b	59.3 b	14.5 b	75.5 b
Control	4.64 a	3.41 c	53.29 c	18.75 a	63.25 c
Aloe vera gel					
30%	4.29 b	4.28 a	68.73 a	10.25 c	83.5 a
20%	4.32 b	3.73 b	61.51 b	12.5 b	71.75 b
Control	4.56 a	3.26 c	54.36 c	17.5 a	65.5 c
Clove extract					
300 ppm	4.45 b	4.21 a	62.75 a	9.75 c	86.25 a
150 ppm	4.49 b	3.85 b	56.42 b	13.25 b	74.5 b
Control	4.67 a	3.29 c	50.21 c	18.5 a	66.75 c

Dissimilar letters in the column indicate significant differences at the 5% level according to Duncan's test.

Juice pH

The effect of salicylic acid, aloe vera gel, and clove extract was significant ($p < 0.01$) (Table 1). Increasing the concentration of salicylic acid, aloe vera gel and clove extract increased the juice pH. The highest pH juice 4.32 was seen in 2 mM salicylic acid, and also 4.28 was seen in 30% aloe vera gel, and 4.21 was observed 300 ppm clove extract (Table 3). Changes in the pH of juice during ripening are caused by the leakage of organic acids from the vacuoles to the cell cytoplasm, the pH of the juice also increases due to over-ripening of the fruit and turns from acidic to alkaline (Modares et al. 2014).

Total phenol

The effect of salicylic acid, aloe vera gel, clove extract and their interaction effects was significant on total phenol ($p < 0.01$) (Table 1). Increasing the concentration of salicylic acid, aloe vera gel, and clove extract caused increased total phenol. The highest amount of total phenol, 307.5 mg.g FW^{-1}, was seen in interaction of 2 mM salicylic acid + 30% aloe vera gel + 300 $kg.cm^{-2}$ clove extract, and also interaction of 1 mM salicylic acid treatments + Aloe vera gel 30% + clove extract 300 $kg.cm^{-2}$, and salicylic acid 2 mM + aloe vera gel 20% + clove extract 300 $kg.cm^{-2}$ and also salicylic acid 1 mM + aloe gel Vera 30%+ clove

extract 150 kg.cm^{-2}. The lowest value of this index was 149.75 mg.g FW^{-1} related to the control (Fig. 1). Phenolic compounds are the main and useful secondary metabolites that act as a strong antioxidant. The amount of phenol in fruits and vegetables after harvesting can decrease or increase depending on the storage conditions (Gheysarbigi et al. 2020). Aloe vera gel is a hydrocolloid coating that increases the barriers against oxygen and water. The effect of aloe vera gel concentration on total phenol content showed that the highest amount was in the coated sample with a concentration of 30% and the lowest amount was in the control (without coating). Reduction of titratable acidity and organic acids through conversion to carbohydrates provides the carbon skeleton for phenol synthesis (Plaza et al. 2006). It can be stated that the reason for the reduction of phenolic compounds at the end of the storage period is the failure of the cell structure during the aging phenomenon during the storage period (Ghasemnezhad and Shiri 2010). Phenolics synthesize the secondary metabolites of the plant. They are responsible for the flavor and color of the products. Generally, they exist as flavonols in the skin of the fruit (Tarin et al. 2012).

Vitamin C

The effect of salicylic acid, aloe vera gel, clove extract and their mutual effects on vitamin C was significant ($p < 0.01$) (Table 1). With increasing salicylic acid, aloe vera gel, and clove extract vitamin C increased. The highest vitamin C, 25.38 mg.100 ml^{-1}, was observed in the interaction of 2 mM salicylic acid + 30% aloe vera gel + 300 ppm clove extract, which was in the same statistical group with 1 mM salicylic acid + 30% aloe vera gel + 300 ppm clove extract, 2 mM salicylic acid + 20% aloe vera gel + 300 ppm clove extract, 2 mM salicylic acid + 30% aloe vera gel + 150 ppm clove extract, and also 1 mM salicylic acid + 30% aloe vera gel + 150 ppm clove extract. The lowest value of this index was 10 mg.100 ml^{-1} related to the control, and also 20% salicylic acid treatment (Fig. 2). Vitamin C is an important attribute to measure the shelf life of fruits in storage. The content of ascorbic acid in fruits and vegetables can be influenced by various factors such as genotypic differences, climatic conditions before harvest, training methods, maturity and harvest time and post-harvest operations, as well as vitamin C has the least stability and is easily degraded during the storage process. Vitamin C, as a type of acid in fruit, is rapidly consumed in the respiratory reaction with the beginning of the aging process. The amount of vitamin C decreases with the destruction of fruits, and the main reason for the destruction of ascorbic acid in the tissue of fruits is the oxidative process, which is accelerated in the presence of light, oxygen, heat, and oxidizing enzymes (Plaza et al. 2006; Kalt 2005). In this regard, Mansour Gorgani et al. (2018) reported that the use of aloe vera gel increased vitamin C in kiwi and the results of the present study were consistent with the results of (Sahar and Wahab 2015) on apricots. They stated that salicylic acid is the regulator of many processes related to the growth and development of the plant and causes the preservation of vitamin C during the storage of the plant after harvesting.

