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Comparative study on the effect of pre and post-harvest calcium chloride treatments on microbial and sensory characteristics of sweet cherries

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Abstract
This research work was conducted to study the effect of pre and post-harvest calcium chloride treatments on microbial and sensory characteristics of sweet cherries grown in District Skardu Gilgit Baltistan. The samples treated with calcium chloride packed in foam trays and stored at room temperature for 20 days. The applied treatments were C_0 (untreated cherry fruit), C_1 pre (Cherry fruit (0.5% Calcium chloride), C_2 pre (Cherry fruit (1% Calcium chloride), C_3 post (Cherry fruit (0.5% Calcium chloride) and C_4 post (Cherry fruit (1% Calcium chloride). All the samples were analyzed for physiochemical characteristics at an interval of 4 days. The treatment C_4 post was observed best on the basis of physiochemical and sensory attributes. The color and flavor score given by the panel judges was declined, lowest fall of noticed in C_4 (7.50 and 8.53%) respectively. Similarly texture and overall acceptability score also decreased, minimum decrease recorded in C_4 (12.19 and 19.51 %) respectively. Microbial analysis showed that the plate count of the sample was improved, maximum fond in C_0 (44.33) 98.27% while minimum noted in C_4 (8.16) 81.50. The treatment C_4 post-horvest was observed best on the basis of physicochemical and sensory attributes.

Keywords: cherry fruit, calcium chloride, cultivar, Skardu G.B

1. Introduction
Sweet cherry (*Prunus avium* L.) belongs to the genus *Prunus* is one of the most famous fleshy, stone, pulpy and temperate fruit. Cherry fruit can be consumed as fresh, dried, pickled and process into in jam, marmalade and juice or canned product. There are several species of cherry growing in the world such as sweet cherry (*Prunus avium*), citrus, pie or tart cherries (*Prunus cerasus*), black cherry (*Prunus serotina*), West Indian Cherry ((*Prunus myrtifolia*) (Looney and Kupperman, 1996) [15]. Cherry fruit have 125-265 g / kg fresh weight and 3.67 to 8.66 g / kg wet weight while sugar comprises of more than 80% of glucose and fructose (Usenik *et al*., 2008). This fruit contains phenolic compounds (1500 mg / kg wet weight), among this 60-74% by weight are flavonols, hydroxycinnamates and anthocyanins (Usenik *et al* 2008). Sweet cherry plays an important role in the maintenance of healthy life preventing the diseases (Yilmaz *et al*., 2009). The health benefits are associated with strong antioxidant activities known to help weight loss, neuro protective effects, prevent arthritis pain and inflammation (Jakcobek *et al*., 2007). In Pakistan total area under cherry cultivation was 1,065 thousand hectares with total production of 1,981 thousand tones while According to the statistical data in Gilgit Baltistan total area under cherry cultivation was 1,302 hectares with total production of 2,384 tones. Gilgit Baltistan located extreme North of Pakistan where it borders the Xinjang province of China in North, Chitralin west and Kaghan valley in South. Gilgit Baltistan lies in temperate regions and there are various high quality temperate fruits including cherry, apricot, mulberry etc are grown abundantly due to the favorable atmospheric conditions (Fruit. Veg. Condiments Stat. Pak. 2013-2014; Agri. Stat. Dptt. Gilgit Baltistan. 2013-2014) [4].
Sweet cherry is highly perishable in nature due to its moisture level and thin skin. Sweet cherry is highly perishable in nature due to its high moisture level and thin skin. In Pakistan (Gilgit Baltistan) 30-40 % of cherry fruits losses occur due to lack of knowledge about fresh fruits handling and preservation, improper pre-harvest farming practices, post-harvest processing, storage conditions and transportation facilities and financial support. For improving the fresh fruit production usage of inexpensive pre and post-harvest treatments including calcium chloride applications are immediately required on priority basis for reducing the cherry losses and improving the financial condition of farmers in long run. (Muhammad ali *et al* 2010 and Agri. Stat. Dptt. Gilgit Baltistan. 2013-2014) [19, 4].
Calcium plays very important role in the fruits regarding the cell wall structure, because of its ability

