EFFECT OF POSTHARVEST TREATMENTS TO ENHANCE THE SHELF LIFE AND QUALITY OF CHERRY TOMATO (*Solanum lycopersicon var. cerasiforme*) cv. MARILEE CHERRY RED

DAWLAT SHAH

PHK 926

DIVISION OF HORTICULTURE
UNIVERSITY OF AGRICULTURAL SCIENCES
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DAWLAT SHAH

PHK 926

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In partial fulfillment of the requirements
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in

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BANGALORE **AUGUST, 2011**

Affectionately

Dedicated to

My Beloved Parents,
my wife, Brothers and
My guide

DIVISION OF HORTICULTURE
UNIVERSITY OF AGRICULTURAL SCIENCES
BANGALORE

<u>CERTIFICATE</u>

This is to certify that the thesis entitled "**EFFECT OF POSTHARVEST TREATMENTS TO ENHANCE THE SHELF LIFE AND QUALITY OF CHERRY TOMATO (*Solanum lycopersicon var. cerasiforme*) CV.MARILEE CHERRY RED**" *submitted by* **Mr. DAWLAT SHAH, ID No. PHK 926.,** *in partial fulfillment of the requirements for the award of the degree of* **MASTER OF SCIENCE (Horticulture)** *in* **POST HARVEST TECHNOLOGY** *to the University of Agricultural Sciences, Bangalore, is a record of research work carried out by him during the period of his study in this University, under my guidance and supervision, and that no part of the thesis has been submitted for the award of any other degree, diploma, associateship, fellowship or other similar titles.*

Place: Bangalore
Date: August, 2011

(M. ANJANAPPA)
Chairman of advisory committee

Approved by

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Members : 1. ____________________
(K. N. SREENIVAS)

2. ____________________
(K.M. INDIRESH)

3. ____________________
(M.L. REVANNA)

4. ____________________
(V. PALANIMUTTU)

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EFFECT OF POSTHARVEST TREATMENTS TO ENHANCE THE SHELF LIFE AND QUALITY OF CHERRY TOMATO (*Solanum lycopersicon var. cerasiforme*) CV. MARILEE CHERRY RED

ABSTRACT

The present investigation was carried out to find out the "Effect of postharvest treatments to enhance the shelf life and quality of cherry tomato (*Solanum lycopersicon var. cerasiforme*) cv. Marilee Cherry Red" under ambient condition. The experiment was carried out in Postharvest Technology at Department of Horticulture, UAS, G.K.V.K., Bangalore, during 2010, experiment was laid out in complete randomized factorial design and replicated three times with sixteen treatments. Fruits treated with postharvest treatments, *viz.*, cold water, 2 per cent CaCl2, 4 per cent KMnO4 for five minutes and packed in150 and 200 gauges of polyethylene bags with(0.5%) and without ventilation.

Among the treatments T_3P_2- fruit treated with $CaCl_2$ at 2 percent and packed in 150 gauges of polyethylene packages with 0.5 per cent ventilation was recorded higher pH (4.96 and 4.90), total sugar (6.33%), reducing sugar (1.86%), TSS (6.10°Brix), titratable acidity (0.46%), ascorbic acid (22.90%) and non-reducing sugar (4.93%) at 9th, 10th, 10th, 11th, 13th, 13th, and 15th days after storage respectively. The minimum physiological loss in weight (5.16%), spoilage (13.33%) and the highest shelf life (15.33 days) and firmness (2.00 kg/cm^2) was recorded on 10th days after storage. With respect to organoleptic scores the maximum colour (4.33 from 5.0 score), taste (4.66), flavour (5.0), overall acceptability (4.66) after 10th days of storage.

Thus based on shelf life and quality parameters usage of 2 per cent $CaCl_2$ and packed in 150 gauges of polyethylene packages with 0.5 per cent ventilation is optimum for storage of cherry tomato at ambient temperature.

Signature of the student (DAWLAT SHAH)

Signature of major advisor (M. ANJANAPPA)

ಚೆರ್ರಿ ಟೊಮ್ಯಾಟೊ (ಸೊಲ್ಯಾನಮ್ ಲೈಕೋಪರ್ಸಿಕಾನ ತಳಿಸಿರಾನೆಫರ್ಮೆ) ತಳಿ ಮೆರಿಲ್ಲೆ ಚೆರ್ರಿ ರೆಡ್ ನಲ್ಲಿ ಜೀವನಾವಧಿ ಮತ್ತು ಗುಣಮಟ್ಟವನ್ನು ಹೆಚ್ಚಿಸಲು ಕೊಯ್ಲೋತ್ತರ ಉಪಚಾರದ ಅಧ್ಯಯನ

ಧೌಲತ್ ಷಾ.

ಸಾರಾಂಶ

ಪ್ರಸ್ತುತ ಅಧ್ಯಯನವನ್ನು ಚೆರ್ರಿ ಟೊಮ್ಯಾಟೊ ತಳಿ ಮೆರಿಲ್ಲೆ ಚೆರಿ ರೆಡ್‌ನಲ್ಲಿ ಜೀವನಾವಧಿ ಮತ್ತು ಗುಣಮಟ್ಟವನ್ನು ಹೆಚ್ಚಿಸಲು ಸಂಶೋಧನೆಯನ್ನು ಗಾಂಧಿ ಕೃಷಿ ವಿಜ್ಞಾನ ಕೇಂದ್ರ ಬೆಂಗಳೂರಿನ ತೋಟಗಾರಿಕಾ ವಿಭಾಗದಲ್ಲಿ ಕೈಗೊಳ್ಳಲಾಯಿತು. ಸಂಶೋಧನೆಯಲ್ಲಿ ಹಣ್ಣುಗಳನ್ನು ವಿವಿಧ ಕೊಯ್ಲೋತ್ತರ ಉಪಚಾರಗಳಾದ ತಣ್ಣಗಿನ ನೀರು, ಶೇಕಡಾ ೨ರ ಕ್ಯಾಲ್ಸಿಯಂ ಕ್ಲೋರೈಡ್, ಶೇಕಡಾ೪ರ ಪೊಟ್ಯಾಷಿಯಂ ಪರ್‌ಮ್ಯಾಂಗನೇಟ್ ದ್ರಾವಣದಲ್ಲಿ ೫ ನಿಮಿಷಗಳ ಕಾಲ ಉಪಚರಿಸಿ ೧೫೦ ಮತ್ತು ೨೦೦ ಗೇಜ್ ಪಾಲಿಥಿನ್ ಚೀಲಗಳಲ್ಲಿ ಶೇಕಡಾ ೦.೫ ರಷ್ಟು ಗಾಳಿಯಾಡಿಸುವಿಕೆ ಹಾಗೂ ಗಾಳಿಯಾಡುವಿಕೆ ಇಲ್ಲದಂತೆ ಪ್ಯಾಕ್ ಮಾಡಲಾಯಿತು.

ಉಪಚಾರಗಳಲ್ಲಿ ಶೇಕಡ ೨ರ ಕ್ಯಾಲ್ಸಿಯಂ ಕ್ಲೋರೈಡ್ ನಲ್ಲಿ ಉಪಚರಿಸಿದ ಹಾಗೂ ೧೫೦ ಗೇಜ್ ಮತ್ತು ಶೇ. ೦.೫ರಷ್ಟು ಗಾಳಿಯಾಡುವ ಪ್ಯಾಕ್ ಮಾಡಿದ ಹಣ್ಣುಗಳಲ್ಲಿ ಗರಿಷ್ಠ ರಸಸಾರ (೪.೯೬), ಒಟ್ಟು ಸಕ್ಕರೆ(೬.೩೩), ರೆಡ್ಯೂಸಿಂಗ್ ಸಕ್ಕರೆ(೧.೮೬), ಒಟ್ಟು ಕರಗುವ ಘನ ಪದಾರ್ಥ(೬.೧೦ ಬಿ.), ಆಮ್ಲೀಯತೆ(೦.೪೬), ಆಸ್ಕಾರ್ಬಿಕ್ ಆಮ್ಲ(೨೨.೯೦), ನಾನ್–ರೆಡ್ಯೂಸಿಂಗ್ ಸಕ್ಕರೆ (೪.೯೩)ಶೇಕಡಾ ಮತ್ತು ೯,೧೦,೧೧,೧೩ ಮತ್ತು ೧೫ ದಿನಗಳ ಸಂಗ್ರಹಣೆಯ ನಂತರ ಇರುವುದು ತಿಳಿದು ಬಂದಿದೆ. ಕನಿಷ್ಠ ಶಾರೀರಿಕ ತೂಕ (ಶೇ.೫.೧೬), ಹಣ್ಣುಗಳು ಕೊಳೆಯುವಿಕೆ(೧೩.೩೩%) ಹಾಗೂ ಗರಿಷ್ಠ ಜೀವನಾವಧಿ(೧೫.೩೩%) ಮತ್ತು ಹಣ್ಣುಗಳ ಧೃಢತೆ (೨ ಕಿ.ಗ್ರಾಂ/ಸೆ.ಮೀ) ೧೦ ದಿನಗಳ ಸಂಗ್ರಹಣಾ ಅವಧಿಯಲ್ಲಿ ದಾಖಲಾಗಿರುವುದು ತಿಳಿದು ಬಂದಿದೆ.