Total antioxidant

The effect of salicylic acid, aloe vera gel, clove extract and their interaction on total antioxidant was significant ($p < 0.01$) (Table 1). Increasing the concentration of salicylic acid, aloe vera gel, and clove extract caused, improved total antioxidants. The highest total antioxidant 509.75 m mol.l^{-1} was observed in the interaction of salicylic acid 2 mM + aloe vera gel 30% + clove extract 300 ppm. The lowest value of this index 320.53 m mol.l^{-1} was seen in the control (Fig. 3). Enzymes with antioxidant activity play an important role in countering oxidative reactions during fruit ripening processes and delay aging processes in fruits (Silva et al. 2010). Due to the detoxification of reactive oxygen species, antioxidants protect fruits from abnormalities and affect the quality of fruits. The decrease in antioxidant capacity during long-term storage can be caused by the decrease in phenolic compounds and vitamin C (Ferreyra et al. 2007). Previous studies have also shown that salicylic acid treatment increased the total antioxidant capacity of peaches (Huang et al. 2008; Yang et al. 2020).

Fruit weight

The effect of salicylic acid, aloe Vera gel and clove extract on fruit weight was significant ($p < 0.01$) (Table 2). Increasing the concentration of salicylic acid, aloe vera gel, and clove extract made improved fruit weight. The highest fruit weight was observed in salicylic acid 2 mM 24.65 g, aloe vera gel 30%, 73.68 g and clove extract 300 ppm 62.75 g. The lowest value of this index was seen in control (Table 3). Fruit weight loss can be associated with loss of quality, including loss of firmness and other undesirable changes in color, pleasantness, and loss of nutritional quality, which is lost in the form of water vapor from the air spaces inside the fruit to the space around it. The reduction in weight loss in covering treatments (salicylic acid, aloe vera gel and clove extract) is due to the slowness of physiological processes such as breathing and sweating. Not covering fruits (control treatment) increases the rate of respiration and other metabolic processes, which causes a decrease in substrates such as sugars and proteins and leads to more weight loss (Gheysarbigi et al. 2020; Sinha et al. 2021). In the same with the results of the present study, it has been reported that salicylic acid closes the stomata and leads to suppression of respiration and minimizes the weight loss of peach fruits (Tarin et al. 2012).

Table 2
Variance analysis of peach weight traits and decay

S.O.V	d.f	Mean of squares			
		Fruit weight	Amount of weight loss	Fruit flesh percentage	decay
salicylic acid (S)	2	7432.58**	531.09**	371.32**	569.36**
aloe vera gel (A)	2	6948.21**	397.37**	481.95**	811.25**
clove extract (D)	2	3455.90**	480.72*	631.74**	362.53**
A×S	4	41.75ns	44.35ns	5.43ns	472.46**
D×S	4	31.82ns	28.51 ns	3.75ns	681.33**
D×A	4	26.44ns	33.26 ns	2.62ns	556.72**
D×S×A	8	19.71ns	18.71 ns	7.56 ns	735.46**
Error	81	49.46	35.74	14.32	25.79
C.V (%)		12.65	9.73	10.93	11.35

