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Influence of water soluble coatings on posharvest quality of sweet cherry (*Prunes avium L.*) grown in Gilgit-Baltistan

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Abstract

The effects of semperfresh along with polyethylene bags on quality of cherries were studied. Freshly harvested cherry fruits (*Prunes avium*) were segregated into four groups and coated with three different levels of semperfresh i.e. 1, 2, and 3%, while the forth one left as a control. Half of the cherries from each of the above groups were sealed in low density perforated polyethylene bags while the other half of the cherries were placed in open wooden trays. Each group was analyzed for the different quality parameters like, firmness, weight loss, titratable acidity, total soluble solid, total sugar, ascorbic acid, pH, antioxidant activity, total phenolics compound and sensory evaluation. It was revealed from the study that the semperfresh was found effective to reduced weight loss, improved firmness appreciable ascorbic acid content and titratable acidity, high antioxidant activity and total phenolics compound and acceptable flavor, taste and color scores in fruits during storage time. The results of this study suggest that semperfresh 3% increased the shelf life of cherries up to 15 days at room temperature without any change in quality.

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Introduction

Sweet cherry (*Prunes avium* L.) grows in temperate zone and a non climacteric fruit. It is cultivated all over the world with approximate annual production of 2.3 million metric tons (USDA, 2011). Cherry is one of the popular stone fruit in Pakistan and is being cultivated in Baluchistan, Khyber Pakhtunkhawa and all districts of Gilgit-Baltistan (GOB, 2000; NAAS, 2011).

Sweet cherries are nutritionally important source of the antioxidant, phenols, flavoniods, ellagic acid, perillyl alcohol, melatonin, Beta-sitosterol, vitamin C and fiber. The presences of these functional components have been attributed to its total antioxidant activity (Goa and Mazza, 1995; Guillen; 2005, Toma, 2007). The fruit can be consumed in fresh, dried, frozen, juice form, as desserts and used for other culinary purposes. In ancient days the cherry fruit being used for their medicinal purposes as well (Mamta, 2009).

Different post harvest techniques like controlled atmosphere storage, modified atmosphere storage, sub atmospheric storage, Low temperature storage, ethylene absorbents and surface coating are used to increase the storage life of fruits and vegetable. Researchers are interested in developing methods that are cheap, easy use and pose no health hazard to the consumer (Wilcock *et al.,* 2004). Amongst them modified atmosphere packaging (MAP) has been effective in delaying the quality changes in sweet cherry (Remon *et al.*, 2003). The combination of MAP, essential oils and cold storage has shown better quality retention in cherry fruits during storage (Serrano *et al*., 2005b).

Semperfresh coating is composed of sucrose esters of fatty acids, sodium carboxy methyl cellulose and mono and diglycerides of fatty acids. It is an edible, biodegradable and tasteless product it successfully preserved the quality parameter of fruit during transportation and storage (Stuart, 1987). Semperfresh application on cherry fruit under cold storage resulted in reduced weight loss, increased firmness, ascorbic acid content, and titratable acidity with uniform skin color during storage (Yaman and Bayoindirlh, 2002). Derivatives of fatty acids and polysaccharides coatings based on chitosan alone or in combination with hypobaric treatments reduced weight loss, respiration rate and post harvest decay in sweet cherry (Romanazzi *et al.,* 2003; Alonso and Alique, 2004).

During glut season from harvest to marketing, 35 percent cherry losses occur during the transportation and post harvest handling operations in Gilgit-Baltistan (NNAS, 2011). Sweet cherry being highly perishable commodity deteriorates after harvest and fails to reach consumers at its prime quality due to short storage life. Therefore a need arises to develop cheap, easy to use on farm postharvest technique to reduce its losses. The present study has been designed to identify the best level of edible coating and polyethylene film on the quality attributes of cherry and to assess its storage life under ambient temperature.

Materials and methods

Collection of sample

Fruits were harvested at commercial maturity stage (red color) from Danyore, Gilgit-Baltistan on 14th May, 2010. After washing, sorting, grading and drying the cherry fruits were subjected to different levels of semperfresh (Agri Coat Industries, UK). The physico-chemical parameters evaluated after a day interval.