ಸ್ವೀಕರಣಾರ್ಹತೆಯ ಪರೀಕ್ಷೆಯಲ್ಲಿ ಗರಿಷ್ಠ ಬಣ್ಣ(೪.೩೩) ರುಚಿ (೪.೬೬), ಪರಿಮಳ(೫.೦೦), ಒಟ್ಟಾರೆ ಸ್ವೀಕರಣಾರ್ಹತೆ (೪.೬೬) ಶೇಕಡಾ ೧೦ ದಿನಗಳ ಸಂಗ್ರಹಣಾ ಅವಧಿಯಲ್ಲಿ ಇರುವುದು ತಿಳಿದು ಬಂದಿದೆ. ಆದ್ದರಿಂದ ಜೀವನಾವಧಿ ಮತ್ತು ಗುಣಮಟ್ಟವನ್ನು ಆಧರಿಸಿ ಶೇಕಡಾ ೨ರ ಕ್ಯಾಲ್ಸಿಯಂ ಕ್ಲೋರೈಡ್ ನಲ್ಲಿ ಉಪಚರಿಸಿದ ಮತ್ತು ೧೫೦ ಗೇಜ್ ಪಾಲಿಥಿನ್‌ನಲ್ಲಿ ಶೇಕಡಾ ೦.೫ ರಷ್ಟು ಗಾಳಿಯಾಡಿಸದ ಹಾಗೂ ಸಾಮಾನ್ಯ ಉಷ್ಣತೆಯಲ್ಲಿ ಸಂಗ್ರಹಣೆಮಾಡಿದ ಚೆರ್ರಿ ಟೊಮ್ಯಾಟೊಹಣ್ಣುಗಳು ಉತ್ತಮವಾಗಿರುವುದು ಅಧ್ಯಯನದಿಂದ ತಿಳಿದು ಬಂದಿದೆ.

ತೋಟಗಾರಿಕಾ ವಿಭಾಗ,
ಯು.ಎ.ಎಸ್, ಜಿ.ಕೆ.ವಿ.ಕೆ., ಬೆಂಗಳೂರು.

ಪ್ರಧಾನ ಮಾರ್ಗದರ್ಶಕರ ಸಹಿ
(ಎಂ. ಆಂಜನಪ್ಪ)

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INTRODUCTION

I. INTRODUCTION

Tomato (Solanum *Lycopersicum* L.) is one of the world's most commercially produced vegetable and is also one of the world's major food crops. Cherry tomato *(Solanum lycopersicum* var. *cerasiforme)* is botanical variety of cultivated tomato or smaller garden variety of tomato. It is a botanical variety of the cultivated tomato or a smaller garden variety of tomato, having chromosome number 2n=24. It is thought to be the ancestor of all cultivated tomatoes. They are often about cherry sized which is probably how the small tomatoes got their name. They are round to oblong with colors which may range from green-streaked heirloom varieties to rich glossy red. Despite being small in size, cherry tomatoes are packed with flavor and they are often quite sweet to boot.

In the world leading tomato growing countries are China, USA, Turkey, Italy and India. In India tomato is cultivated extensively in the states of Bihar, Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh…etc. Tomato is grown in an area of 5.20 Lakh hectares, with an annual production of 7.42 Million tones in India (Anon., 2003). In Karnataka it grown in an area of 35,429 hectares with an annual production of 9.52 Lakh tones (Anon, 2009).

Cherry tomatoes are generally considered to be similar but not identical to the wild relative of the domestic tomato. It is widely cultivated in Central America when the Conquistadores arrived and is distributed in California, Korea, Germany, Mexico and Florida (Anon., 2009a). There are a number of uses for cherry tomatoes. They are excellent in salads and other appetizers and can be used whole or cut in half. Some cooks enjoy roasting or grilling them, while others eat them raw as snack tomatoes. People happen to like them in guacamole and salsas. The sweetness of cherry tomatoes can complement a wide range of foods and it intensifies with cooking. They are perfect for making processed products like sauce, soup, ketchup, puree, curries, paste, powder, rasam and used in pasta and sandwich. Unripe green fruits are used for preparation of pickles and chutney. They are often more sour than standard tomatoes.

It has good nutritional value with total carbohydrate (6.0 g), sugars (4.0 g), protein (1.0 g), calcium (1.0 %), and iron (2.0 %). They are a great source of vitamin C (13 mg/100g), dietary fibre (2.0 g), vitamin A (25 I.U) and vitamin K and also a good source of vitamin E(Alpha Tocopherol), thiamine, niacin, vitamin B6, foliate, phosphorus, copper, potassium and manganese. They are low in sodium (7.0 mg), and very low in total fat (0.3 g) saturated fat(0.1 g) and Cholesterol(0.0 mg). Cherry tomatoes are also rich in medicinal value. Its vitamin C will enhance the iron absorption and it increases the haemoglobin. It is a diuretic, perfect vegetable for a diet which helps to eliminate toxins while person is on a diet. The pulp and juice are digestible, mild aperients and promoters of gastric secretion and acts as blood purifiers. It has antiseptic properties against intestinal infections (Anon., 2009b). And it has powerful anti-cancer properties, useful against mouth cancer and sour mouth. Acidosis is quite common in our society leading to many ailments such as headaches, fatigue, sleeplessness, absorption problems, arteriosclerosis, muscular aches and loss of calcium from the bones. Thus, these problems can be prevented by adding cherry tomatoes to diet as they have an alkali power (Anon., 2009b).

The increase in production of cherry tomato is resulting in market glut and economic loss to the farmers, as there are no proper post harvest technological methods for storage. Therefore, emphasis should be given for conservation after harvest along with the endeavors to further boost the production. Hence, research has to be focused on development of post harvest management methods by which the quality of the produce is maintained from deterioration between harvest and consumption, so as to maintain the supply of the fresh tomatoes through proper channel, to consumer of the country around the year. This will avoid glut, scarcity, price fluctuations and loss of production and ensure supply of superior quality of tomato fruits with enhanced storage life, which may promote even export of cherry tomatoes.

Cherry tomato fruits are considered to be highly susceptible to moisture loss leading to shriveling and loss of fresh appeal. The principal causes for postharvest losses are infection by pathogens, rough handling, improper packaging, improper mode of transportation and unhygienic conditions. During storage, the produce quality deteriorates due to the physiological activities such as increased rate of respiration and loss of moisture. In India where the bulk of urban population doesn't have either cold storage or controlled or modified atmospheric storage facilities to a necessary extent, development and standardization of techniques that can extend keeping qualities at ambient conditions are extremely important. In developed countries, tomatoes in general and cherry tomato in particular are sole in prepackages under cold chain but this kind of arrangements may not be possible in India as establishment of cold storages and cold chain for retailing involves lots of money and development of infrastructure. Therefore, the best way is to find out some low cost technology to extend shelf life and to retain quality under ambient condition at both farm and market or retail level.

Hence the present investigation was undertaken to study the “Effect of Postharvest Treatments to Enhance the Shelf life and Quality of Cherry Tomato *(Solanum lycopersicon var. ceraciforme)* Cv.Marilee Cherry Red ", with the following objectives:

a) To Study the effect of different gauges of polyethylene packages with or without ventilation to increase shelf life of cherry Tomato.

b) To study the effect of pre-treatments on shelf life of cherry tomato.

c) To study physical, chemical and sensory characteristics of the packed cherry tomato.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Physiological and biochemical processes such as transpiration, respiration and ripening continue after harvesting of fruits and vegetables. Cherry tomato fruit is a cultivar of tomato which has a very short life and it is perishable after harvest which is one of the major drawbacks for long distance transport and marketing. The extension of shelf life of cherry tomato with minimum loss during storage would enable efficient transport and storage of cherry tomato. In this chapter an attempt is made to collect the reviews of work on shelf life of cherry tomato traits with the aids of different gauges of polyethylene covers with or without ventilation and chemicals like calcium chloride and potassium permanganate. Due to non availability of sufficient reviews on cherry tomato the reviews are also collected on tomato, fruit-vegetables and fruits.

Several post harvest technologies have been developed to minimize the post harvest losses. Post harvest activities such as curing, washing, waxing, and coating with fungicide have contributed to minimize post harvest losses in the last decade. Modern package containers involving use of corrugated fiber board boxes in lien of conventional wooden boxes tray packing with liner and low/high density polyethylene. Polyethylene films have shown tremendous effect on preserving shelf life as well as maintaining quality of tomato and other fruits and vegetables during long term storage.

2.1 Effect of chemical treatments on physical parameters of fruits and vegetables during storage

2.1.1 Calcium Chloride

Calcium chloride dip (8%) of mature green 'Julie' mangoes retarded the ripening by delaying the peel colour development and textural softening. The fruits had a higher organoleptic rating and the weight loss was lower with a shelf life of 14 days as compared with a shelf of 5 days for untreated fruits (Mootoo 1991).

Mangoes treated with different concentrations of $CaCl_2$ solutions (2, 4, 6 and 8%) kept under ambient and cold storage conditions had a retarded colour development and textural softening as compared to untreated fruits. The fruits dipped in six per cent $CaCl_2$ solution showed the lowest weight loss than other treatments and the shelf was extended up to nine and fourteen days, under ambient and cold storage as compared to four and seven days for control (Sundaralingam 1996).

Vishalnath and Bhargava, (1998), reported that physiological and pathological losses and changes in color of tomato at three days interval under ambient condition. Where under low temperature these could be stored up to 15 days beyond which the fruits lost their original color. Tomato treated with calcium nitrate (1%), Bavistin (0.1%) and virsoil (5%) maximum firmness and reduced both pathological and physiological loss.

Apple cv. Red Delicious fruits treated with $CaCl_2$ (2%) recorded the lowest physiological loss in weight after 90 days of storage. The fruits treated with $CaCl_2$ (0.5%) + SO_2 (0.5%) showed the highest sugar, TSS and organoleptic ratings after the storage period (Bhartiya *et al.,* 1998).

Cucumber fruits treated with calcium chloride had a storage life of more than 14 days as compared to control (10 days). The fresh weight reductions were lower and inhibited the decrease in ascorbic acid content (Kwon *et al.,* 1999).

Cantaloupe cylinders (melon) were dipped for one min in 2.5% solutions of either calcium chloride ($CaCl_2$) at 25°C or calcium lactate at 25 and 60°C. Both calcium salts maintained melon firmness throughout cold storage. Calcium lactate imparted undesirable bitterness to the fruit pieces. No significant differences were observed in the physiological behaviour of the treated fresh-cut compared to just-cut samples (Irene and Diane*,* 2000).

Treating of strawberry fruits with 1, 2 and 3 per cent of $CaCl_2$ retained the highest level of total sugars, acidity and ascorbic acid and exhibited the highest overall acceptability. The shelf life was extended to seven days but the control fruit had a shelf life of one day (Upadhayaya and Sanghavi, 2001).