**Significant at $p < 0.01$, * Significant at $p < 0.05$, ns: no significance (at $p < 0.05$).

Amount of weight loss

The effect of salicylic acid, aloe vera gel, and clove extract was significant on weight loss ($p < 0.01$) (Table 2). Increasing the concentration of salicylic acid, aloe vera gel and clove extract reduced the weight loss of peaches. The lowest amount of weight loss was 9.25% related to 2 mM salicylic acid, 10.25% related to 30% aloe vera gel and 9.75% related to 300 ppm clove extract (Table 3). The most important factor in reducing fruit weight during the storage period is the increase in evaporation and transpiration from the surface of the fruit. Since the temperature is low in storage conditions, salicylic acid is probably able to reduce the amount of damage to the structure. The investigation during the storage period shows that the salicylic acid treatment compared to the control treatment was able to control the weight loss of the fruits to some extent, which seems to be caused by the reduction of fruit respiration by salicylic acid and the subsequent reduction of metabolism and as a result control weight loss. When plant extract or salicylic acid is added to the fruits in cold storage conditions, transpiration in the fruits is reduced and as a result, it minimizes the weight loss effect of the peach fruits and this leads to the improvement of the ability Preservation of peach fruits (Sahar and Wahab 2015). Edible coatings increase the shelf life of fruits by delaying the loss of water, the loss of aromatic compounds, respiration, and delaying the structural changes of the fruit. This reduction of water loss is probably due to the effects of the coating as a semi-permeable barrier against O_2, CO_2, humidity and the movement of solutes, as a result, it reduces the rate of respiration, water loss and oxidation reactions (Tesfay and Magwaza 2017).

Fruit flesh

The effect of salicylic acid, aloe vera gel, and clove extract was significant on fruit flesh ($p < 0.01$) (Table 2). Increasing the concentration of salicylic acid, aloe vera gel and clove extract increased the percentage of peach flesh. The highest percentage of fruit flesh 87.5% was seen in 2 mM salicylic acid, 83.5% was observed 30% aloe vera gel and 86.25% was seen in 300 ppm clove extract (Table 3). One of the important reasons for weight gain in the treatments of salicylic acid, aloe vera gel and clove extract is the slowness of physiological processes such as breathing and sweating, which in the control treatment has increased the rate of breathing and other metabolic processes (Gheysarbigi et al. 2020; Sinha et al. 2021). Higher firmness in treated fruits may be attributed to hydrolysis of soluble starch. The delay in ripening stages in salicylic acid depends on the concentration of fruit treatment (Tarin et al. 2012).

Decay

The effect of salicylic acid, aloe vera gel, and clove extract was significant on decay ($p < 0.01$) (Table 2). Increasing the concentration of salicylic acid, aloe vera gel and clove extract decreased the percentage of peach flesh. The lowest decay rate 21.5% was observed in the interaction of 2 mM salicylic acid + 30% aloe vera gel + 300 ppm clove extract, and the highest value of this index was 40.5% related to the control treatment (Fig. 4). The percentage of decay in fruits is mostly influenced by contamination with microorganisms. Fruits treated with salicylic acid and vegetation had the best marketability, which may be due to the high resistance of fruits caused by vegetation to fungi, which prevented the occurrence of physiological disorders during storage. While salicylic acid and vegetation reduce the rate of decay, which may be related to the increase in the amount of antioxidant enzymes during storage, which leads to improved storability and increased shelf life of peaches. Salicylic acid reduced fungal decay and increased storage in grapes (Mohamed and Mehdi 2014) and peaches (Khademi and Ershadi 2013). Antioxidants also reduce decay during cold storage and the market life of Le Cante pears (Hafez et al. 2010).

Conclusion

The results of the present study indicated that coating the fruits with plant extracts and salicylic acid increased the shelf life and quality of peaches after harvesting compared to the control (no use) and the interaction effects of the treatments had a greater effect on some investigated traits compared to their main effects. Increasing the concentration of salicylic acid, aloe vera gel, and clove extract caused improved total phenol, fruit weight, vitamin C, fruit flesh percentage, juice pH and decreased total acidity, decay percentage and a decrease in fruit weight. Therefore, in order to increase the shelf life and maintain the quality of peaches after harvesting, it is recommended to coat the fruit with salicylic acid, aloe vera gel, and clove extract.

Declarations

Disclosure statement

No potential conflict of interest was reported by the authors.

Statement and Declarations

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Code availability ('Not applicable')