Preparation of coating

Semperfresh coatings (1%, 2% and 3%) were prepared by dissolving 10.0g, 20.0g and 30.0g of semperfresh in 1000 ml distilled water and stirred for 10 minutes on hot plate for uniform mixing. The fruits were dipped for three minutes in different concentration of semperfresh solutions i.e. 1%, 2% and 3%. They were air dried and kept in open card board trays. The coated fruits were categorized in to two groups for packed and unpacked storage as mentioned in treatments.

Treatments

The set of different treatments includes; T_1 (Control), T_2 (1 % Semperfresh), T_3 (2 % Semperfresh), T_4 (3 % Semperfresh), T_5 (1 % Semperfresh + Polyethylene), T_6 (2 % Semperfresh + Polyethylene) and T_7 (3 % Semperfresh + Polyethylene).

Storage of cherries

Treated cherries along with control were stored at ambient temperature maintained at 25±2 °C and RH 70-80% for 15 days (14th May, 2010 to 28th May 2010) for further studies.

Physico-chemical analysis

Cherries were analyzed for physico-chemical parameters after a regular day interval for period of 15 days and at the end of storage.

Physical analyses

The physical analyses at regular interval of a day were carried out to evaluate the quality change in the cherries during storage. The weight loss was determined by weighing the samples with digital balance (OHAUS, Model TS4KD Florham Park, NJ, USA) and reported as percent loss in sample weight based on its initial weight. Total soluble solids (TSS) were recorded as °Brix by Digital Refractometer (PAL-III ATAGO, Japan) according to AOAC (1994) method no. 932.12. The pH values were measured by using pH meter (Inolab German) according to AOAC (1990), method No. 981-12. Fruit firmness was determined by means of a Fruit Firmness Tester (Penetrometer) equipped with an 11 mm plunger, using ten fruits from each treatment. Values were expressed in Newton (N) as described by (Mazumdar and Majumder, 2003).

Chemical analyses

The cherry fruits were analyzed for different chemical parameters after a day interval. Titratable acidity was determined in terms of malic acid according to AOAC (1994) method no. 932.12. Ascorbic acid was determined by using 2,6 dichlorophenol indophenol dye as described by AOAC (1994) method no. 967.21. Total sugar was determined by Lane and Eynon titration method as described in AOAC (1990). method No. 925-35.

The total phenolics content expressed as Gallic acid equivalent was measured by using Folin-Ciocalteau's reagent as described by Singleton and Rossi (1965). Five g of sample was extracted with 25 mL methanol by shaking. To 100 µL of the sample extract (diluted 1:5 (v/v) with methanol) 6 mL of twice distilled water and 500 µL of Folin-Ciocalteau's reagent were added. After that samples were kept for 5 minutes at room temperature and 1.5 mL of sodium carbonate (20 percent w/v) was added. The extract was mixed and allowed to stand for 30 minutes at 40 °C before measuring the absorbance at 765 nm. A mixture of water and reagent was used as a blank. The total phenolic content was expressed as mg gallic acid equivalents (GAE) per 100 g fresh weight of edible fruit.

Antioxidant activity was determined by using a modified version of Brand-Williams *et al.* (1995). This involves the use of free radical 1.1-diphenyl-2-picrylhydrazy (DPPH). A 50 µL methanolic solution of each extract (diluted 1:6) was placed in test tubes and 200 µL of 0.1 mM methanolic solution of DPPH was added and allowed to react in the dark at room temperature. The decrease in absorbance of DPPH at 517 nm was measured in 5 minutes intervals until the absorbance stabilized (30 minutes). All samples were analyzed in triplicate. The radical scavenging activity of extracts was expressed % DPPH scavenging activity by using following equation.

DPPH scavenging activity (%) = [(Abs Control-Abs Sample)/Abs Control] × 100.

Sensory evaluation

The organoleptic evaluations of cherry fruits were carried out for taste, flavor and color by a panel of five judges selected from the Department of Food Technology, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi. A nine point hedonic scale was used for sensory evaluation as described by Lawless and Heyman (1998).

Statistical analysis

The data obtained for the above parameters were statistically analyzed by using two factor factorial in Complete Randomized Design (RCD) using MSTATC statistical software as described by Steel *et al.* (1996).