Jitender Kumar *et al.* (2003) reported that physiological loss in weight of guava fruits were increased progressively irrespective of storage condition. However, the highest physiological loss in weight(PLW) was recorded in case of control fruits. High respiration could be correlated to their more shriveling, browning and loss of glossiness which ultimately made the fruits unmarketable. While chemical treated fruits showed less physiological loss in weight(PLW).

Durba *et al.* (2006) studied the effect of harvesting method and calcium chloride on shelf life of tomato. Tomato (Hybrid Gootya) with stalk and without stalk were harvested at breaker stage and dipped in distilled water and different concentrations of calcium chloride *viz.* 0.25%, 0.50%, 0.75% and 1.0% for fifteen minutes. The maximum shelf life and firmness was noticed in 1.0% calcium chloride treated fruits (16.50 days) followed by 0.75% calcium chloride treated fruits (16.17 days).

Tomato fruits treated with gibberellic acid (0.1, 0.3 and 0.5%), calcium chloride (0.5, 1.0 and 1.5%) and salicylic acid (0.1, 0.2 and 0.4mM) were studied. As a result the least decay percentage was observed in the fruits treated with GA_3 0.1%, $CaCl_2$ 1.5% and SA 0.4mM.

Hence, it could be concluded that postharvest treatment with GA_3(0.1%),$CaCl_2$ (1.5%) and SA(0.4mM) has the potential to control decaying incidence, prolong the storage life and preserve valuable attributes of postharvest tomato, presumably because of its effect on inhibition of ripening and senescence processes(Nirupama *et al.*, 2010).

2.1.2 Potassium permanganate

Mahajan and Chopra (1994) reported that titratable acidity content of apple declined gradually with the advance in storage period. The fruits packed along with $KMnO_4$ recorded the highest average titratable acidity thorough out the storage period whereas control fruits had the lowest acidity content.

Polyethylene package and $KMnO_4$ treated custard apples were found best for reducing fruit spoilage and physiological loss in weight. These fruits retained the natural colour with increased storage life compared to other treatments. Brown paper wrapping was also effective in reducing ripening with a decrease in titratable acidity and ascorbic acid content (Bhadra and Sen 1999).

2.2 Effect of chemical treatments on chemical parameters of fruits and vegetables during storage

2.2.1 Calcium Chloride

Cucumber fruits treated with calcium chloride had a storage life of more than 14days as compared to control (10 days). The fresh weight reductions were lower and inhibited the decrease in ascorbic acid content (Kwon *et al.,* 1999).

Mahajan and Sharma (2000) reported that mango Cv. Dashehari treated with $CaCl_2$ (6%) turned out to be the most effective treatment in reducing the weight loss and more steady changes in total soluble solids and sugars compared to control.

Praveen Jholgikar (2001) reported that calcium plays an important role in many physiological and biochemical process in plants. Its role in extending shelf life of fruits by maintaining firmness and reducing respiration has been clearly documented. The involvement of calcium in metabolism for retardation of respiration was postulated be way of reducing degradation and internal breakdown of tissues.

In a study conducted by Narayana *et al.* (2002) post harvest application of calcium chloride on ripening, shelf life and quality of banana showed minimum weight loss at sixth day of storage and found to be involving in delay ripening process maximum green life and shelf life was achieved. The PLW was low, whereas pulp to peel ratio, TSS and acidity increased during storage. The organoleptic score of ripe fruits for color, flavour, texture and overall acceptability was better.

A study was conducted by Gopikrishna and Haribabu (2002) on shelf life of guava fruit. The lowest PLW and highest shelf life was noticed in fruits treated with four per cent calcium nitrate whereas high PLW and minimum shelf life was observed in control. This is due to the fact that calcium is known to retard the rate of respiration, decay and checks cellular disintegration by maintaining protein and nucleic acid synthesis.

The acidity content of guava fruits under storage showed a decreasing trend after 6^{th} day of storage in all the treatment in an investigation carried out by Mishra *et al.* (2003) Most of the treatments proved ineffective in keeping the acidity level low during storage. Concentrations of calcium chloride (0.20 to 0.50 per cent) have been found effective in asserting acidity during extended storage period.

Shivani *et al.* (2005) reported the effect of polyethylene packaging and chemical treatments on shelf life of sapota fruits. The fruits were packed in polyethylene of different thickness *viz.* 50, 100 and 150 gauge polyethylene was used for individual wrapping and lining of fruits. Fruit packed individually in different thickness polyethylene were found better in reducing decay loss retained maximum firmness, maximums acidity and ascorbic acid content. Maximum fruit firmness was retained in fruit packed individually in 100 gauge polyethylene. Fruits packed individually in 150 gauge polyethylene recorded maximum TSS where 100 gauge polyethylene packed fruit in both the wrapping and lining showed high acidity and ascorbic content. At ambient condition Ca $(NO_3)_2$ 0.5 and l.0 per cent Ca $(NO_3)_2$ l per cent + Benlate 1000 ppm were found to be effective in reducing spoilage and physiological loss in weight (PLW) and maintaining fruit firmness.

Navadeep Kaur *et al.* (2005) conducted a study on storage behavior of pear. Pear fruits were stored using calcium chloride (6,8 and 9%) as post-harvest treatment and thereafter individually wrapping in news paper, polyethylene and butter paper. It revealed that calcium chloride six per cent in combination with individually seal packing with polyethylene bag (100 gauges) proved to be the most efficacious in reducing the weight and spoilage losses with high organoleptic rating. Calcium chloride 6.0 per cent with the wrapping in butter paper was the next best treatment. It was concluded that fruit can economically be stored at ambient temperature up to 18 days.

Tomato fruits were dipped in 0, 0.5, 1.0 and 1.5% of calcium chloride and evacuated air about 350 – 400 mm-Hg for 10 minutes (infiltration). Then the fruits were placed on foam tray and wrapped with PVC film. The fruits were kept at 5°C, 85% RH. It was found that vitamin C content and respiration were increased, while total solids and total acids were slightly decreased. The fruits which dipped in 0.5% calcium chloride infiltration could delay ripening (Sompoch and Chanthaporn, 2006).

In a study conducted by Akath Singh *el al.* (2008) on weight loss, decay and chemical changes associated with ripening of strawberry fruit during storages at ambient condition (13-24°c and RH 70%). Weight loss and decay loses were minimum in fruits treated with $CaCl_2$ @ 2 per cent and packed with high density polythene. Maximum amount of ascorbic acid and anthocyanin were responsible for reducing the color and quality of strawberry at 6^{th} day of storage. TSS and acidity was least in fruits packed in perforated HDPE.

Tomato fruits treated with gibberellic acid (0.1, 0.3 and 0.5%), Calcium chloride (0.5, 1 and 1.5%) and Salicylic acid (0.1, 0.2 and 0.4mM) were studied. The significant impact of treatment is found on the least decay percentage in the order of fruits treated with GA 0.1%, $CaCl_2$ 1.5% and SA 0.4mM. Hence, it could be concluded that postharvest chemical treatment with GA, $CaCl_2$ and SA has the potential to control decaying incidence, prolong the storage life and preserve valuable attributes of post harvest tomato, presumably because of its effect on inhibition of ripening and senescence processes (Nirupama *et al.,* 2010).

2.2.2 Potassium Permanganate

Naresh Kumar *et al.* (2001) reported that guava fruits under control showed maximum acidity (0.45 %) and minimum in chalk impregnated with $KMn0_4$ (0.42 %). Acidity of the fruits increased up to two days and then decreased upto end of storage. Decrease in acid content may be due to conversion of acid into sugars by enzymes invertase. Maximum total sugar and reducing sugar were recorded in news paper impregnated with KMn04 and minimum in control irrespective of storage period.

Ketsa *et al.* (2006) studied the effect of bulk packaging on 'Klugai khal' bananas which were packed in perforated polyethylene bags with or without potassium permanganate as ethylene absorbent. Banana stored in bags with ethylene absorbent remained green for 6 weeks compared to 3 weeks in hilts packed with $KMnO_4$.

2.2.3 Other Chemicals

Jadhav *et al.* (1992) reported extending the shelf life of custard apple fruit by using growth regulator and packaging, 400 ppm 2,4-D + 0.5 per cent topsin + 100 gauge polyethylene packaging with two per cent was more effective in enhancing the storage life of fruit at ambient temperature for five days without affecting fruit quality and slowed down the ripening process and maintained higher organoleptic qualities till end of storage. The fruits packed in polyethylene bag showed low loss in weight during storage period. Packed fruits showed (33.2 %) loss in weight as compared to 59.5 per cent in unpacked fruit at 7^{th} day. Polyethylene was also found beneficial in arresting the ripening process. 2, 4-D and topsin at 5 per cent showed significantly lower loss in weight and steady increase in TSS (25.0 7 %) at 5^{th} day and slight reduction in 7^{th} days of storage. However acidity was found higher in fruit treated with chemical.

Chlorine dioxide (ClO_2) gas treatment with different concentration 0, 5, 10, 20, and 50 mg l^{-1} on postharvest physiology and preservation quality of green bell peppers was studied. The vitamin C content, titratable acidity and total soluble solids of the peppers treated by all the tested CIO_2 gas did not significantly change during the storage. The results suggested that ClO_2 gas treatment effectively delayed the postharvest physiological transformation of green peppers, inhibited decay and respiration, maintained some nutritional and sensory quality, and retarded malondialdenyde(MDA) accumulation(Hua *et al.*, 2007).

Sudha *et al.* (2007) studied the value addition for long term storage of sapota fruit products. He concluded that to avoid the huge wastage, the fruits could be processed and preserved properly value added products have increased the shelf life. Among the different products from sapota from dehydrated sapota made from GA_3 (treated fruit lower ascorbic acid and higher total sugar), retarded the oxidation and metabolism, so value addition of sapota fruit considerably improved the shelf life marketability and give higher net profit.

In a study conducted by Deepak Gangwar *et al.* (2008) on post-harvest of chemical treatment on shelf life and physico-chemical quality, Banana bunches were dipped in aqueous solution of growth regulators 2,4-D (25, 50, 125, 250 & 300 ppm) 1AA, 25 and 50 ppm and GA_3 (150 and 200 ppm) concentration for 30 second, air dried and kept at ambient condition (25 to 30°C) extended shelf life up to 21 days.