to strengthen plasma membrane, structure rigidity and improve cellular signaling responses (Poovaiah and Reddy, 1993; Tsantili *et al*, 2007) [21, 21 27]. Pre-harvest calcium chloride treatments retard the aging, softening and hence delay senescence in majority of thin skin fruits (Poovaiah *et al*, 1988; Picchioni *et al*, 1998) [21, 24] and reduce disintegration and disorders such as bitter pit (Conway, 1989; Fallahi *et al*., 1997) [5, 9]. The Calcium treatment before picking of fruits is the safest and most effective method to improve the quality and extend the shelf life of fresh fruit. For cherries Ca treatments were used many years ago to reduce cracking of the fruit (Meheriuk *et al*., 1991) [18]. Earlier the post-harvest application of calcium chloride delayed the senescence in fruit with no detrimental effect on consumer acceptance and it also stabilized the plant cell wall and protects it from cell wall degrading further Post-harvest $CaCl_2$ treatments also reduced fruit softening and enhanced the (shelf life (White and Broadley, 2003). Postharvest calcium chloride solution applications directly contacts with the surface of the fruit and penetrate in cell wall and bind the cell wall with middle lamella of cells and protect cell wall degradation by increasing the integrity and firmness of the fruit (White and Broadley, 2003). Post-harvest calcium dips efficiently increase the calcium content in pericarp as well as in mesocarrp of the fruit and stabilized the membrane by making cross liking in cell wall and strengthen to the cell wall (Ippolito *et al*., 2005) [12]. Calcium application improve fruit superiority by delaying the fruits ripening, slow down the respiration and enhance the fruits shelf life and marketability the (Ishaq *et al*., 2009) [13].

By keeping in view the above various aspects this research work was conducted to study the effect of pre and post-harvest calcium chloride treatments on overall quality of sweet cherry fruits during storage at room temperature and minimize the losses of cherry fruit in Gilgit Baltistan province of Pakistan.

2. Materials and Methods

Sweet cherries were divided in to two pre and post-harvest lots in the orchard. Further research work was carried out in the analytical laboratory of PCSIR (Pakistan Council of Scientific and Industrial Research Center) in Skardu Gilgit Baltistan.

Pre-harvest treatments

About 0.5 and 1% calcium chloride ($CaCl_2$+Water) were applied as pre-harvest foliar sprays at an interval of 10, 20 and 30 days before harvest. Cherries were harvested when they obtained its optimum maturity. Harvested fruits were brought to the laboratory immediately then the fruits were be packed in foam trays and stored at room temperature.

Post-harvest treatments

Sweet cherry fruits were harvest at commercial maturity stage from the local orchard and transfer to the laboratory. The fruits were graded and good quality fruits selected and dipped in solution of (0.5 and 1%) calcium chloride for 5-10 minutes. Fruits were packed in foam trays and stored at room temperature (Hussain *et al*. 2012) [11]. The plan of study for this research work is mentioned below.

Treatments

C_0	Cherry fruit at
$C_{1\ Pre}$	Cherry fruit (0.5% Calcium chloride)
$C_{2\ Pre}$	Cherry fruit (1% Calcium chloride)
$C_{3\ Post}$	Cherry fruit (0.5% Calcium chloride)
$C_{4\ Post}$	Cherry fruit (1% Calcium chloride)

2.1 Physio-chemical analysis

The total plat count of the cherry sample was determined by the approved standard method of AOAC (2012) [1].

2.2 Sensory evaluation

All the samples of cherry fruits were examined organoleptically for color, flavor, texture and overall acceptability by a panel of 9 expert judges at every 4 days intervals. Nine point hedonic scales were used for sensory evaluation as reported by Larmond (1977) [16].

2.3 Statistical Analysis

All analytical parameters was analyzed in triplicates and the obtained data was calculated statistically by using Complete Randomized Design (CRD) two factor factorial experiments and means were compared by LSD test as followed by (Steel and Torrie, 1980) [26].

3. Results and Discussion

3.1 Physico-Chemical Analysis

3.1.1 Water Activity

The main purpose of current research work was to study the effect of pre and post-harvest calcium chloride treatments on microbial and sensory characteristics of sweet cherries grown in Gilgit Baltistan. Sweet cherry samples were analyzed at an interval of 4 days for physiochemical sensory characteristics that are mentioned as under.