Results and discussion

Weight loss (%)

Semperfresh at different concentration was effective in reducing weight loss (%) of treated cherries as compared to control during storage (Fig. 1). There was an increase in weight loss with the passage of time. However, the rate of change in weight loss was different in different treatments. It was observed that the increase in coating concentration weight loss reduces. The weight in loss in T_7 packaging material was low as compare to the fruits treated havening same concentration in open air but packaging material promoted the mold growth.

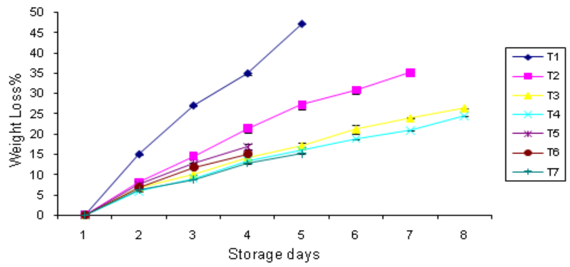

Fig. 1. Effect of semperfresh coatings on weight loss of cherry during storage.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of $P< 0.05$. Weight loss is generally associated with the water loss from the fruit higher the respiration and transpiration, the greater will be the weight loss. Water losses result in visible wilting in the surface of the commodities when it exceeds 4 to 6% of the total fresh weight **(**Kays, 1991; Mir and Beaudry, 2004).

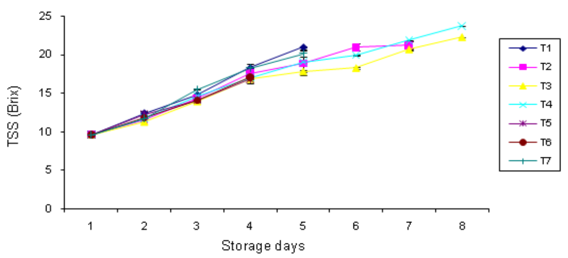

Fig. 2. Effect of semperfresh coatings on TSS of cherry during storage.

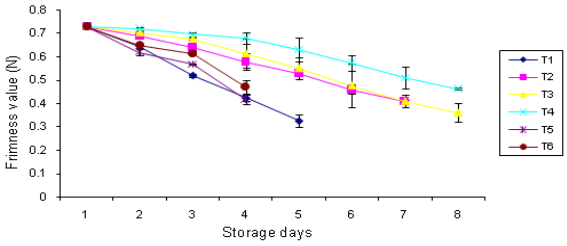

Fig. 3. Effect of semperfresh coatings on cherry fruit during storage.

The reduction in weight loss might be due to the hygroscpic effect of higher concentrations. It has been reported that the higher concentration of semperfresh caused the lowest weight loss in cherry fruit (Yaman and Bayoindirlh, 2002), Amasya apple (Sumnu and Bayindirli, 1995) and in Julie mangoes (Dallha and Hanson, 1988). The lower weight losses, also has been reported in sweet cherry (Alonso and Alique, 2004).

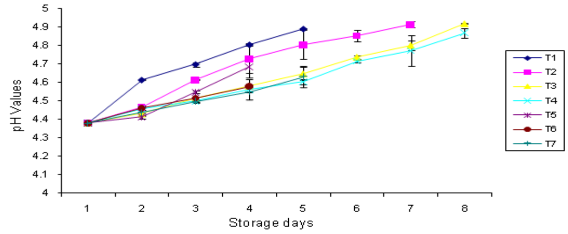

Fig. 4. Effect of semperfresh coatings on pH of cherry during storage.

Total soluble solids (TSS °Brix)

There was an increase in TSS during storage (Fig. 2). Changes in TSS are directly correlated with hydrolytic changes in starch concentration during ripening in the post harvest period. In all post harvest treatments there was increase in total soluble solid. TSS during storage depends on the stage of ripeness at harvest and storage intervals (Jimenez, *et el.,* 1996). The result indicates that the increase in TSS in treated cherries was slower as compared to control cherries.