2.3 Effect of packaging on physical parameters of fruit and vegetables during storage

Chandakari and Kambharge (1979) explained the utility of firm thickness and extent of perforations. Among the various packaging used for storing oranges, polyethylene film of 100, 150 and 200 gauge with 0.3 and 0.4 per cent area of vents were found better for extending shelf life of fruits at ambient temperature (27°C).

Jain *et al.* (1982) studied the shelf life of Ber fruits (cv. Umran). Fruits packed in perforated polyethylene bags were stored up to 27 days. But only fruits stored up to three weeks were acceptable organoleptically.

Tarkase and Desai (1989) reported that orange fruits stored in polyethylene bags with 0.3 per cent ventilation were found highly effective for prolonged shelf life when compared with the results of fruits stored in un-perforated polyethylene bags.

Packagings play a dominant role in storage and marketing activities of fruit industry. The increase in consumer demand for good quality fruits necessitated to search for suitable packaging material which can preserve the quality, the sensory and nutritive value of fruits till consumption and is also economically proficient and safe. The quality deterioration during storage in most of the cases are of chemical, physico-chemical, physical and microbiological origin and rate of changes many be influenced by packaging material (Puri 1989).

Jain and Chitkara (1990) reported that 200 gauge polyethylene packages can be directly correlated with the PLW of the Ber fruits where the polyethylene packages were effective in reducing the PLW and ultimately the losses in juice and pulp content because of providing better sealing and avoid of transportation losses when compared with the fruits packed in paper and gunny bags.

Oranges packed in LDPE or HDPE imperforated bags and stored at 28-35°C for 15 days had the lowest weight loss and pH and highest TSS than the perforated bags (Efiuvwevwere and Oyelade, 1991).

Sealed packaging of orange and lemons with high density polyethylene film delayed softening and inhibited weight loss and deformation of the fruits compared to the fruits subjected to cold treatment The fruits also had better appearance and were firmer than non sealed fruits and lemons with high density polyethylene film delayed softening and inhibited weight loss and deformation of the fruits compared to the fruits subjected to cold treatment. The fruits also had better appearance and were firmer than non sealed fruits(Ben yeshoshua and Illana Kobiler, 1991).

Jadhav *et al.* (1992) reported that titratable acidity content of custard apple under open storage condition was low (0.27 %). It was increased significantly (0.38%) with increase in storage in polyethylene bags and further reduction in acidity was observed towards senescence of fruits. On 5th day of storage the acidity was significantly higher in the fruits packed in polyethylene bag (0.28 per cent) than the fruits kept open, showed higher. This indicated that besides reduction in weight loss and maintaining turgidity of fruits, polyethylene bag was also found beneficial in arresting the ripening process of custard apple.

Kariyanna *et al.* (1992) reported that the sapota Cv. Kalipatti fruits packed in polyethylene bag (150 gauges) with one per cent area of vents reduced PLW significantly and fruits packed in polyethylene bag possessed better sensory appeal when compared to other treatments.

Tomatoes harvested at breaker stage and packed in 300 gauges of polyethylene bags with three vents recorded minimum changes in moisture, firmness, total soluble solids, acidity and sugars than the control fruits. The organoleptic score was high in above acceptable limits for these fruits with a shelf life of 42 days (Naik *et al.,* 1993).

Tomato were packaged inindividual wrapping and control at two storage temperatures (13°C and 24°C) for a period of 50 days after harvest. Several physicochemical qualities attributes i.e. weight loss, decay percentage, coloration of the fruits were evaluated and compared. Bagging of fruits were efficient in reducing weight loss, but detrimental in increasing decay and secondary infection. Individuals wrapping was practically preferred, it reduced the percentage of decay. Storage at 13°C was more favorable for prolonged shelf life but storage at 24°C was the best for rapid ripening and good red color of the fruits (Mustafa and Mughrabi, 1994).

In a study conducted by Prasad *et al.* (1994) on effect of packaging material on the shelf life of pomegranate fruits Cv. Jolore Seedless during storage. Use of proper package material reduces physiological loss in weight and increasing period of storage from the various packaging material such as paper, polyethylene, gunny and refrigerator. The refrigerator packaging was recorded minimum physiological loss in weight due to low temperature minimum enzymatic activities during storage. TSS of fruits increased with increasing period of storage.

Venkatesha and Reddy (1994) observed that packaging of guava fruits in polyethylene bags had remarkable effect on reducing physiological loss in weight (PLW) and retention of firmness, greenness and organoleptic qualities compared to control fruits. Among the bagged ones fruits held in 300 gauge polyethylene bag with ventilation recorded least physiological loss in weight, retained more firmness as well as greenness and extended shelf life up to 10 days as against 3 days in control fruits

Singh and Narayana (1995) concluded that packaging of mango fruits Cv. Dashehari in polyethylene bags with 0.5 per cent ventilation extended storage life and marketability and preserved the quality better than control fruits up to 10 days.

Banana cv. Magrabi wrapped in polyethylene stored for one month had acceptable quality parameters as determined by TSS, moisture content, acidity, reducing sugars, total sugars and organoleptic traits, but the control fruits were misshapen and decayed after storage (Elzayat, 1996).

Okra pods were stored on trays or in rigid, vented containers(clam-shells) fitted with absorbent bottom pads. Trays were either wrapped with plastic film (+/- perforations) or left unwrapped. There was less weight loss for okra stored in clamshells and perforated, wrapped trays than on un wrapped trays (Steven, 1996).

Sapota fruits treated with gibberellic acid (75 ppm) and packed in polyethylene bag (100 gauges) with 1-2 per cent ventilations in modified atmosphere(10-13°C temperature) fruits can be stored up to 18 days with minimum spoilage and retard respiration and transpiration (Waskar and Nikam 1997).

Naik and Rokhade (1997) reported that ber fruits stored in perforated sealed polyethylene bag showed minimum PLW. This might be due to characteristic feature of polyethylene in reducing the rate of transpiration by restricting the diffusion of gases and feedback mechanism.

Minimum weight loss of (77.5 g) was recorded for tomatoes packed in black polyethylene bags. While a maximum weight loss of (224.16 g) occurred for unpacked fruits. The best colour retention and firmness was noted in black polyethylene bags (Badshah *et al.,* 1997).

Ali Batu and Keith Thomson (1998) studied the effect of modified atmosphere packaging on postharvest qualities of pink tomato. He suggested that sealed packaging, especially using with PE50 and PP films, delayed the development of the red color of tomato until thirty days of storage and those tomato were also still very firm even after sixty days of storage. Tomato sealed within PE50 and PP films had also the lowest weight loss and the highest soluble solids after 60 days of storage.

Polyethylene package and $KMnO_4$ treated custard apples were found best for reducing fruit spoilage and physiological loss in weight. These fruits retained the natural colour with increased storage life compared to other treatments. Brown paper wrapping was also effective in reducing ripening with a decrease in titratable acidity and ascorbic acid content (Bhadra and Sen 1999).

Chilli cv. Pusa Jwala packed in 100 gauges of polyethylene had the lowest PLW (5.5%) on 25th day of storage, but highest ascorbic acid content was in fruits packed with 300 gauges of polyethylene. Respiration rate decreased in polyethylene packed fruits (Brar *et al.,* 2000).

Ingawale *et al.* (2001) reported that custard apple fruits packed in 100 gauge polyethylene cover of 2 per cent ventilation showed less loss in weight and external appearance was good at all the storage periods compared to control. Besides reduction in weight loss and maintaining turgidity of fruits, polyethylene packaging was also found beneficial in arresting the ripening process of custard apple.

Elif Das, *et al.* (2002) worked on effect of controlled atmosphere storage, modified atmosphere packaging and gaseous ozone treatment on the survival of *Salmonella enteritidis* on cherry tomato. As a result, in the case of initial population of 3.0 log10 cfu/tomato, cells died completely on 4^{th} day in MAP storage and on 6^{th} day in both CA and air storage. The death rate of *S. enteritidis* on the surfaces of tomato that were stored in MAP was faster than that of stored in air and in controlled atmosphere storage.

Kinnow Mandarin fruits stored in polyethylene bags had the lowest physiological loss in weight (4.0%) compared to other treatments (Rana *et al.,* 2002).

Laxman Kukanoor (2002) reported that ventilated polyethylene bag significantly reduced the physiological loss in weight of mango fruits. Poly bag acts as barrier for moisture movement resulting in buildup of high relative humidity in the vicinity of fruits thereby retarding moisture loss through transpiration. The maximum per cent of rotting of fruits was found in poly bag. This may be correlated to the congenial atmosphere of spoilage vapour from the fruit through transpiration. The level of ascorbic acid and acidity were found to be always higher in polyethylene bag.

Choudhary *et al.* (2003) reported that packaging is very important in perishable fruits like sapota to check the physical damage and appearance of fruit during marketing, storage and transportation. Among the various packaging materials used for assessing the storage behavior the fruits stored in paper cartoons with polyethylene bags (100 gauges) having 1-2 per cent ventilation showed the best result with shelf life and high total soluble solids with normal physical appearance and good marketability.

Minimum physiological loss in weight (PLW) was recorded in kinow mandarin fruits sealed in high density polyethylene (HDPE) whereas highest physiological loss in weight was recorded in control *i.e.,* unsealed fruits also the peel percentage. Peel thickness and spoilage was minimum in fruits sealed in 150 gauge HDPE compared to fruits sealed in 50 and 100 gauge polythene packages after 30,40 and 60 days of storage (Sukut kaur *et al.,* 2004).

Anju Bhat (2004) reported that Ber fruits stored in polyethylene bags having $KMn0_4$ recorded least physiological loss in weight, least ripening per centage, maximum firmness and recorded high organoleptic scores.

Sudhir Yadav *et al.* (2005) reported that during storage the ber fruits were inspected at each interval for spoilage. No spoilage was observed up to 3 days of storage. Subsequently on 6^{th} and 9^{th} day of storage fruits found infected with *Pencilliumm expannun, Aspergilus niger and Rhizoctonia stolonifer.* Incidence of these organisms increased with storage period particularly under polyethylene bags which are not perforated.

