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Biochemical attributes of apricot as influenced by salicylic acid during ambient storage

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Abstract

Apricot is a delicate fruit of very short storage life, which limits the marketing options of the produce. It has high nutritional prospects and carries appreciable amounts of biologically active components and hence there is an increasing demand for fresh apricot. Keeping in view the growing interest in this fruit, the present investigation was planned to evaluate the effect of different concentrations of salicylic acid (0.5, 1, 1.5 and 2millilimol) on storage quality of apricot during ambient storage. Some biochemical quality parameters as total soluble solids, pH, acidity, ascorbic acid, total phenolics, carotenoids, antioxidant capacity and enzymatic activity (polphenol oxidase, peroxidase and catalase) were evaluated. The results revealed that salicylic acid application significantly maintained quality attributes of apricot at ambient conditions. Among different concentrations; 2 mmol/l salicylic acid retained maximum ascorbic acid, carotenoids, antioxidant activity and maintained lower levels of degrading enzymes followed by 1.5 mmol/l. The effective concentrations of salicylic acid (2, 1.5 mmol/l) slowed down ripening process and kept the produce acceptable up to 12 days, whereas, lower concentrations had no pronounced effect on fruit quality as compared to control. The results suggested that salicylic acid may be used as a postharvest treatment to extend shelf life of apricot for distant marketing.

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Introduction

Apricot (Prunus armeniaca L.) is among the highly nutritious fruits of Rosaceae family and appreciated for its health promoting contents. Studies have shown that apricot fruit is effective in preventing stomach ulcers and oxidative damages to living systems (Enomoto *et al.,* 2010; Miyazawa *et al.,* 2006). A recent study has revealed that Pakistani apricot is rich in nutritional and bioactive composition (Ali *et al.,* 2011). The compositional studies of apricot have stirred the interest of researchers towards the postharvest quality maintenance of the fruit. The delicate nature of apricot fruit demands a careful handling and effective preservation techniques to avoid nutrient losses and sensory characters. Apricot is among the climacteric fruits with a limited storage life (Egea *et al.,* 2007). Quality deterioration of apricot starts soon after harvest. The fruit is highly susceptible to textural softening, fruit decay and loss of flavor during postharvest due to continued respiration and metabolic activities with the evolution of ethylene (Valdes *et al.,* 2009).

Fresh fruit consumption is increasing in the recent years for better nutritional and health benefits. Thus shelf life extension of fruits to retain compositional quality is instrumental in fulfilling consumer demand for healthy food and harvest maximum market potential. Postharvest quality of fruits is affected by a number of factors i.e. type of fruit, stage of maturity at harvest, composition of storage atmosphere, temperature and mechanical damage (Martinez-Romero *et al.,* 1999). Postharvest treatments have been applied to improve storability of fruits. Certain chemical agents like calcium salts, organic acids and plant based hormones are in use to extend shelf life of perishable commodities. Salicylic acid (SA); an endogenous plant growth regulating hormone is thought to be effective in a number of metabolic and physiological processes (Asghari *et al.,* 2010). As a natural phenolic complex, it exhibits a high potential in controlling postharvest losses of horticultural produce and provide resistance against pathogenic attacks. SA has been shown to interfere with synthesis or action of ethylene, abscisic acid and cytokinins. Salicylic acid has been used in a number of studies for postharvest quality maintenance of different commodities. The role of SA and its derivatives have been investigated against chilling injury in tomato fruit (Ding *et al,* 2002); delay ripening in banana (Srivastava and Dwivedi, 2000), shelf life improvement by inhibiting ethylene production, fungal decay and enzymatic activity of Haward Kiwi fruits (Aghdam *et al.,* 2011). Keeping in view its effective role in postharvest quality maintenance, this study was planned to investigate the effect of SA on bioactive composition, antioxidant capacity and enzymatic activity of apricot at ambient storage.

Materials and methods

Collection of sample and treatment design

Apricot fruits (from Gilgit-Baltistan) harvested at commercial maturity stage were shifted immediately to the postharvest laboratory. The fruits were sorted, cleaned and divided in to five lots for further treatments. One lot was kept control, while the remaining sets were dipped for 3 minutes in four different concentrations of salicylic acid i.e. 0.5, 1, 1.5 and 2 mmol/l, air dried and packed into card board cartons and stored at ambient conditions. Biochemical characteristics were assessed on two day intervals.