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Figures

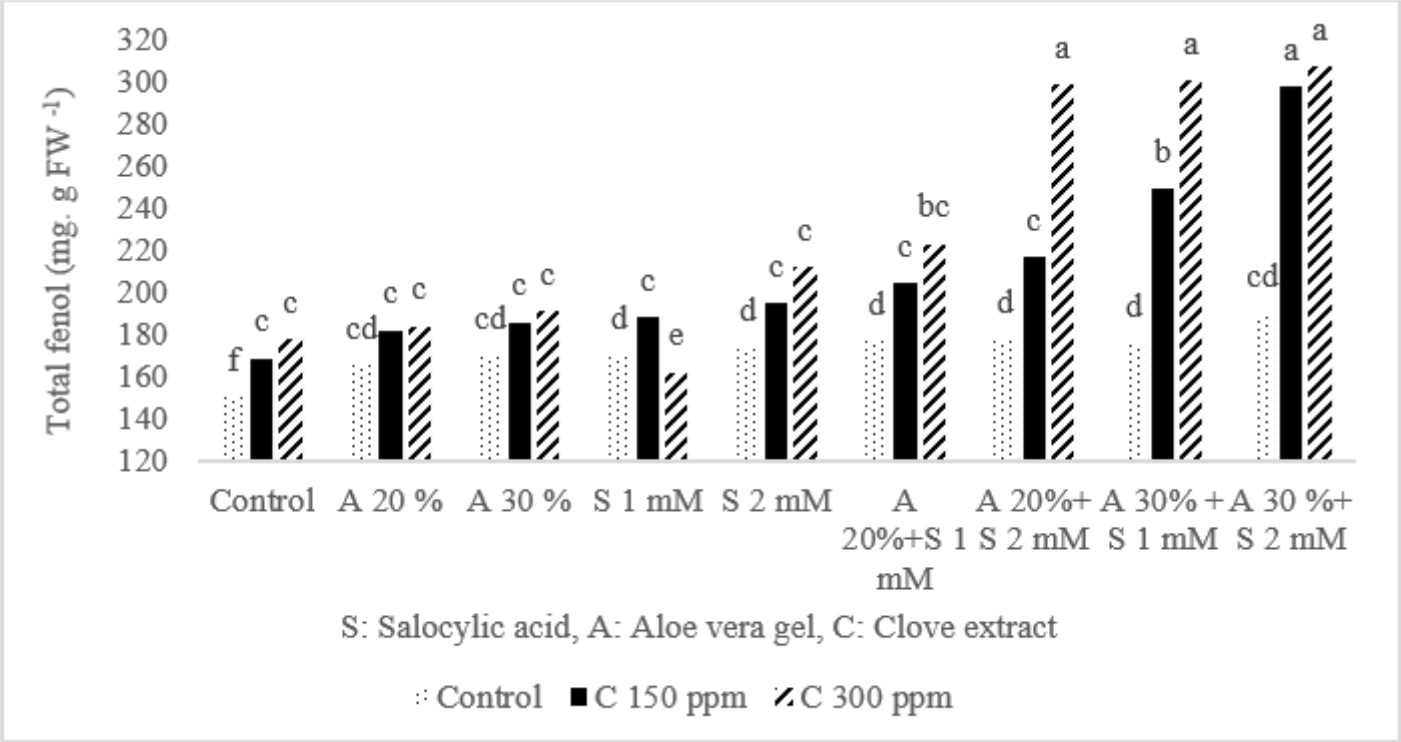

Figure 1

Interaction of salicylic acid, aloe vera gel and clove extract treatments on total phenol