Dinesh and Gautam (2005) reported that, fruits of custard apple stored under ambient conditions in ventilated polythene bags were showed minimum fruits rot (10%) and minimum physiological loss in weight (9%) when compared to fruits stored in unventilated polyethylene packs after 15 days of storage.

Sudhir Yadav *et al.* (2005) studied the bio-chemical and oraganoleptic quality changes during storage of ber fruits in different packaging materials. They reported that an increase in PLW of ber fruits in all treatments with period of storage was obvious as the different physiological process, like transpiration and respiration, continued in fruit even after harvest. However, minimum PLW was found in perforated polyethylene bag followed by sealed polyethylene bags and plastic bags throughout the storage period.

The polyethylene packaging was used by Ingawale and Jadav (2005) to prolong the shelf life of custard apple. The fruits were stored at ambient condition polyethylene bags having 50, 100, 200, 250 gauge and with 0.5, l.0, 2.0 and 2.5 per cent ventilation respectively. The fruit packed in 100 gauge polyethylene bag with 2 present ventilation showed less loss in weight, good appearance and also daily softening, significantly increase TSS, sugar content acidity and decrease chlorophyll content.

In a study conducted effect of ventilation on shelf life and quality of peaches by Dinesh Singh *et al.(* 2005), peach fruits were packed in transparent 200 gauge polythene bag punched uniform by (0.135 sqcm^2) with 2.5per cent ventilation and stored under ambient condition (20-41°C temperature and 65 per cent relative humidity) was found minimum weight loss (0.8 per cent) and minimum fruit rot (10.9 per cent) compared to control (39.3 per cent)after 6th days of storage and extended the shelf life by 4 days compared to un punched polyethylene bag.

Maximum sapota fruit firmness was retained in fruits packed in 100 gauge polyethylene bags and was found better in reducing decay loss as compared to use of other polyethylene lining *viz.,* 50 and 150 gauges (Shivani Jindal *et al.,* 2005).

Losses in the gross weight of the fruits, physiological loss in weight, bruise damage and spoilage were generally lower in fruits that were packed in polyethylene bags, such fruits also exhibited slower decrease in fruit firmness and slower respiration rate and fruits from such packages were of better quality as compared to packaging treatment without the use of polyethylene liners (Thakur Reddy and Lal Kaushal, 2005).

Mondal *et al.* (2006) reported that when tomatoes are enclosed in polyethylene bag and stored at 25°C they are more resistant to oxidative stress and less chilling injury than unenclosed fruit stored at the same temperature.

Rana (2006) reported that polyethylene film package not only ensures that the packed fruits reach the consumers in their original condition without any loss but also prevent the shortening of shelf life and quality impairment of fruits as influenced by outer atmosphere.

Apart from being economical polyethylene packages also fulfill all the functions necessary for protection and distribution.

Shelf life of custard apple fruits could be extended up to seven days when packed in individual polyethylene films of 75 gauges at ambient storage condition as against four days in untreated and unpacked fruits (Masalkar and Garande, 2007).

Bell pepper stored in polyethylene bags and stored at 0,10 and 20°C.The best correlation between visual color evaluation and the objective color measurements, was obtained for the a* (greenness) measurements. Panelists could discriminate between samples stored at 0 and 10°C and polyethylene bags in contrast to a* measurements which did not differ significantly. Calculated hue angles exhibited the highest discriminatory ability of any of the objective color parameters. Green bell pepper dices were dipped in two metabisulphite solutions, 2400 and 3600 mg. kg^{-1}, respectively (Sigge *et al.,*2007).

Pods of the Hot Red' and Hot Yellow' cultivars of hot peppers were either sealed packaged in low density polyethylene bags (LDPE) or wrapped as a control in paper bags and examined for quality. Hot Yellow' stored better and was less perishable than Hot Red' at all three temperatures. Both cultivars stored best at 10°C, but there were severe limitations to pod quality and shelf life due to decay in the LDPE bags and extensive shrivelling in the paper bags. Decay caused by *Erwinia carotovora* was hastened by the moisture-laden environment caused by the high relative humidity in the LDPE bags (Majeed Mohemmed., 2007).

Muneruzzaman *et al.* (2009) Showed effect of harvesting, poly bags, CaC_2^+ polyethene and storage conditions on the post harvest quality of tomato cv. Roma VF. Tomato fruits cv. Roma VF at half ripe stage showed less decay, highest vitamin C., increase in reducing and non-sugar and increase in storage life with polyethylene bags as compared to tomatoes treated with calcium carbide and packed in polyethylene bags.

Shehla Samimi and Tariq Masud (2007) showed that treated tomato fruits with polyethylene showed lower weight loss (%), flavor, texture, color and overall acceptability was higher in treated fruits as compare to control at the red stage of ripening.

2.4 Effect of packaging on chemical parameters of fruits and vegetables during storage

Dhillon *et al.* (1981) found that level of sugars in pear fruit under storage was influenced by the calcium and maximum sugar percentage was recorded in fruits treated with $CaCl_2$ (6%) during storage up to 23 days of storage contrary to this, a wrapping treatments decreased the sugar content marginally and this marginal difference in sugar percentage particularly in polyethylene wrapping can be attributed to the slow biochemical changes in fruits.

Nagaraju *et al.* (1992) storage life of sapota Cv. Kallipatti fruits was extended up to 12 days in zero energy cool chambers. The fruit in cool chamber significantly decreased physiological loss in weight; retain more firmness, delayed initiation of rotting (45.5 %) and shriveling (31.11 %). The rate of changes in total soluble solids, acidity, reducing sugar and total sugar was slow as compared to rapid changes in fruit stored in ambient condition.

Yalleraddi and Radder(1996) reported that the total soluble solids content of fruits increased marginally up to 6^{th} day of storage and on further storage, it decreased. The fruits packed in polyethylene bags showed significantly higher total soluble solids compared to corrugated paper box with mesh, which are the maximum total soluble solids in wooden boxes in directly correlated with low PLW of fruits due to more aeration In the above said packages. The percentage of reducing and non-reducing sugar content of Ber fruit increased as the storage period advanced.

Haribabu *et al.* (1990) reported that post harvest storage of custard apple find out suitable method to minimize post harvest losses. The storage treatment included the use of polyethylene bag, wax emulsion, coating fungicidal and growth regulator dipping and $KMnO_4$ as ethylene absorbent Fruits treated with 2, 4-D, 30 ppm + Bavistin 500 ppm or @ 6per cent wax emulsion + Bavistin stored up to seven days 500 ppm In poly bag could be stored eight days and Bavistin 500 ppm in poly bag containing, $KMnO_4$, could be stored nine days so $KMnO_4$ may be transported to distant market with loss post harvest losses.

Ali Batu and Keith Thomson (1998), studied the effect of modified atmosphere packaging on postharvest qualities of pink tomato. They suggested that sealed packaging, especially using with PE50 and PP films, delayed the development of the red color of tomato until 30 days of storage and those tomato were also still very firm even after 60 days of storage. Tomato sealed within PE50 and PP films had also the lowest weight loss and the highest soluble solids after 60 days of storage.

Naresh Kumar *et al.* (2001) reported that guava fruits under control showed maximum acidity (0.45 per cent) and minimum in chalk impregnated with $KMnO_4$ (0.42) per cent. Acidity of the fruits increased up to 2^n day and then decreased up to end of storage. Decrease in acid content may be due to conversion of acid into sugars by enzymes invertase. Maximum total sugar and reducing sugar were recorded in news paper impregnated with $KMnO_4$ and minimum in control irrespective of storage period.

Sapota fruits were stored in different concentration of growth regulator *viz.,* GA_3 (100 ppm), silver nitrate (200 ppm), Malic Hydrazide (500 ppm) and packed in 200 gauge polyethylene bag with 1 and 2 per cent ventilation at ambient room temperature (28-30 C). Silver nitrate (200 ppm) extends the shelf life up to 15 days followed by Malic Hydrazide (500 ppm) 13 days (Dhamodharan *et al., 2001*).

By dipping the banana bunches in GA_3 solution (150 ppm) shelf-life of banana can be extended upto 11 days and 32 days at room temperature 25 days to 30°C and 13 + 1°C respectively. Banana packed in paper bag, wrapping papers and polyethylene bags; low density polyethylene bag were more effective in reducing fruit softening reduced PLW and total sugar. Fruit stored at 32 days of storage (Janesh and Suresh Kumar 2001).

Hofinan *et al.* (2001) ethylene treated fruit without 1-MCP ripened about twice as fast untreated fruit, while 1-MCP treatment alone Increased DTR(days taken for ripening) by about 4 per cent as compared with untreated fruit. 1-MCP treatment prevents the ethylene stimulation of ripening, so that the 1-MCP treated fruits packed in polyethylene bag ripened more slowly than untreated fruits.

Erip Roberts *et al.* (2002) conducted an experiment on effect of storage temperature on ripening and postharvest quality of grape and mini-pear tomato. They are suggested that these grape and pear tomato should be harvested near red ripe stage for best flavor. Storage at 5 °C resulted in about 30% reduction in total titratable acidity (0.41%-pear and 0.34% grape) whereas those from other treatments maintained similar levels (0.53 to 0.67%).

Sudhir Yadav *et al.* (2005) conducted an experiment on bio-chemical and organoleptic quality changes during storage of ber fruits transported with different packaging materials reveal that chemical and organoleptic quality, TSS(total soluble solid) and acid ratio increased throughout the storage ascorbic acid showed an increase during transportation only and declined throughout the storage period. Acidity of fruit decreased continuously throughout the storage. Acidity of fruit was decreased under sealed polyethylene and plastic bag. The fruit of both the cultivars under all the packages become unfit for consumption by 8th day of ambient room storage.

The organoleptic rating of guava cv. sadar fruits was affected by various treatments and storage periods. Higher scores were recorded with calcium nitrite both at 0.5 and 1.0 per cent after 6 days of storage in the other hand the lowest scores was recorded in control fruits. This was mainly due to onset of senescence of tissues as a result of decrease in firmness and dull appearance of skin color. (Tamil selvan and Bal 2005).