3.1 Characteristics of Whole Cherry Fruit

The physiochemical analysis of Sweet cherry (*Prunus avium* L.) without calcium chloride treatment showed in Fig-1.The averages of moisture content (81%), pH (4.41), TSS (13.91^{o}Brix), non-reducing sugar (1.54 %), reducing sugar (9.86%), acidity (1.54%) and ascorbic acid (9.51 mg/ 100g) respectively. All these components are in close agreement with the findings of Nirmal *et al*. (2012) who reported pH (4.39), TSS (14.83^{o}Brix), acidity (0.68%), reducing sugar (8.14%) and vitamin C (9.32 mg/ 100g) in sweet cherries).

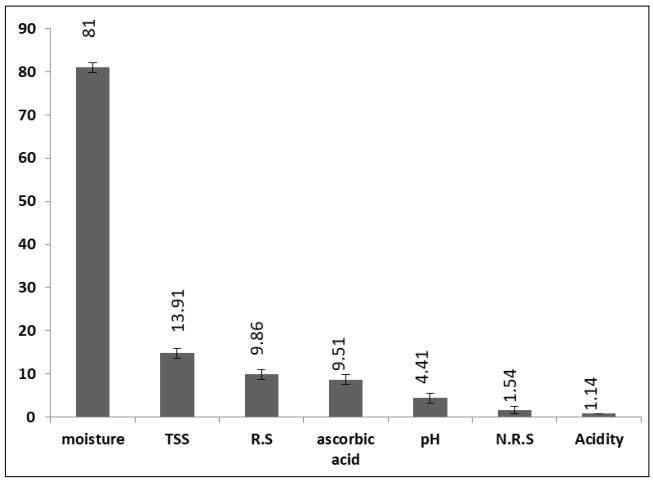

Fig 1: Physiochemical composition of fresh sweet cherry fruit. These values show the ranges in cherries and the vertical bars illustrate standard error of mean of cherry sample.

3.2 Microbial analysis

3.2.1 Total plate count.

The sweet cherry samples were examined at 4 days of interval for total plate count during storage. Initially the total plate count in treatment (C_0 to C_4) recorded as 2.00, 1.00, 2.00, 2.00 and 2.00 which finally increased up to 116, 43, 34, 19 and 16 CFU / ml during storage (Table-10). The mean value increased from 1.8 to 45.50 significantly during storage. Highest mean value was noted in C_0 (44.33) which is followed by C_1 (18.66) while lowest was noted in C_4 (8.16) which is nearby C_3 (9.83). Increment in term of percentage maximum was recorded in C_0 (98.27) while minimum was recorded in C_4 (81.50) during storage.

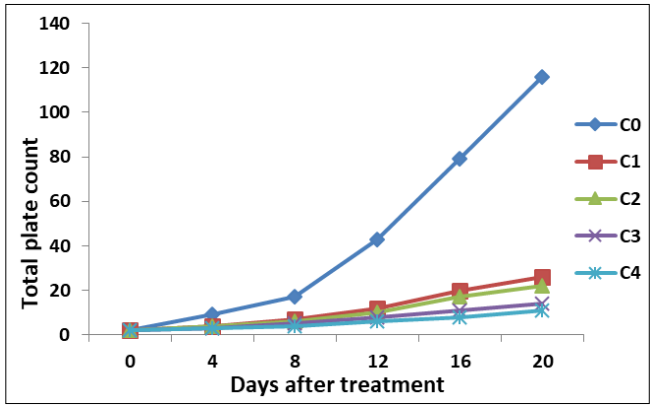

Fig 2: Effect of pre and post-harvest calcium chloride treatments on total plate count of sweet cherries.

Applied $CaCl_2$ and storage interval had considerable effect on TPC of sweet cherry samples (Appendix-x). Examination was arranged on the selected plate having countable number of colonies in the range of 25 – 250 or 30 – 300 CFU/ ml. The findings are conformity with the results of Ayub *et al*., (2008) [2] which noticed the increment of total plate count during storage. Our results also harmony with manual of food quality control 4-rew-1 and microbial analysis FAO (Rome, 1920). Conway (1982) [5] stated that calcium chloride treatments reduced decay caused due to fungal pathogens in apple and sweet cherry. This might be the inhibitory effect of calcium on decay which is related to cell wall integrity by calcium ions and that making cell wall strong and less prone to enzymes formed via fungal pathogens (Conway *et al*. 1988) [5]. Similarly Droby *et al*., (1997) [8] also reported that calcium ions can retard the microbial growth via direct inhibition of fungal growth and pectinolytic activity during storage.