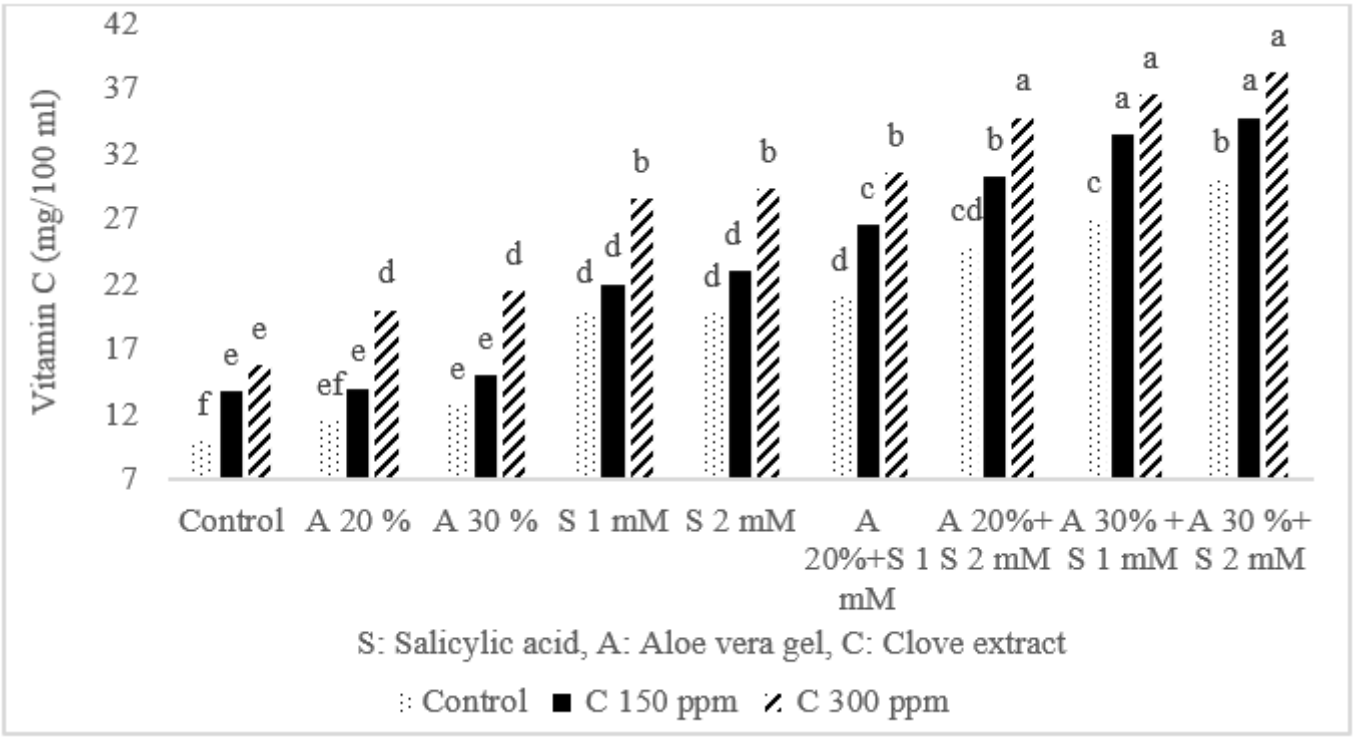

Figure 2

Interaction of salicylic acid, aloe vera gel and clove extract treatments on vitamin C