Analyses of biochemical characteristics:

Total soluble solids (TSS), pH, Titratable acidity (TA), Ascorbic acid (AA):

All the determinations were carried out according to standard procedures of AOAC, (2005). TSS contents in apricot fruit were determined with the help of a refractometer (PAL-3, ATAGO, Japan). Wedge shaped pieces of ten fruits were taken and extracted for a composite juice sample. Data was recorded for three replications and expressed as degrees Brix. pH of fruit samples was assessed by a pH meter and TA was determined by titration with 0.1 normal NaOH. Similarly, ascorbic acid was estimated by titration with 2, 6-dichlorophenol indophenols dye.

Total phenolic compounds (TPC):

TPC were measured by using the Folin-Ciocalteu (FC)

assay (Sponas and Wrolstad, 1990). Fruit sample was crushed and homogenized, and then 5 g puree was diluted to 30 ml with deionized water and clarified by centrifugation at 10 000 g for 15 min. The extract was filtered through a 0.45 mm membrane filter. Filtrate (0.5 ml), 5 ml 0.2 normal FC reagent, and 4 ml of 7.5% sodium carbonate solution were added to a 25 ml volumetric flask and filled to volume by deionized water. The contents were allowed to stand for 5-8 minutes at 50 °C and the absorbance was measured at 765 nm using a CE-2021 Spectrophotometer (CECIL Instruments, Cambridge, United Kingdom). Total phenolics were quantified from a calibration curve using gallic acid as standard. The concentrations were expressed as milligrams of gallic acid equivalent (GAE) per kilogram on dry weight basis.

Total carotenoids (TC)

TC were extracted by using the procedure reported by Rodriguez-Amaya, (1999). Briefly, five grams of sample was homogenized with 100 ml of methanol/petroleum ether (1:9, v/v) and the mixture was transferred to a separating funnel. Petroleum ether layer was filtered through sodium sulphate, transferred to a volumetric flask, and total volume was made up to 100 ml with petroleum ether. Finally, the total carotenoid content was measured by a spectrophotometer (CE-2021) at a wave length of 450 nm and the results were expressed as milligrams of β-carotene equivalents per kilogram of dry weight.

Free radical scavenging capacity (FRSC)

Antioxidant activity (AoA) was measured as percentage of DPPH (2, 2-diphenyl-l-picrylhydrazyl) free radical reducing power described by Brand-Williams *et al*, (1995). Five gram of ground frozen tissue was taken in triplicate, homogenized and extracted with 10 ml methanol (MeOH) for 2 hours. From the above extract, 0.1 ml was taken in a test tube and 3.9 ml of DPPH solution (6×10^{-5} mol·l^{-1}) was added. The mixture was incubated at room temperature for 30 minutes and then absorbance was measured at 517 nm in a UV-Spectrophotometer (UNICO 2100 Series, company, city, Japan). The DPPH solution was freshly prepared daily, stored in a flask covered with aluminum foil and kept in dark at 4 °C between the measurements. Control sample was prepared containing the same amount of MeOH and DPPH solution and measured daily. Radical scavenging activity (RSA) was calculated as percent inhibition of DPPH radical by the following formula:

$$RSA = \frac{A_0 - A}{A_0} \times 100$$

where A_0 is absorbance of control and A is absorbance of sample.

2.2.4 Enzyme Assay

2.2.4.1 Extraction of enzymes

Enzyme extraction was carried out according to the method described by Abbasi *et al*. (1998) with some alterations. Briefly, 5 gram of frozen apricot pulp of ten fruits was pasted with a mortar and pestle and suspension was made with 15 ml of 100 mmol/l KH_2PO_4 buffer (pH 7.8) with 0.5% (v/v) Triton X-100 and 1 g polyvinyl polypyrrolidone (PVPP). The above homogenate was then centrifuged (18000 x g) for 30 minutes at 4°C and the supernatant was collected and stored at -2°C. Three replications from each treatment were taken for the data.