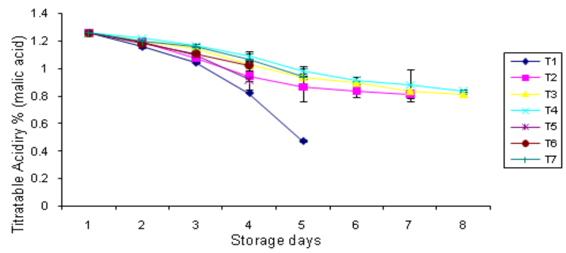

Fig. 5. Effect of semperfresh coatings on titratable acidity of cherry during storage.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of P< 0.05.

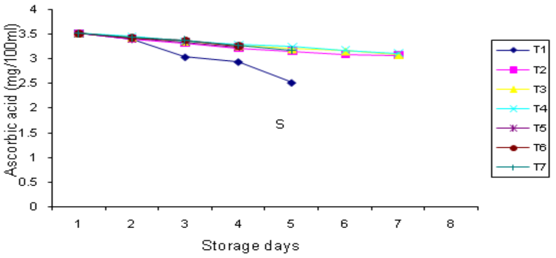

Fig. 6. Effect of semperfresh coatings on ascorbic acid of cherry during storage.

These results are in line with the findings of Sumnu and Bayindirli, (1995) reported in Amasya apple and Dallha and Hanson, (1988) in Julie mangoes and Bayindirli *et al.* (1995) in mandarins.

Firmness (N)

Semperfresh coatings decreased the loss in fruit firmness as compared to the control (Fig. 3). This may be due to the development of internal atmosphere in coated fruit. At harvest the firmness value of cherry was 0.73 ± 0.012 N. Changes in firmness was observed in different treatments during storage. Control showed lowest firmness 0.33 ± 0.027 N value as compare to coated cherries T_2 (41 ± 0.006 N) T_3 (0.36 ± 0.40 N) and T4 (0.46 ± 0.005 N).

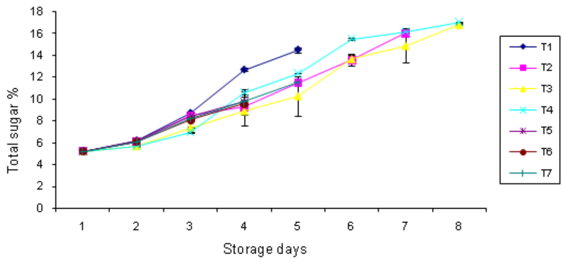

Fig. 7. Effect of semperfresh coatings on total sugar (%) of cherry during storage.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of P< 0.05.

These results indicate that the decrease in firmness in treated fruits was slower as compared to control. During ripening depolymerization occur in fruit, with an increase in pectin esterase and poly galactronase activities. The low oxygen and high carbon dioxide concentrations reduce the activities of these enzymes and maintains the firmness of fruits and vegetables during storage (Salunkhe *et al.,* 1991).

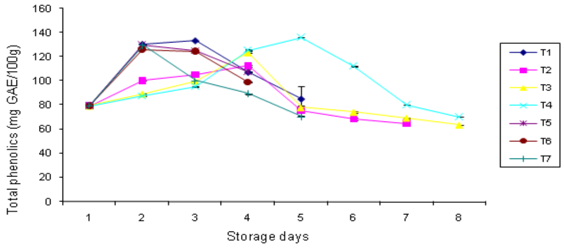

Fig. 8. Effect of semperfresh coatings on total phenolics of cherries.

In sweet cherries the softness depend on the increase activities of enzymes responsible for fruit quality loss i.e. poly galacturonase, ß-galactosidase and pectin methyl esterase (Batisse *et al.*, 1996; Gerardi *et al.,* 2001; Remon *et al.*, 2003). These findings agree the studies of Yaman and Bayindirh (2002) that coated the sweet cherry with semperfresh having different concentrations and reported that it help in slowing down the rate of decrease in firmness values with the increase in semperfresh concentrations. These results also agree the findings of Sumnu and Bayindirli, (1995) who reported that the different concentration of semperfresh effective in reducing weight loss.

pH

Semperfresh coatings maintained the lower pH during storage in coated fruits as compared to the control (Fig. 4). The pH of cherry fruit was 4.380 ± 0.006 at harvest, but it increased during storage. The packaging material showed no effect in pH, the best result (4.91± 0.016) showed by T_4. Control showed rapid ripening (4.89 ± 0.09) because of their perishable nature. The other treatments gave significantly different pattern of result.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of P< 0.05.