In a study conducted by Thakur *et al.* (2005) use of polythene box liner and ethylene absorbents for quality retention of apple fruit was assessed. After lining them internally with low density polyethylene bags and placing ethylene absorbent *viz.* Ethysor, Purufil or green keeper inside the carton / boxes, the fruit were then transported in an ordinary truck to market where changes in the physico-chemical characteristics of fruit. Bruise, damages, weight loss PLW and spoilage were generally lower. Fruits also exhibited slower decrease in fruit firmness and slower increase in TSS content. Green keeper showed lower decrease in titratable acidity, minimum increase starch content and had better quality as compared to the packaging treatment without the use of PE liner and ethylene absorbents.

Post harvest application of potassium permanganate on shelf life of peach fruits was studied by Sihag *et al.* (2005). They harvested fully ripened fruits and packed in cardboard boxes of 4 kg capacity treated with $KMnO_4$ of 1000 ppm, 2000 ppm, 3000 ppm and 4000 ppm concentrations. News paper was used as cushioning material and stored at room temperature. The TSS increased significantly with increasing period of storage. The PLW, TSS, acidity was observed in fruits treated with 3000 ppm $KmnO_4$ with least in l000 ppm treated. The higher acidity might be due to ascorbic respiration & higher vapor transpiration rate. Use of $KMnO_4$ in packaging material enhanced the shelf life of fruit by obsorbing evolved ethylene.

Madhavi *et al.* (2005) reported that, sapota fruits dipped in aqueous solution of etheral (500, 1000, 2000 and 3000 ppm) and packed in 100 gauges of polyethylene bag with 1-2 per cent ventilation. Thousand ppm etheral treated fruits ripened uniform and faster rate, hydrolytic enzyme activities slow down, increased sugar concentration. However, acidity, ascorbic acid and spoilage was decreased. However, TSS and sugar increased up to end of the shelf life.

Matured Rasthali Banana hands were packed in polyethylene bag with different carrier viz. saw dust, coir-pith, rice bran were soaked in 30per cent saturated $KmnO_4$ solution and packed. The study was conducted by Tanuja priya *et al.*(2005) in a zero cool chamber (ZECC) where the temperature and relative humidity between 24.2 C and 90-98 per cent respectively. The result indicated that, packing of banana hands in 400 gauge polyethylene bag with coir pith as carrier extend the shelf life of rasthali banana up to 27 days as against 12 days in control without loss in quality of fruit. The quality parameters like TSS, Total sugar starch acidity chlorophyll contents and lower PLW observe compared to control.

Akath Singh *et al.*(2007) reported that shelf life and quality of passion fruit with polyethylene packaging under specific temperature fruit stored both high density and low density polyethylene storage at ambient temperature (26.5 and 65.7 per cent RH) fruits packed in perforated HDPE of 0.03 mm thickness showed a shelf life of 28 days. The quality and nutritional value of fruit were better preserved but slight reduction in flavour.

Application of oxalic acid decreased the incidence of decay and delayed the ripening process in mango fruit during cold storage with inhibition of development of pathogen, spore germination and mycelium growth *(Colletotrichum gloeosponoides).* There was no reduction in fruit quality. Oxalic acid treatment resulted in decrease of lipoxygenase activity and increase in super dioxide dismutose activity and promising method to suppress post harvest deterioration and extend the shelf life, possibly due to a combination of its physiological effect in delaying the ripening process (Xiao-Lin Zhing *et al.,* 2007).

Shehla Sammi and Tariq Masud (2007) observed that treated tomato fruits with polyethylene showed lesser TSS contents and titratable acidity while ascorbic acid contents, sugar to acid ratio, flavour, texture, color and overall acceptability was higher in treated fruits as compared to control at the red stage of ripening. Total sugars (%) were low in fruits treated with calcium chloride and boric acid with or without potassium permanganate.

Asrey Ram, *et al.* (2008) conducted maturity, transportation and storage study in strawberry fruit. The freshly harvested fruits were grouped into 3 categories (small, medium and large) and packed in 200 gauge capacity planets of 0.4 mm thickness. After overnight cooling at 10°C and 85 per cent relative humidity, pun nets were staked in 5 kg capacity corrugated fiber board boxes In 4 layer and transported. Post harvest loss estimation of small fruits were found to be least transportation damage (5.4 to 8.4 per cent) and decay loss (13.15 per cent) compared to large fruits (17.7 to 24.4 per cent and 93 per cent). Large and 2/3 mature fruits were prone to water loss and acidity. Small fruits showed higher TSS, highest sugar content (5.08 per cent), lower respiration rate and higher puncher force.

In a study conducted by Sanjay singh *et al.* (2008) on effect of different post harvest treatments on shelf life and quality the fruits after harvest. Ber fruits (Cv. Gola and gama kirti at ambient condition) stored in perforated polyethylene bag treated with calcium nitrate. Treated fruits showed minimum spoilage (1.5%), ascorbic acid, titratable acidity and PLW. While the highest TSS, total sugar and reducing sugar was recorded in treated fruits with Calcium nitrate which were packed in polyethylene packages and also shelf life increased up to nine days.

MATERIAL AND METHODS

III. MATERIALS AND METHODS

The present investigation was carried out to study the "Effect of postharvest treatments to enhance the shelf life and quality of cherry tomato (*Solanum lycopersicon var. cerasiforme*) cv. Marilee Cherry Red" using different gauges of polyethylene packages with or without ventilation a long with chemical treatment under ambient storage conditions. The present investigation was carried out at Postharvest Laboratory, Division of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Science, Bangalore during 2010. The details of the experiment material used and the methods adapted for the investigation are presented in this chapter.

3.1 Experimental Material

Cherry tomato (Cv. Marilee Cherry Red) were harvested from vegetable garden of Namdari Seed Pvt. Ltd. and transported to Division of Horticulture UAS, GKVK, Bangalore. The fruits were brought to the laboratory with least damage and at most care. Initial observations of the cherry tomato fruits were recorded and were used to study the shelf life using different treatments.

3.1.1 Calcium chloride

Calcium chloride is a salt of calcium and chlorine. It behaves as a typical ionic halide and chemical formula of the product is $CaCl_2$ and is solid at room temperature. As an ingredient, it is listed as a permitted food additive in the European Union for use as a sequestrant and firming agent with the E number E509, and considered as generally recognized as safe (GRAS) by the U.S. Food and Drug Administration. The average intake of calcium chloride as food additives has been estimated to be 160–345 mg/day for individuals.

As a firming agent calcium chloride is used in canned vegetables, fruit packaging, in firming soy bean curds into tofu and in producing a caviar substitute from vegetable or fruit juices. It is commonly used as an electrolyte in sports drinks and other beverages including Smart water and Nestle bottled water.

3.1.2 Potassium Permanganate

Potassium permanganate is an inorganic chemical compound with the formula $KMnO_4$. It is a salt consisting of K^+ and MnO_4^- ions. Formerly known as permanganate of potash or Condy's crystals, it is a strong oxidizing agent. It dissolves in water to give intensely purple solutions, the evaporation of which leaves prismatic purplish-black glistening crystals. In the year 2000 worldwide production was estimated at 30,000 tonnes. It is mainly used as ethylene absorbent compound for extending shelf life and preservation of fruits and vegetables.

3.2 Preparation of different concentration of Chemicals

3.2.1 Calcium chloride

Forty grams of calcium chloride was weighted by electronic balance in order to make two per cent calcium chloride solution. Later calcium chloride solution was prepared by dissolving 40 grams of calcium chloride powder in 2 liters of warm and distilled water and stirring continuously by stirring rod at most care till the calcium chloride completely disappeared in distilled water.

3.2.2 Potassium permanganate

Potassium permanganate powder was brought from laboratory store and then 80 grams (4%) of it was weighted at electronic balance then added to 2 liters of warm and distilled water and slowly stirred by stirring rod continuously till the small crystal of $KMnO_4$ completely disappeared in distilled water.

3.3 Polyethylene bags

Most widely used material is obtained by polymerization of ethylene gas under high pressures of 1000-3000 atmospheres. Low density polyethylene (LDPE) is fairly soft, slightly translucent flexible material with waxy feel. It possesses excellent resistant to most chemicals, good barrier to water vapour, but less barrier to oxygen. It has high permeability to volatiles and swells in contact with fats and oils. It gives a very good heat seals and easily coated on to other material and serves as a good laminated layer.

3.3.1 Preparation of polyethylene bag

Low density polyethylene bags of 150 and 200 gauges (30 × 20cm) were selected and each circular hole of polyethylene bag $0.4cm^2$ in diameter were punched on polyethylene bags at equidistance from each other. Half the number of bags are kept without making holes and used as bags without ventilation. Out of $300cm^2$ area of the bag $60cm^2$ top portions were sealed with the help of sealing machine by using formula πr^2.

=Actual utilized space x ventilation /Area

Area= π x r x r = 3.14 x 0.2 x 0.2 =0.13 where π= 3.14. r = 0.4 cm

15x15 cm actual utilized space – sealed area =300-60= $240cm^2$

$$= \frac{240 \times 0.5 ventilation}{0.13 \times 100} = 9.2$$

So it almost 10 holes were made at equal-distance from one another.

3.4 Characteristic of cherry tomato

The experiment was carried out during Oct-Nov 2010. Cherry tomato Cv. Marilee cherry red was brought from Namdari Pvt. Ltd. It is a hybrid cherry tomato which is released by Enza Zaden a UK based company but now it is cultivating at Namdari Pvt. Ltd. It is a cherry tomato, the top variety for mid summer and autumn plantings. Marilee cherry red tomato deals easily with the high light intensity and produces strongly under stress conditions in the heat of summer and sets fruits easily. The 16-18 grams round fruits are firm, tasty and especially suited for export. It is an early matured cultivar.