Polyphenol oxidase (PPO) Assay

Polyphenol oxidase (PPO) was determined based on catichol oxidation according to Jiang and Fu, (2007). A reaction mixture of 2 ml total volume was prepared by taking 1.3 ml (0.05mole) potassium phosphate buffer (pH 7.5), 0.2 ml (0.2mole) catichol and 0.5 ml enzyme extract in test tube. The contents were incubated at 30 °C for 5 min. Absorbance was measured at 420 nm in a UV-visible spectrophotometer (CE-2021). Enzyme activity was determined based on change in absorbance over a period of 1 min and expressed enzyme units per gram of fresh weight.

Peroxidase (POD) Assay

Peroxidase activity was determined according to Abbasi *et al.* (1998). An assay mixture of 3 ml total volume was prepared with 2.1 ml, 15mmol/l $NaKPO_4$ buffer (pH 6.0), 600 µl substrate, consist of 300 µl 1 mmol/l H_2O_2 and 300 µl 0.1 mmol/l guaiacol and

300 µl enzyme extract. Activity was calculated at 470 nm on the basis of change in optical density over a 3 minutes period and expressed as U g^{-1} of protein on fresh weight basis.

Catalase (CAT) Assay

CAT activity was determined according to the method described by Abbasi *et al.* (1998). To complete the reaction two solutions were used as buffer A and B. the buffer A consist of 2.7 ml, 15 mole KPO_4 (pH 7.0), while buffer B consist of 2.7 ml, 12.5 mmol/l H_2O_2 in 15 mole KPO_4 (pH 7.0) to the cavettes containing buffer A and B 300 µl enzyme extract was added and kept in dark. Optical density was measured at 240 nm by as spectrophotometer at 45 s–and 60 s–starting from the time when the enzyme extract was added to the cavettes. The difference in the optical density of two time intervals (45 and 60 seconds) was noted and used to calculate the catalase activity and expressed as enzyme units per gram (U g^{-1}) of protein on fresh weight basis.

Statistical analysis

The data obtained was subjected to two-way analysis of variance (ANOVA), by considering treatments and storage time as source of variance. The means were separated by Duncan Multiple Range test according to Steel *et al.* (1997) at a probability level of $p < 0.05$, using MSTAT-C software (Michigan State University, 1991, United States of America).

Results and discussion

Biochemical parameters of apricot fruit as affected by different concentrations of salicylic acid were evaluated on two day intervals during ambient storage. Total soluble solids of apricot fruit progressively increased in all treatments during storage (Fig. 1). Interaction means for treatments and storage had significant differences at $p < 0.05$. The initial TSS values increased up to the 8th day in control and 0.5 mmol/l SA treatment followed by a decline during the later stages. Similarly, 1, 1.5 and 2 mmol/l SA treated samples showed an increase in TSS up to 10th day and reduced slightly afterward. The effect of treatments was significant and hence higher concentrations of SA maintained a slow ripening process that resulted in to maximum TSS values towards the extended storage. TSS content is indicator of maturity and ripening of fruits. The slower rates of increase in TSS values indicate that salicylic acid delayed the ripening process of apricot fruit. Surface applications of anti-ripening agents delay degradation activities and check evaporation of moisture from fresh commodities (Hayat *et al.,* 2005). Salicylic acid has been found effective in reducing respiration rates and metabolic activities and hence slow down ripening process (Pila *et al,* 2010). Our findings also agree with Srivastava and Dwivedi, (2000) who found SA effective in delaying ripening of banana fruit during postharvest storage.

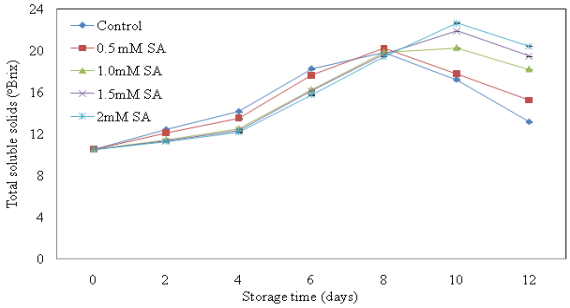

Fig. 1. Total soluble solids in apricot under different concentrations of SA retained in 2 mmol/l at ambient storage. Vertical bars show standard error of means (n = 3).