4. Sensory evaluation

The sweet cherry samples were evaluated for sensory analysis such as color, flavor, texture and overall acceptability during storage. Color is one of the main attribute of the fruits that attract the consumer.

4.1 Color

The samples of the sweet cherry fruits were observed for color at 4 days interval during storage at room temperature and the data presented in table (7). As initial color scores were noticed as 8.20, 8.30, 8.40, 8.20 and 8.00 gradually decreased to 3.70, 6.80, 7.00, 7.30 and 7.40 during study time. The lower mean value for color found in C_0 (6.01) while higher was recorded in C_4 (7.78) which is followed by C_3 (7.72). The maximum reduction of color observed in treatment C_0 (54.87) and the lowest was noticed in C_4 post (7.50).Sweet cherry fruits color significantly ($P< 0.05$) changed during storage. Lysiak *et al* (2008) [17] reported that the application of 2% calcium chloride retained maximum color scores (1.61 to 3.42) as compared to untreated speech fruits samples. These results are related to study of White and Broadly (2003) which showed that calcium treatments increase integrity of cell wall during pectic polymers cross linking in fruits, that is why it impart the color of fruits rather than untreated fruit.

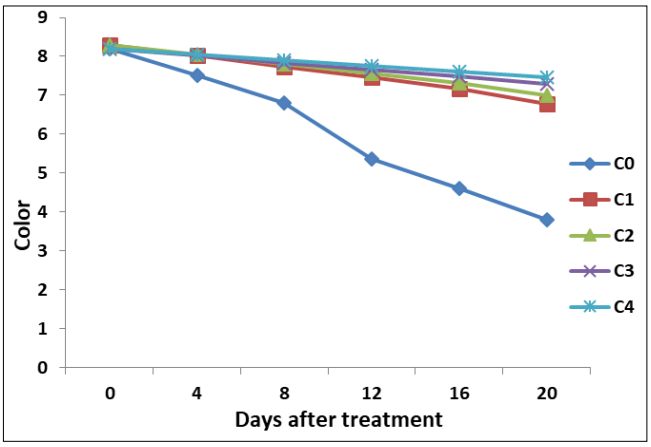

Fig 3: Effect of pre and post-harvest calcium chloride treatments on color of sweet cherries

4.2 Flavor

Flavor is one of the most important sensory attribute which is essentially having aroma and taste. The flavor of the sweet cherry fruits reduced from 8.40 to 3.60

during 20 days of storage. The highest mean value (7.83) found in C_4 while lowest value (6.05) recorded in C_0. In term of percentage maximum falling was noticed in C_0 (57.14) and the lowest was in C_4 (8.53). Flavor is volatile compound and changes occurred in it with the passage of time. The results showed that the flavor of sweet cherry samples was decreased due the declined in ascorbic acid content. Ayub *et al*., (2005) [2] observed that the reduction of flavor from (5.06 to 3.12) in Guava fruits during storage. Desirable flavor retention in plum fruit that treated with calcium chloride, this might be due to the maintenance of firmness of fruits as well as slow down the respiration rate as reported by Fast (1978).

4.3 Texture

Texture is the important aspect of the fruit and it is related to the fruit firmness and moisture content present in the sample. This study showed significant effect of $CaCl_2$ and storage on texture of sweet cherry samples during storage period. The early textural scores of cherry fruit samples were noticed as 8.20, 8.30, 8.40, 8.10 and 8.20 for (C_0, C_1, C_2, C_3, C_4) that finally declined to 3.70, 5.30, 6.20, 6.40 and 7.20. The highest mean value for texture noted in treatment C_4 (7.70) while lowest recorded in C_0 (5.95). The extreme texture value falling found in controlled sample C_0 (54.87) and minimum falling noted in C_4 post (12.19).These results are conformity with the research work of Saira *et al*., (2009) [25] thy recorded significantly maximum mean value (6.32) for calcium treated apricots as compare to untreated (3.42) sample during 10 days storage time. Prakash *et al*., (2000) [22] stated that the fruits firmness can be retained for long time by calcium treatments because calcium salts maintain the cell membrane integrity in this way the texture and firmness of fruits maintained for long time.