3.5 Experimental methods

The experiment was carried out during Oct-November 2010. The fruits were harvested at breaker stage directly from the Namdari Pvt. Ltd's vegetable garden and packed in plastic crates immediately and transported to Division of Horticulture UAS, GKVK, Bangalore. Then fruits were washed in running water to remove dust and chemicals residues present on the surface of fruits. The fruits were graded into uniform size and fruits were spread on newspaper sheets and let them to dry out for half an hour. Then fruits were dipped in recorded Calcium chloride and potassium permanganate solutions for five minutes and again spread them for half an hour to be dried. The treated fruits were placed in polyethylene bags with or without ventilation and sealed by using sealing machine. There were about 4 treatments and 3 replications. In each replication, 16 Kg of cherry tomato fruits were packed in 48 polyethylene bags at 250g each. These polyethylene bags were kept at ambient storage conditions.

Plate 1. General view of cherry tomato

3.6 Detail of experiment

Crop	: **Cherry Tomato**
Variety	: **Marilee Cherry Red**
Statistical design	: **Factorial CRD**
Number of replication	: **3**
Number of treatments	: **4**
Packages	: **Two gauges(150 and 200)**
Stage of harvest	: **Breaker Stage**
Method of harvest	: **Manually**
Storage condition	: **Ambient condition**
Quantity of fruits/treatment	: **1.0 Kg**
Quantity of fruits/replication	: **16 kg**
Total quantity of fruits	**: 48 kg**

3.6.1 Treatments

T_1- Control

T_2 - Fruits dipped in cold water for five minutes

T_3- Fruits dipped in $CaCl_2$ at 2% for five minutes

T_4 - Fruits dipped in $KMnO_4$ at 4% for five minutes

3.6.2 Packages

P_1-150 gauge polyethylene bag +WV

P_2 -150 gauge polyethylene bag +V (0.5%)

P_3-200 gauge polyethylene bag +WV

P_4 -200 gauge polyethylene bag +V (0.5%)

3.6.3 Treatment/packaging material

T_1P_1-150 gauge + Fruits without any treatment + WV

T_1P_2 -150 gauge + Fruits without any treatment + V (0.5%)

T_1P_3-200 gauge + Fruits without any treatment + WV

T_1P_4 - 200 gauge + Fruits without any treatment + (0.5%)

T_2P_1-150 gauge + Fruits dipped in cold water for five minutes + WV

T_2P_2 -150 gauge+ Fruits dipped in cold water for five minutes + V (0.5%)

T_2P_3- 200 gauge + fruits dipped in cold water for five minutes +WV

T_2P_4 - 200 gauge + Fruits dipped in cold water for five minutes +V (0.5%)

T_3P_1- 150 gauge + Fruits treated with 2% $CaCl_2$ + WV

T_3P_2 - 150 gauge + Fruits treated with 2% $CaCl_2$ +V (0.5%)

T_3P_3- 200 gauge + Fruits treated with 2% $CaCl_2$ + WV

T_3P_4 - 200 gauge + Fruits treated with 2% $CaCl_2$ +V(0.5%)

T_4P_1 - 150 gauge + Fruits treated with 4% $KMnO_4$ crystal + WV

T_4P_2 - 150gauge + Fruits treated with 4% $KMnO_4$ crystal + V (0.5%)

T_4P_3- 200 gauge + Fruits treated with 4% $KMnO_4$ crystal + WV

T_4P_4 - 200 gauge + Fruits treated with 4% $KMnO_4$ crystal + V (0.5%)

WV = without ventilation

V = ventilation

3.7 Storage place

The packaged bags were stored at ambient temperature (25°C±3) and relative humidity around (75±5 %) conditions prevailing in the laboratory, which had provision for proper aeration and light. The bags were arranged on the wooden table side by side. The temperature during storage period is given in Appendix-I.

3.8 Observation recorded

The initial observations were recorded before imposition of treatment of fruits. During storage changes in physico-chemical and organoleptic characters were recorded in case of TSS, acidity, ascorbic acid, pH, firmness, physical loss in weight and number of fruits spoiled at 1, 3, 5, 7, 9, 11, 13 and 15 days and in case of Total sugar, reducing sugar, non- Reducing sugar and organoleptic observations were recorded on 1, 5, 10 and 15 days at specified intervals of storage period respectively. The detail methodology adopted for recording the observations during the experimentation are described below.

3.9 Physical parameters

3.9.1 Physiological loss in weight (%)

Six fruits in each replication were labeled for recording the weight loss, weight of the six fruits was recorded from each replication in all treatments at periodically intervals, and cumulative losses in weight were calculated and expressed in per cent.

3.9.2 Firmness (Kg/cm^2)

Firmness was determined by using fruit Penetrometer (Model Cat.No.166), the fruits was punctured at two places opposite to each other in radial axis with the plunger and the pressure required was recorded and expressed in kg/cm^2.

3.9.3 Spoilage

The treated fruits were visually observed for fungal, moulds and bacterial growth at regular intervals throughout the storage period and observation were recorded.

3.9.4 Organoleptic evaluation

Evaluation of organoleptic character of the fruits was carried out by a panel of five judges on 1st, 5th, 10th and 15th days after storage. Fruit characters like Taste, color, Flavor and over all acceptance were judged by the following score chart. Fruits were ranked for quality parameters, from higher to lower descending order of acceptability.

3.9.5 Taste

The taste was determined by actual tasting and grouped into following categories:

Category	Scoring Point
1 Best	5
2 Better	4
3 Good	3
4 Okay	2
5 Bad	1
6 Very bad	0

3.9.6 Colour

The color of the fruit was determined by visual assessment and grouped into following categories:

Category	scoring point
1) Best	5
2) Very much attractive	4
3) Acceptable attractive	3
4) Moderately attractive	2
5) Slightly attractive	1
6) Not attractive	0

3.9.7 Flavour

The flavour of pulp was judged by actual tasting and grouped into the following categories:

Category	Scoring Point
1) Extremely pleasant	5
2) Very much pleasant	4
3) Pleasant	3
4) Moderately pleasant	2
5) Slightly pleasant	1
6) Not at all pleasant	0

3.9.8 Over-all acceptability

This was determined by individual's opinion and grouped into following categories:

Category	Scoring Point
1) Extremely acceptable	5
2) Highly acceptable	4
3) Acceptable	3
4) Moderately acceptable	2
5) Slightly acceptable	1
6) Not acceptable	0

3.10 Chemical parameters

3.10.1 Total soluble solid

Total soluble solids (TSS) of the fruit juice were determined by using hand refractometer 0-32(°Brix) range. The values were expressed as per cent total soluble solids of the fruits (Ranganna, 1977).

3.10.2 Titratable acidity (%)

The acidity was determined by diluting known volume of clear juice filtered through muslin cloth with distilled water and treating the same against standard NaOH, using phenolphthalein as an indicator. The appearance of light pink colour was marked as the end point. The result was expressed in terms of citric acid as per cent titratable acidity of fruit juice (Ranganna, 1977).

$$Titratable\ acidity(\%) = \frac{\text{Titer value} \times \text{No of NaOH} \times \text{Volume made up} \times \text{Equilent wieght of citric acid}}{\text{Volume of sample} \times \text{weight of sample} \times 100}$$

3.10.3 Total Sugars (%)

Sugars present in cherry tomato samples were estimated by using the method derived by Lane and Eynon (1923) and Ranganna (1977). 25 ml of the filtrate (prepared for sugar estimation) was hydrolyzed with 5 ml of HCI at room temperature for 24 hours. The hydrolyzed sample was neutralized with 30 per cent NaOH and the volume was made up to 100 ml with distilled water. Since all the sugars present in the sample were converted to reducing sugars, estimation of reducing sugars in the aliquot as explained in the previous section gave the total sugars present.

3.10.4 Reducing sugar (%)

Two grams of cherry tomato sample was blended with 50 ml distilled water in a 100 ml volumetric flask and the sample was neutralized with 1 N NaOH. For clarification, 2 ml of 45 per cent lead acetate solution was added and allowed to stand for 10 minutes. Necessary amount of 22 per cent potassium oxalate was added to remove the excess lead present and the volume was made up to 100 ml by adding distilled water. The solution was passed through Watchman No. 4 filter paper and the filtrate was used for the estimation of reducing sugar. 10 ml of Fehling's solution [Fehling's No. 1 (5 ml) + Fehling's No. 2 (5 ml)] with 50 ml of distilled water was taken in a conical flask heated to boil and titrated against the filtrate sample using methylene blue as an indicator. The end point of titration was brick red colour. Reducing sugar content of fruits was estimated by the following formula.

$$\text{Reducing sugars (\%)} = \frac{0.05 \times \text{Volume made up}}{\text{Titer value} \times \text{Weight of sample}} \times 100$$

3.10.5 Non-reducing sugar (%)

The non-reducing sugar content of cherry tomato samples were determined by the following formula:

Non reducing sugar (%) = Total sugar (%) - Reducing sugar (%)

3.10.6 pH

Digital pH meter was used to measure the pH of the cherry tomato samples; the temperature was kept constant while taking observation for the entire sample.

3.10.7 Ascorbic acid (mg/100g)

Ascorbic acid was determined by 2, 6 dichlorophenol indophenols titration method (Ranganna 1977). Two per cent Meta phosphoric acid was added to 20m of sample to make up the volume to 100 ml. Then 10 ml of 2, 6 dichlorophenol indophenol dye was added to 5ml of this extract and was measured by using spectrophotometer. A standard curve was obtained between absorbance and ascorbic acid content using blank solutions and value for ascorbic acid content of the sample was determined by using the curve.

3.10.8 Statistical analysis

The data on the physicochemical parameters and organoleptic characters of fruits were subjected to completely randomized factorial design analysis and interpretation of the data was carried out in accordance with Panes and Sukhatme (1985).

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The present investigation on "Effect of postharvest treatments to enhance the shelf life and quality of cherry tomato (*Solanum lycopersicon var.cerasiforme)* cv. Marillee Cherry Red" was carried out at department of Horticulture, UAS, GKVK, Bangalore during November 2010 with a view to find out the extent of quality and shelf life of cherry tomato fruits by subjecting them to various postharvest treatments and storing them in different gauges of polythene packages with and without ventilation. The physical, physiological and chemical parameters and also the disease incidence of the fruits at different days of storage were studied.