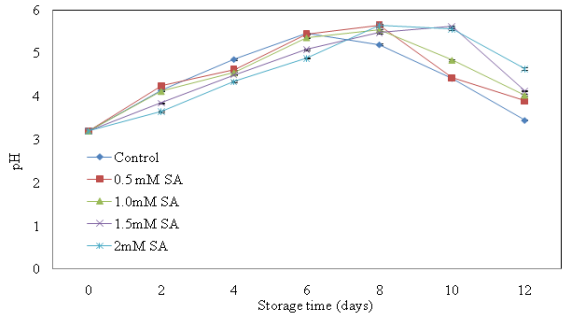

Fig.2. pH of apricot under different concentrations of SA, lower values maintained by 2 mmole/l at ambient storage. Vertical bars show standard error of means (n = 3).

pH values in all treatments increased significantly ($p<0.05$) during initial storage with a slight decline at the subsequent stages (Fig. 2). The increase in pH values was high in control as compared to SA treated samples. The initial value in control set rise at the 6th

day and then declined up to the 12th day. Among the treated samples, the increase in pH values were high in low concentrations of SA (0.5, 1 mmol/l), while 1.5 and 2 mmol/l concentrations maintained comparatively lower rates of pH increase during storage. The interaction means for treatments and storage were found significant (P<0.05). A slight decrease in pH of 0.5, 1 mmol/l observed after 8th day and in 1.5, 2 mmol/l after 10th day. Maximum pH values were retained in 2 and 1.5 mmol/l respectively followed by 1 mmol/l whereas minimum values were recorded for control and 0.5 mmol/l concentration of SA. The overall results exhibit that increased SA concentrations were effective in maintaining apricot fruit quality during storage. pH is indicator of acid composition and the differences might be attributed to the effect of different SA concentrations. During maturation process of fruits, acid contents are converted in to saccharides and also utilized by different enzymatic activities (Rathor *et al.,* 2007). Thus the sourness of fruit decline towards ripening and identical change in pH values occur with increased sweetness of the commodity. Ghasemnezhad *et al.* (2010) have also reported a gradual pH increase of apricot fruit coated with chitosan during cold storage. The results of present study are also in consistence with Bhattarai and Gautam, (2006) that acid contents are utilized by fruits during storage due to conversion of fruit contents into intermediate products.

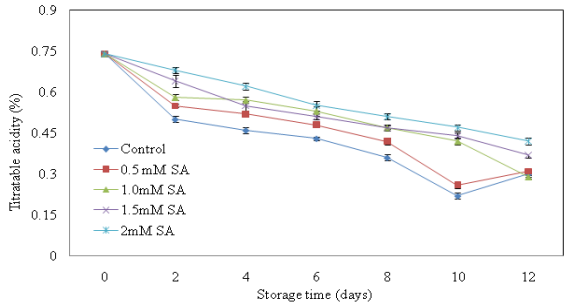

Fig. 3. Titratable acidity of apricot under different concentrations of SA, maximum losses observed in control at ambient storage. Vertical bars show standard error of means (n = 3).

Titratable acidity decreased significantly in all treatments during storage (Fig. 3). The interaction means for treatments and storage also showed significant differences (p<0.05). Maximum losses in TA were found in control and 0.5 mmol/l SA treated fruits, where initial values decreased up to the 10th day and increased slightly in the last interval. The decreasing trend persisted in 1, 1.5 and 2 mmol/l up to the 12th day. Similarly higher TA values were maintained by 1.5 and 2 mmol/l up to the 12th day. The decreasing pattern in acidity was much slow in samples treated with 2 mmol/l concentration followed by 1.5mmol/ls that indicates the shelf stability of fruit. These results demonstrated that increased SA concentrations delayed ripening of apricot during storage at ambient conditions. Titratable acids and simple saccharides are the key contributors in determining the flavour attributes of fruits (Raffo *et al.,* 2007). These acids also influence stability and keeping quality of fruits and have been considered as an index of maturity or spoilage (Hasib *et al.,* 2002). The acid composition of fruit is influenced by metabolic changes related to ripening and enzymatic activities in live tissues during storage. Effectiveness of SA in maintaining titratable acidity of apricot fruit during storage is supported by the findings of Srivastava and Dwivedi, (2000) that SA retained higher acid contents in strawberry. The decreasing patterns in TA in the present study are also in agreement with reports that organic acids might be used in respiration process and final contents decrease during storage (Echeverria and Valic, 1989).