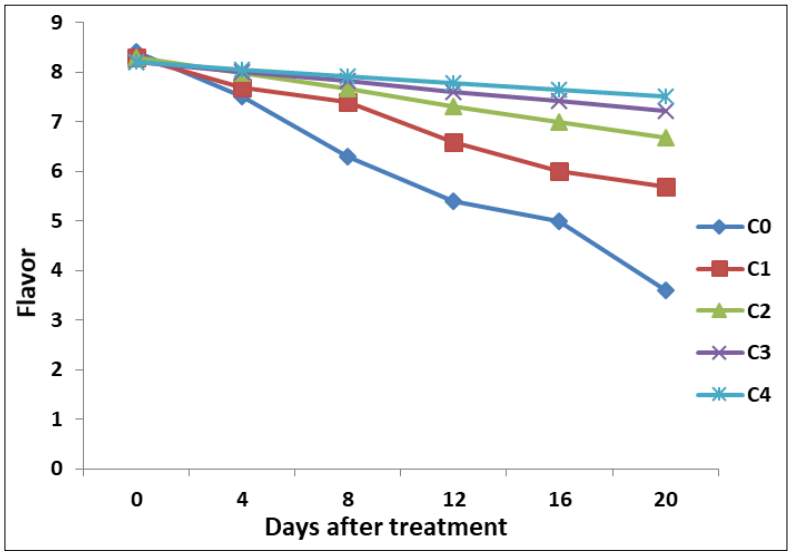

Fig 4: Effect of pre and post-harvest calcium chloride treatments on texture of sweet cherries

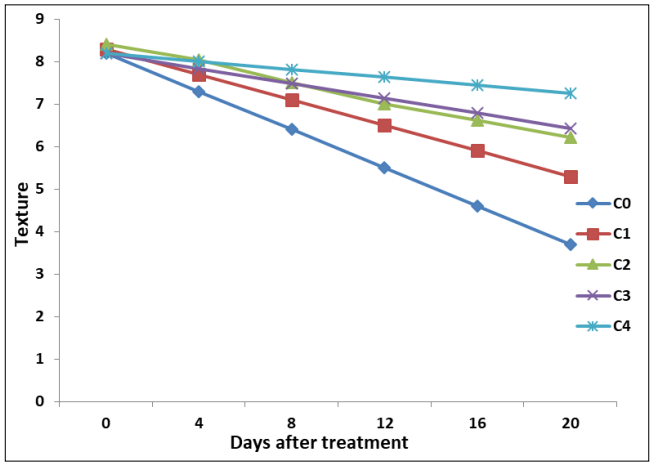

Fig 5: Effect of pre and post-harvest calcium chloride treatments on overall acceptability of sweet cherries

4.4 Overall acceptability

The sweet cherry fruit samples were analyzed for overall acceptability after every four days interval during 20 days storage. Initially the cherry fruit samples were marked by panel judges as 8.20, 8.30, 8.40, 8.10 and 8.20 respectively for treatments (C_0 to C_4) which finally reduced to 3.40 and 6.60 during storage. Significantly higher mean value noticed in C_4 (7.41) while lower value recorded in C_0 (5.82). Large reduction was occurred in C_0 (58.95) followed by C_1 pre (44.57) while smallest found in C_4 (19.51) in contrast to C_3 post (20.98).The overall acceptability based on color, flavor and texture of sweet cherry fruit was significantly ($P< 0.05$) decreased during storage. However it is noted that calcium chloride treatments maintained the overall quality of sweet cherry fruits as compare to untreated sample because it depend on

other sensory characteristic which are superior in calcium treated sample. Hussain *et al*., (2008) [11] reported that the Ca retained the firmness of fruit for long time and also delay the decaying process therefore the higher overall acceptability scores found in calcium treated sample as compared to untreated.

5. Conclusion

The overall results showed that the pre and post-harvest calcium chloride treatments had significant effect on shelf life of sweet cherries physicochemically and organolyptically. It is concluded that post-harvest treatment C_4 post that contain 1% calcium chloride showed good results in maintaining the sensory quality followed by C_3, C_2, C_1 and C_0 and it is also clarified that calcium chloride treatment minimize the microbial growth and imparted better results as compared to untreated sample. However post-harvest calcium chloride treatment had retained the maximum quality better than the pre harvest treatment.

6. Acknowledgments

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