Organic acids are the substrate for the enzymatic reaction and caused in increase respiration rate. Coating reduced the respiration rate by delaying in utilization of organic acids. These result of coating in line with the studies of (Manzano *et al.,* 1997), who observed the effect of coating on Haden mango and reported that the wax coating decreased the rate of increase in pH.

Titratable acidity (% in terms of malic acid)

Titratable acidity declines throughout storage (Fig. 5). At harvest titratable acidity was 1.263 ± 0.009%. The increase in semperfresh coatings concentration significantly decreases the loss in titratable acidity. T.A in coated fruit did not reached the lowest level as observed in control0.075 ± 0.006 %.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of $P< 0.05$.

During ripening malic acid and citric acids are converted in to sugars and increase in sugar level (Martinez *et al.*, 1997). Malic acid is pre dominant organic acid in cherries that is found in high amount (Serrano *et al.,* 2005a), as compared to citric acid fumaric and shikimic acid. However the amount of organic acid content differed among cultivars (Usenik *et al.*, 2008).

Titratable acidity retention in Amasya apple by 5g/L semperfresh was reported by Sumnu and Bayindirli, (1995) similarly in julies mangoes (Dallha and Hanson, 1988) and by Bayindirli *et al.* (1995) in mandarins. These lines agree with the studies of Yaman and Bayoindirlh (2002) which coated the cherry fruit with different coatings and found that the coating helped in slowing down the rate of decrease in titratable acidity.

Ascorbic acid (mg/100g)

Ascorbic acid content was declined gradually till the end of the storage period with respect to the initial value (Fig. 6). At harvest ascorbic acid content was (3.52 ± 0.015 mg/100 g) highest but during storage it decreased. T_4 showed (3.05 ± 0.017 mg/100 g) ascorbic acid content at the last day of storage while control showed 2.52. ± 0.009mg/100g). During storage it was observed that the high concentration of semperfresh were more effective in delaying the decreasing rate of ascorbic acid in cherry fruit.

During storage the amount of ascorbic acid in fruit and vegetable is lost due to the activity of enzyme phenoloxidase and ascorbic acid oxidase (Salunkhe *et al.,* 1991). While studying on green bean, spinach and broccoli, researcher found that the small amount of ascorbic acid losses when lower oxygen content is present during storage conditions (Weichmann *et al.* 1985) because ascorbic acid oxidase and other oxidases are responsible for the oxidation of ascorbic acid.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other except T_2 and T_3 they were non-significant to each other but significantly different from the other groups at a level of $P< 0.05$.

these result are agree with the results of Yaman and Bayindirlh (2002) they reported that reduction in ascorbic acid content was low as compare to control. These results are also in line with the findings of Ayranci and Tunc (2004) who studied on apricots and green peppers by applying edible coating and reported low vitamin C loss occur during storage.

Total Sugars (%)

Total sugar throughout the storage increased continuously (Fig. 7). At harvest amount of total sugar was (5.20 ± 0.058%). T_1 showed total sugar (14.51± 0.222%), T_2 (16.03± 0.34%), T_3 (16.82± 0.032%) and T_4 (17.07± 0.050%) total sugar at the last days of storage.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of $P< 0.05$.

The predominant sugars in cherries are glucose and fructose along with some amount of sucrose (Ayaz *et al.*, 1996). The soluble solid during storage depends on the stage of ripeness at harvest and storage intervals (Jimenez, *et el.,* 1996).

The above result indicates that the increased in total sugar in treated cherries was slower as compared to control cherries. Control cherries showed rapid ripening as compare to the treated cherry. These results are in line with the findings of Mali and Grossmann (2003) in starch coated strawberry.

Total phenolics compound (mg GAE/100g)

There was initially an increase in total phenolics and at last a slight decreased was observed (Fig. 8). At harvest the amount of total phenolics was 79.63 ± 0.17 mg GAE/100 g. During storage it increased and finally decreased. Total phenolics compound of treated cherries was increased slowly during storage as compared to the control. On the other hand the increased in concentration of coating delayed the increasing rate of phenolics during storage.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of $P < 0.05$.