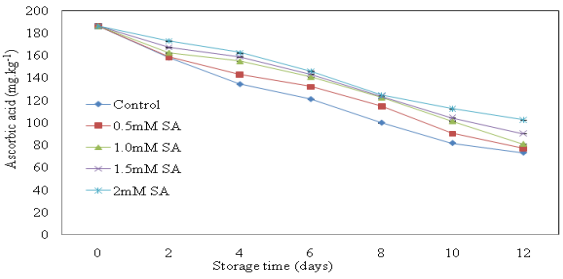

Fig. 4. Ascorbic acid in apricot affected by SA, maximum losses observed in control at ambient storage. Vertical bars show standard error of means (n = 3).

Ascorbic acid content of apricot affected by different concentrations of SA at ambient conditions is presented in Figure 4. An overall decrease in AA was

observed in all treatments throughout storage. Significant differences observed among interaction means for treatments and storage at $p<0.05$. Maximum AA lost in control followed by 0.5 mmol/l SA and the initial AA content (186.0 mg·kg^{-1}) reduced to 63.30, 77.20 mg·kg-1 on the 12th day. Whereas, minimum losses were observed in 2 mmol/l SA (102.50 mg·kg-1) followed by 1.5 mmol/l SA (90.4 mg·kg-1), 1 mmol/l SA (81.20 mg·kg-1) during the 12 day storage. The control set of experiment lost overall quality on the 12th day, followed by 0.5 and 1 mmol/l, while 2 and 1.5 mmol/l retained acceptability at same period. These results revealed that 2 mmol/l SA retained significantly higher ascorbic acid content in apricot at ambient storage.

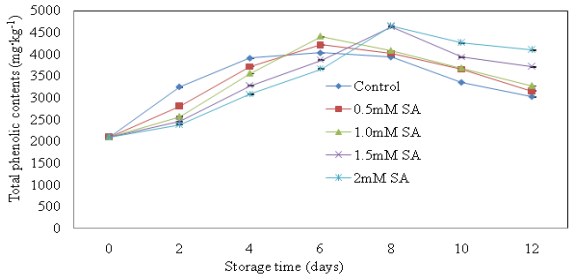

Fig. 5. Total phenolics in apricot retained maximum in 2 mmol/l SA at ambient storage. Vertical bars show standard error of means (n = 3).

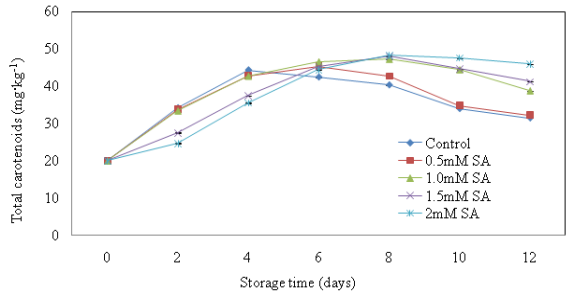

Fig. 6. Total carotenoids in apricot, maximum retention observed in 2 mmol/l SA at ambient storage. Vertical bars show standard error of means (n = 3).

Ascorbic acid is considered as an indicator of nutritional and storage quality of fruits and vegetables. Certain factors as exposure to light, temperature, gaseous composition of storage atmosphere, bruising and postharvest may induce heavy losses to ascorbic acid (Lee and Kader, 2000). They have further observed that conditions favoring water loss cause severe depletion in ascorbic contents of fruits and vegetables. All of the above studies provide evidence for losses in AA during ripening and storage. Ascorbic acid retention in SA treated samples is supported by the previous findings of many researchers, where SA applications maintained higher AA and delayed ripening of tomato, sweet cherry and strawberries (Pila *et al.*, 2010; Valero *et al.*, 2011). The results of present study also indicate that 2 and 1.5 mmol/l SA concentrations were effective in retention of higher AA and extending storage life of apricot as compared lower concentrations.