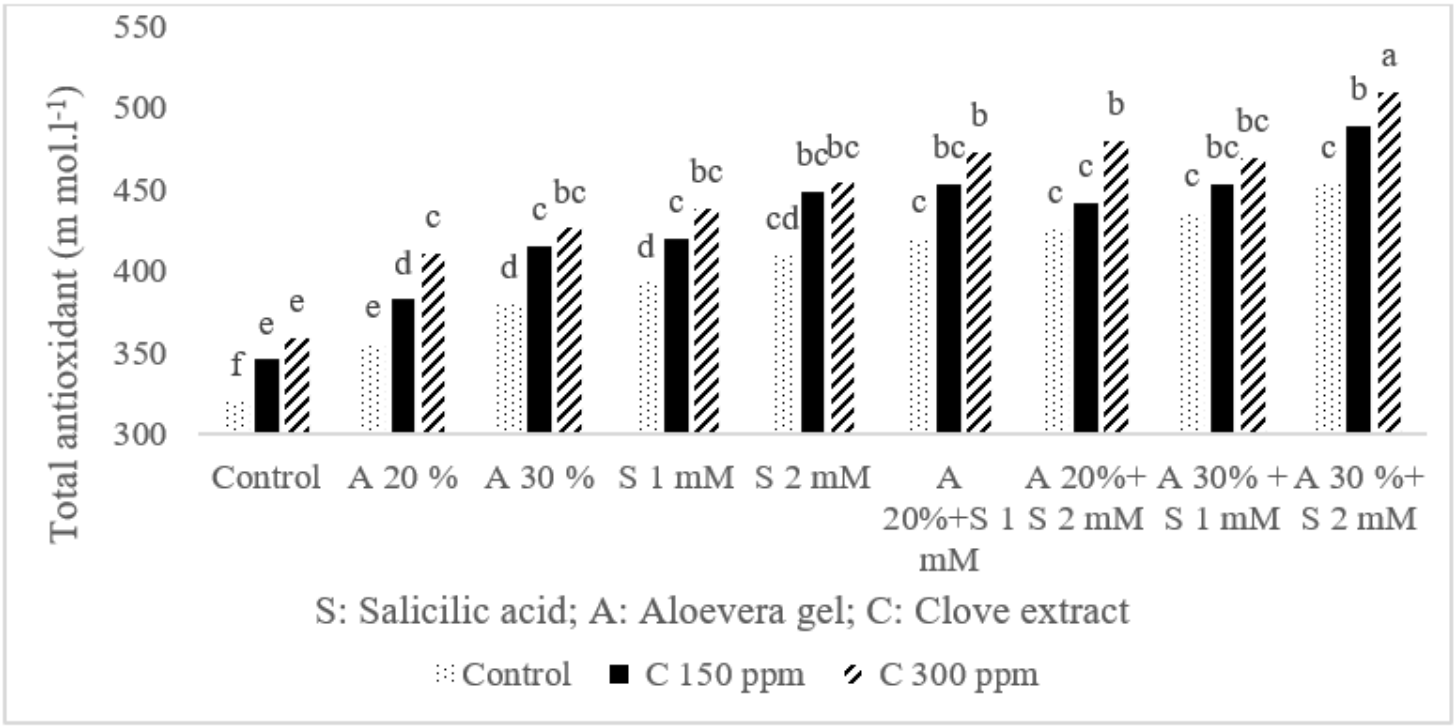

Figure 3

Interaction of salicylic acid, aloe vera gel and clove extract treatments on total antioxidants

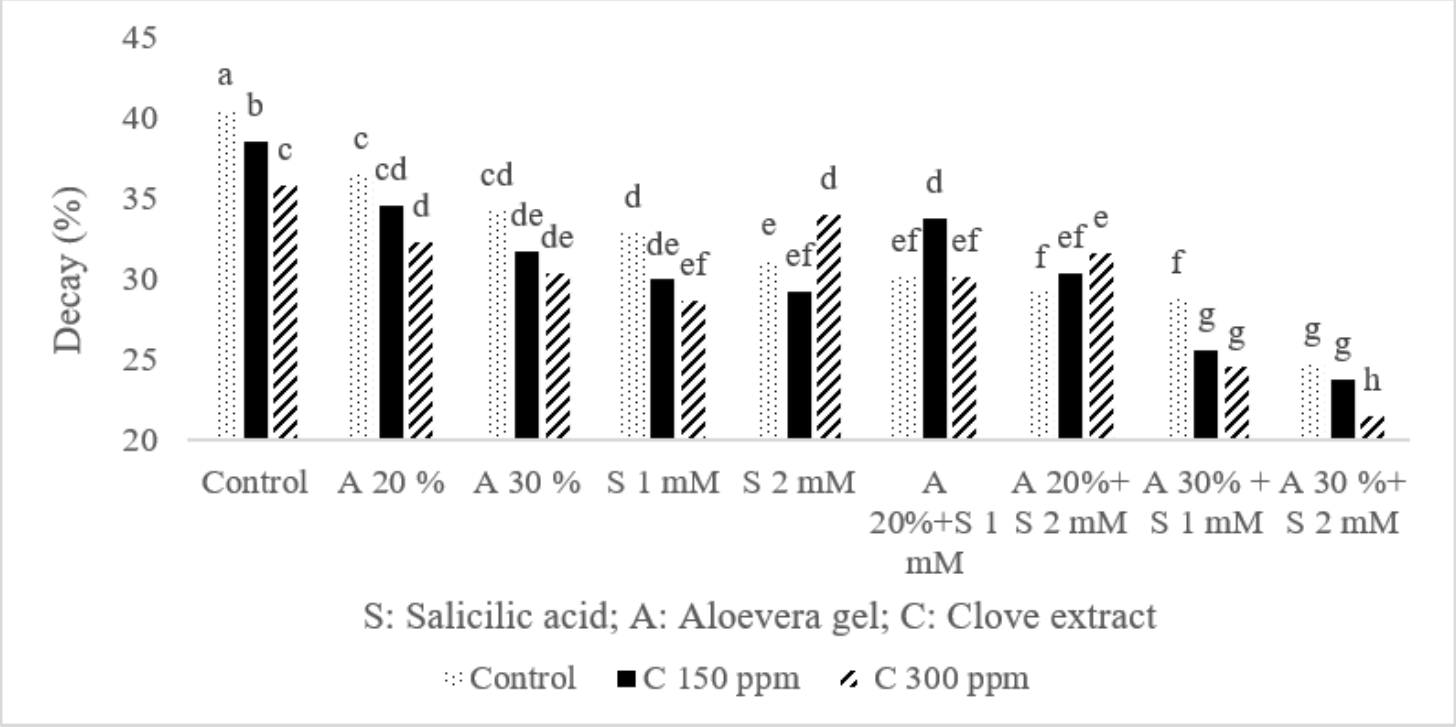

Figure 4

Interaction of salicylic acid, aloe vera gel and clove extract treatments on decay