The main antioxidants in fruit and vegetables are carotenoids, ascorbic acid, and phenolics compounds (Giovanelli *et al*., 1999), vegetables contain phenolics compounds including flavonoids, which also confers antioxidant activity (Shahidi and Naczk, 1995).

These result are in line with the findings of Ghasemnezhad *et al.,* (2010) who reported that the initially increase and then decrease in phenolic compounds in chitosan treated apricot. The increase in anti oxidant activity and phenolics compound in coated tomato also has been reported by Javanmardi and Chieri (2006).These results are compatible with Benhamou and Theriault (1992), and Liu *et al*., (2007) who reported that phenolic compounds was induced in tomato plants and fruit treated with chitosan. The decrease in phenolic compounds at the end of storage might be due to breakdown of cell structure at senescence during the storage (Macheix *et al*., 1990).

Total antioxidant activity

There was an initially increase and then decreased in antioxidant activity was observed in coated cherries. At harvest the antioxidant activity was 64.67 ± 0.88 %. Control showed rapid increase and then decreased in antioxidant activity (Fig. 9). Ripening in cherry is characterized by the conversion of green color in to red color, color and anthocyanins correlate during ripening. Anthocyanins have the direct relationship with antioxidant potential in the fruit (Andrew, 1994; Serrano *et al.,* 2005a). During ripening, the total antioxidant activity increases and this increase are mainly due to change into the lipophilic antioxidant activity (Cano *et al.,* 2003) higher temperatures may negatively affect the antioxidant content of fruit and vegetables (Jonsson, 1991).

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of $P < 0.05$.

Previous studies have shown that there is a positive correlation between antioxidant activity and total phenolic content (Wang *et al*., 1996; Rapisarda *et al*., 1999; Wang and Lin, 2000). Therefore in this study the high total antioxidant capacity could be attributed to the high total phenolic content.

These results are in line with the findings of Ghasemnezhad *et al.,* (2010) who reported that the initially increase and then decrease in antioxidant activity of chitosan coated apricot during storage. The increase in antioxidant activity in coated tomato also has been reported by Javanmardi and Chieri, (2006).

Color (Scores)

The color score of treated cherries increased (Fig. 10). Color is an important parameter in consumer acceptance (Crisosto *et al*., 2003). The main characteristic related to cherry fruit quality is color. In cherry, during ripening change of the initial green color in to red, which is associated with the accumulation of anthocyanins and degradation of chlorophyll (Gao and Maza, 1995) during ripening color changes are correlated to the anthocyanin content (Serrano *et al.,* 2005a).

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of P< 0.05.

Semperfresh coatings significantly affected the skin color score of the cheery fruit, coatings delayed the ripening and respiration rate, inhibited enzyme chlorophyllase activity eventually slowed down the chlorophyll degradation and color development. These finding are associated with (Ait-Qubahou *et al.*, 1995), who reported that semperfresh coating significantly delayed the color changes in fruit.

Taste (Scores)

Sweetness in the cherry fruit is mainly due to glucose and fructose (Bernalte *et al.*, 2003; Esti *et al.*, 2002). The obtained result showed that coated fruits score increases with the passage of time.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of P< 0.05.

These results agree with the findings of the Matinez-Romero *et al.*, (2006) who confirmed that the aloe vera gel imparted an attractive shine in sweet cherries.

Flavor (Scores)

The flavor score of cherry fruit initially increased in treated and in control (Fig. 12). At harvest the flavor score was 6.667 $\pm$ 0.333 with the passage of time the flavor score increased in last few day some declined in flavor score was observed.

The statistical analysis shows that the all 7 groups of cherries were significantly different from each other at a level of P< 0.05.

The findings regarding semperfresh agree the findings of Dang *et al.*, (2008) who reported that semperfresh and aloe vera coatings delayed ripening and imported aroma in mango fruits during storage.

Conclusions

Coating with 1, 2, and 3% of semperfresh retarded ripening and weight loss, increased firmness value, and caused the slowest increase in TSS, total sugar, total phenolics, anti oxidant activity and pH values. The packaging material along with coating caused mold growth and discarded during storage before the 15th day. It can be concluded from the results that T4 (3% semperfresh) is the best postharvest treatment for cherry fruit. Further studies using the different concentration in different temperature conditions are recommended to control mold growth and their effect on quality of cherries.

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