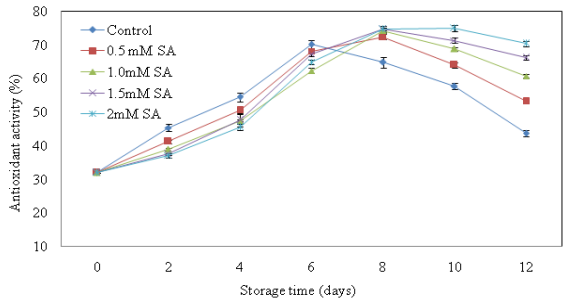

Fig. 7. Antioxidant activity in apricot as affected by SA, maximum losses observed in control at ambient storage. Vertical bars show standard error of means (n = 3).

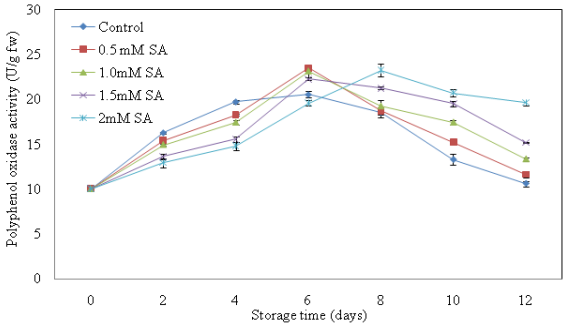

Fig. 8. PPO activity in apricot, minimum activity maintained in 2 mmol/l SA at ambient storage. Vertical bars show standard error of means (n = 3).

TPC of apricot (expressed as mg gallic acid equivalents per kg) during storage at ambient conditions showed an increase during initial stages followed by a decline in all treatments (Fig. 5). Interaction means for treatments and storage showed significant differences at $p<0.05$. In control, 0.5 and 1 mmol/l, the initial TPC (2 100 mg·kg-1) increased to 4222.0 mg·kg-1 up to the sixth day and then declined to 2450.0, 3160.0, 3280.0 mg·kg-1 at the 12th day.

Similarly the increasing trend in 1.5 and 2 mmol/l SA treatments continued to 8th day followed by drop during the remaining intervals. Different concentration of SA significantly affected the TPC, however 0.5 and 1 mmol/l was found least effective as compared to 1.5 and 2 mmol/l SA concentrations. Maximum retention of TPC was observed in 2 mmol/l (4100.0 mg·kg-1) followed by 1.5 mmol/l (3720.0 mg·kg-1) on the 12th day respectively. The overall results demonstrated that increased concentrations of SA maintained fruit quality and TPC content of apricot fruit during storage at ambient conditions.

Phenolic compounds are major functional components in apricot (Kan and Bostan, 2010). The accumulation of soluble phenolic contents has been reported during ripening in fruits and least affected during storage (Ayala-Zavala *et al.,* 2004). Some studies have established that antioxidant compounds increased in fruits during storage (Gil *et al.,* 2006), however decline in phenolic contents is attributed to enzymatic browning and senescence. Phenolics are utilized as substrates by enzymes especially polyphenoloxidase (PPO) and peroxidase (POD) resulting in to decreased concentrations (De Rigal *et al.,* 2000). Salicylic acid as plant hormone regulates growth and ripening process of fruits. As signaling molecule SA activate the antioxidant mechanism in the plants and thus maintains increased levels of phenolic compounds. Valero *et al.* (2011) have also reported that SA application was effective in delaying ripening process in sweet cherry and increase in antioxidant components during storage. The decrease in TPC at the later stage of storage might be due to senescence of tissues (Macheix *et al.,* 1990).

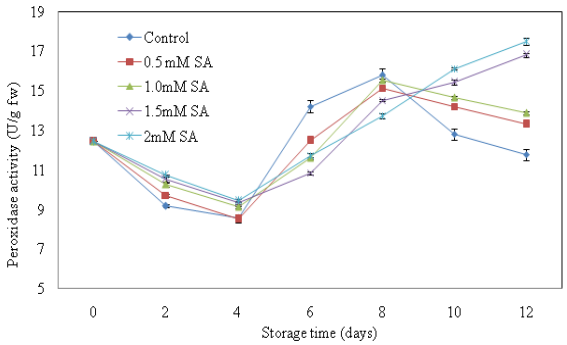

Fig. 9. POD activity in apricot, maximum activity maintained in 2 mmol/l SA at ambient storage. Vertical bars show standard error of means (n = 3).

Total carotenoids (β-carotene Equivalent per kg) increased in all treatments during initial stages of storage and a slight decline occurred in the later stages (Fig. 6). Significant differences were found for the interaction means of treatments and storage ($p<0.05$). Initial 20.00 mg·kg-1 TC values in control increased to 44.3 mg·kg-1 at the 4th day and decline to 31.5 mg•kg-1 at the 12th day. Similarly, maximum TC found for 0.5 mmol/l at the 6th day and 1 mmol/l at 8th day (45.30 and 47.20 mg·kg-1) that decreased to 32.2 and 38.8 mg·kg-1 respectively on the 12th day. 1 and 2mmol/l maintained higher contents up to 12th day and the final contents found were 4.12 and 4.58 mg·kg-1. The decline in 1.5 and 2 mmol/l was minute and non significant trends were found in the post decline stage. Similarly the increase was also gradual in both the treatments that indicate the ability of these concentrations to delay ripening during storage. Carotenoids are important secondary plant metabolites having significant roles from health point of view and contributors to sensory quality of fruits by conferring variety of colors to fruits and vegetables (Rao and Rao, 2007). Variability in apricot colour (from greenish yellow to orange and strong red blushed) is attributed to a wide array of carotenoids (Bureau *et al.,* 2009). Storage response of carotenoids depends on the harvest physiology of fruits and storage conditions. The contents increase if the fruit is still in maturation stage, while contents may decrease during senescent stage. Studies have shown that carotenoids are stable during storage (De Rigal *et al.,* 2000), however losses are attributed to autoxidation and enzyme mediated degradation of pigments. The results of present study demonstrated that salicylic acid slowed down ripening process that resulted into increase of carotenoids during storage. The slight decline in TC contents might be attributed to senescence of fruit. The results are also in agreement with the previous studies that carotenoid content of apricot is affected by postharvest treatments, handling, processing and storage (De Rigal *et al.,* 2000).

Antioxidant activity (AoA) of apricot fruit in terms of DPPH free radical scavenging activity are presented

in Figure 7. Interaction means for treatments and storage regarding antioxidant activity had significant effect at $p<0.05$. AoA in all treatments increased during initial stages, followed by a decline in the subsequent storage (Fig. 7). Control sample demonstrate an increase up to 6th day, 0.5, 1 and 1.5 mmol/l up to 8th day while in 2 mmol/l this trend continued up to 10th day respectively. The increase in antioxidant activity was rapid in control followed by 0.5 and 1 mmol/l concentration, while 1.5 mmol/l and 2 mmmol/l maintained a lower activity during the initial stages. The comparison of results showed that 1.5 and 2 mmol/l SA higher free radical scavenging activity during storage at ambient conditions. AoA is attributed to the compounds capable of scavenging free radicals in the biological system. A great emphasis is given presently on the evaluation of AoA of fruits as important quality parameters due to disease preventive roles of these components. It has been shown that antioxidant capacity in apricot is strongly correlated to the phenolic contents (Ali *et al.,* 2011; Drogoudi *et al.,* 2008). In the present study AoA increased at a slower rate in SA treated samples. This pattern indicates that SA treatments significantly affected ripening process in apricot during storage. Similar results have also been reported by Valero *et al.* (2011) and Mo *et al.* (2008) that SA treated fruit demonstrated continuous increase in antioxidant activity in sweet cherry and apple during storage.

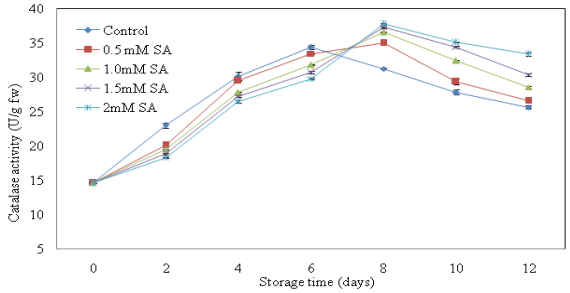

Fig.10. CAT activity in apricot, maximum activity maintained in 2 mmol/l SA at ambient storage. Vertical bars show standard error of means (n = 3).

Polyphenol oxidase activity in apricot increased in all treatments at the initial storage intervals (Fig. 8). Maximum PPO activity was observed in control, 0.5 and 1 mmol/l SA treatments during the 6th day and that declined afterward. The increasing pattern continued in 1.5 and 2 mmol/l attained at the 10th day and started decline afterward. Both concentrations maintained a lower activity during storage that gradually increased with the extended period of storage. The interaction means for treatments and storage were partially significant ($p<0.05$), however as compared to control higher SA concentrations affected PPO activity significantly. PPO mediates browning reactions of phenolic compounds and cause discoloration of fruits and vegetable during ripening, handling, storage and processing (Dincer *et al.,* 2002). Fruit discoloration impairs sensory quality and nutritional content depreciation; thus rendering fresh commodities poor for consumer acceptance. Salicylic acid is now accepted as a strong signal molecule in strengthening defense system in a number of biological mechanisms in plants (Ansari and Misra, 2007). It has been established that SA prevent ethylene synthesis, delay ripening and alleviates oxidative stresses by enzymes and reactive oxygen species (Mahdavian *et al.,* 2007; Mba *et al.,* 2007). The results are also in accordance with Peng and Jiang, (2006) that SA prevented discoloration of fresh-cut Chinese water chestnut.

Peroxidase activity in apricot fruit treated with salicylic acid is presented in Figure 9. The interaction means were partially significant at $p<0.05$ for treatments and storage. Maximum POD activity was observed in control up to 6th day followed by 0.5 mmol/l SA and 1 mmol/l SA that maintained increasing pattern up to 9th day followed by a decline. Whereas 1.5 and 2 mmol/l SA had lower POD activity during initial storage intervals and increased gradually up to 12th day of storage (Fig. 9). The results revealed that 1.5 mmol/l and 2 mmol/l SA were effective in contributing towards lower POD activity during storage. Peroxidases catalyze biochemical reactions responsible for colour changes through degradation of phenolic substance in the presence of hydrogen peroxide along with PPO (Zhang and Zhang., 2008). POD activity is also linked to ripening and further increases with the advancement in senescence mechanism in fruits. A number of factors responsible for increased enzymatic activity are

physical injury and mechanical stresses during handling that damage cellular compartmentalization (*Tian et al.,* 2005). Salicylic acid has been found effective in mitigating biochemical degradation and enzymatic breakdown of tissues. It further hampers ethylene synthesis and slow down senescence due to the inhibitory effect on 1-Aminocyclopropane-l-Carboxylic Acid (ACC) conversion in to ethylene (Zhang *et al.,* 2003). The results of present study indicate that slow ripening was maintained by fruits treated with the increased levels of SA.

Catalase activity in all treatments increased during ambient storage (Fig. 10). Mean interaction values for treatments and storage demonstrated a significant pattern ($p<0.05$). Figure 10 shows that higher CAT activity in control was found at the 6th day of storage followed by a rapid decline up to 12th day. In 0.5 and 1 mmol/l SA treatments, a gradual increase in CAT activity continued up to 8th day and then decreased. While, 1.5 and 2 mmol/l concentrations also maintained an increasing trend up to the 8th day and started a slight reduction up to 12th day. A higher activity was maintained by 1.5 and 2 mmol/l SA during the extended storage period. CAT is an important member of plants defense mechanism and provides cellular resistance against the toxicity of hydrogen peroxide (Akhtar, 2009). It has a preventive role against oxidative damages caused by reactive oxygen species (Ji *et al.,* 1988). As the most efficient antioxidative enzymes, catalase influence the maturation and ripening patterns of fruits, its activity decline at advanced stages of senescence concomitant to loss of hydrogen peroxide scavenging capacity (Ng *et al.,* 2005). Our results showed that CAT activity increased rapidly in control followed by 0.5 and 1mmol/l SA during initial storage intervals. The reason might be early onset of senescence peak in these treatments. Increased concentrations of SA maintained higher activity due to delayed ripening of apricot during storage at ambient conditions. A number of studies on SA role in protection against oxidative stresses have shown increased activity of antioxidant enzymes such as catalase (Ortega-Ortiz *et al.,* 2007).

Conclusion

The present study investigated that out of four concentrations of salicylic acid, 2, 1.5 mmol/l concentrations were effective in maintaining chemical and bioactive composition of apricot during ambient storage. It can be concluded that apricot harvested at commercial maturity stage can be successfully stored for two weeks by treating with higher concentrations of SA along with ethylene scavenger to facilitate distant marketing of fresh fruits.

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