The experiment was laid out in a factorial complete randomized design (factorial CRD) with three replications. The fruits were subjected to pretreatment using 2 per cent $CaCl_2$, 4 per cent $KMnO_4$ and cold water for 5 minutes. The pretreated fruits were packed in polythene packages of 150 and 200 gauges with and without ventilation. The observations were recorded on physical and chemical parameters up to the end of storage days in all treatments. The results of the experiment are presented under the following headings.

4.1 Physical parameters

4.1.1 Physiological Loss in Weight (%)

The physiological loss in weight differed significantly over the storage period irrespective of postharvest treatment, packaging and their interactions (Table 1 and Figure 1).

With respect to the postharvest treatments the lowest physiological loss in weight throughout the storage period was found in the fruits treated with 2 per cent $CaCl_2$ (1.73, 1.9, 2.96, 3.37, 5.15 and, 6.14 %), followed by cherry tomato treated with 4 per cent $KMnO_4$ (1.85, 2.7, 3.65, 3.90, 5.44 and 6.68 %) at 3rd, 5th, 7th, 9th, 11th and 15th days of storage respectively. While the highest Physiological loss in weight was found in fruits without any treatment (2.55, 3.75, 4.24, 4.65, 5.48, 6.45 and 6.91 %) at 3rd, 5th, 7th, 9th, 11th and 15th days of storage respectively.

With respect to packages the fruits packed in 150 and 200 gauge polyethylene bag with ventilation(0.5%) showed lowest PLW throughout the storage period (1.81, 2.61, 3.37, 3.73, 4.74, 5.44 and 6.2 % and; 2,13, 2.81,3.63,4.03, 5.43,6,10 and 6.76) at 3rd, 5th, 7th , 9th,11th and 15th day of storage respectively. The highest physiological loss in weight (PLW) was recorded in fruits packed in 200 gauges of polythene bag without 0.5% ventilation (1.42, 1.80, 3.13 and 4.60 %), at 3rd, 5th, 7th, 9th, 11th and 15th days of storages.

In interaction effect, there was significant difference between treatments as influenced by the postharvest treatments and the polythene packages. The lowest physiological weight loss in fruits was recorded in fruits treated with 2 per cent $CaCl_2$ fruits stored at 150 polyethylene bag with 0.5 per cent ventilation (1.61, 1.73, 2.30, 3.03, 3.96, 4.26 and 5.16) at 3rd, 5th, 7th, 9th, 11th and 15th days of storage respectively. Followed by fruits treated with 4 per cent $KMnO_4$ (2.03**,** 2.23, 3.35, 3.86, 5.06, 5.04 and 6.53 and 2, 2.93, 3.86, 3.83, 5.73, 5.93 and 6.73%) respectively at 3rd, 5th, 7th, 9th, 11th and 15th days of storage respectively. The highest PLW was recorded in control packed in 200 gauges of polyethylene bags (2.85, 4.03, 4.76, 5.16, 5.76, 6.43 and 6.96%) at the 3rd, 5th, 7th, 9th, 11th and 15th days of storage period respectively.

4.1.2 Shelf life (Days)

The data pertaining to the effect of pre treatments and packaging on shelf life of cherry tomato (days) during storage period are presented in (Table 1 and figure 2).

Table 1. Effects of postharvest treatments and packaging on physiological loss in weight (%) and shelf life (days) of fruits during storage

Treatment	Treatment details	Physiological Loss in weight (%)								Shelf life (Days)
		Days after storage								
		At harvest	3	5	7	9	11	13	15	
T_1	Control	-	2.55	3.75	4.24	4.65	5.48	6.45	6.91	8.50
T_2	Cold water	-	1.85	3.21	3.65	4.30	5.57	6.27	6.74	9.79
T_3	2% $CaCl_2$	-	1.73	1.90	2.96	3.37	4.48	5.15	6.14	13.25
T_4	4% $KMnO_4$	-	2.17	2.70	3.69	3.90	5.44	5.82	6.68	10.45
	F Test	-	*	*	*	*	*	*	*	*
	S. Em ±	-	0.04	0.05	0.06	0.05	0.05	0.06	0.06	0.18
	CD at 5%	-	0.11	0.14	0.20	0.14	0.16	0.17	0.17	0.53
Packages(P)										
P_1	150 gauge WV	-	2.16	3.03	3.77	4.14	5.20	5.88	6.68	10.66
P_2	150 gauge V 0.5%	-	1.81	2.61	3.37	3.73	4.74	5.44	6.20	11.29
P_3	200 gauge WV	-	2.20	3.05	3.77	4.30	5.60	6.28	6.83	9.75
P_4	200 gauge V 0.5%	-	2.13	2.81	3.63	4.03	5.43	6.10	6.76	10.29
	F Test	-	*	*	*	*	*	*	*	*
	S. Em ±	-	0.04	0.05	0.06	0.05	0.05	0.06	0.06	0.18
	CD at 5%	-	0.04	0.14	0.20	0.14	0.16	0.16	0.17	0.37
Interactions(TxP)										
T_1P_1	Control + 150 gauge WV	-	2.76	4.03	4.76	5.16	5.76	6.43	6.96	8.33
T_1P_2	Control + 150 gauge V 0.5%	-	1.85	3.50	4.10	4.06	4.66	5.93	6.43	9.00
T_1P_3	Control + 200 gauge WV	-	2.73	3.90	4.33	4.73	5.73	6.83	7.16	8.16
T_1P_4	Control + 200 gauge V 0.5%	-	2.85	3.60	3.76	4.53	5.76	6.63	7.10	8.50
T_2P_1	Cold water + 150 gauge WV	-	1.88	3.5	3.83	4.20	5.56	6.00	6.80	9.33
T_2P_2	Cold water + 150 gauge V 0.5%	-	1.75	3.00	3.56	3.96	5.26	6.16	6.66	11.00
T_2P_3	Cold water + 200 gauge WV	-	1.91	3.36	3.50	4.73	5.80	6.50	6.86	9.16
T_2P_4	Cold water + 200 gauge V 0.5%	-	1.86	3.00	3.73	4.33	5.66	6.43	6.63	9.66
T_3P_1	2% $CaCl_2$ + 150 gauge WV	-	1.73	1.93	3.03	3.43	4.36	5.40	6.16	13.66
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	-	1.61	1.73	2.30	3.03	3.96	4.26	5.16	15.33
T_3P_3	2% $CaCl_2$ + 200 gauge WV	-	1.76	2.00	3.36	3.60	5.03	5.53	6.63	11.33
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	-	1.83	1.93	3.16	3.43	4.56	5.43	6.60	12.66
T_4P_1	4% $KMnO_4$ + 150 gauge WV	-	2.26	2.66	3.46	3.76	5.13	5.70	6.80	11.33
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	-	2.03	2.23	3.53	3.86	5.06	5.40	6.53	9.83
T_4P_3	4% $KMnO_4$ + 150 gauge WV	-	2.40	2.96	3.90	4.16	5.83	6.26	6.66	10.33
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	-	2.00	2.93	3.86	3.83	5.73	5.93	6.73	10.33
	F Test	-	*	*	*	*	*	*	*	*
	S. Em ±	-	0.08	0.10	0.13	0.10	0.11	0.12	0.12	0.37
	CD at 5%	-	0.23	0.28	0.4	0.29	0.32	0.35	0.35	1.06

* = Significant at 5%, NS = Non-significant, WV= without ventilation, V= with ventilation

The shelf life of the cherry tomato recorded at the end of storage period revealed that there was a significant difference between the postharvest treatments, polyethylene packages and their interaction. Among the postharvest treatments, fruits treated with 2 per cent $CaCl_2$ showed longer shelf life (13.25 days) followed by fruits treated with 4 per cent $KMnO_4$ (10.45 days) and fruits treated with cold water (9.79 days). However, the shortest shelf life of fruits was recorded in fruits without any treatment (8.5 days).

Similarly the data on the effect of polythene package showed significant difference with respect to shelf life of fruits where longest shelf life (11.29 days) was recorded in fruits packed in 150 gauge polythene bags with 0.5per cent ventilation followed by fruits stored in150 gauge polythene bag without ventilation (10.66 days) and lowest shelf life was recorded in fruits packed in 200 gauges polythene bag without ventilation (9.75 days).

In the interaction there was a significant difference among the shelf life of fruits. The highest shelf life was recorded in the fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauge polythene bag with 0.5 per cent ventilation (15.33 days) followed by cherry tomato fruits treated with 2 per cent $CaCl_2$ and packed in 200 gauge polythene bag with 0.5 per cent ventilation (13.33 days). The shortest shelf life was observed in fruits without any treatment and packed in 200 gauge polythene bags without ventilation (8.16 days).

4.1.3 Firmness (Kg/cm^2)

The data pertaining to firmness (Kg/cm^2) of cherry tomato fruits during storage are presented in table 2 and figure 3.

The firmness of the fruits decreased over the storage period irrespective of pretreatment and packaging and their interactions.

However, there was a significant difference between the postharvest treatments, packaging and interactions.

Among postharvest treatments, the maximum firmness throughout the period at storage days was found in the cherry tomato fruits treated with 2 per cent $CaCl_2$ (3.05, 2.90, 2.15, and 1.52 kg/cm^2), followed by cherry tomato fruits treated with 4 per cent $KMnO_4$ (3.06, 2.40, 1.56 and 1.24kg/cm$_2$) at 1st, 5th, 10th and 15th days of storage respectively. While the minimum firmness was found in cherry tomato fruits without any treatment (2.13,1.36, and 1.12 kg/cm^2) at 5th, 10th and 15th days after storage respectively.

The cherry tomato fruits packed in 150 and 200 gauge polyethylene bag with ventilation(0.5%) showed maximum firmness throughout the storage period with (2.9, 2.41,1.79 and 1.37kg/cm$^{2)}$ and;(2.71, 2.39, 1.50 and 1.40 kg/cm^2) at 1st, 5th, 10th and 15th day of storage respectively. The minimum firmness was recorded in cherry tomato packed in 150 gauges of polythene bags without ventilation (2.26, 1.76 and 1.25kg/cm^2) at the 5th, 10th and 15th days of storages.

In interaction, the significant difference was noticed on cherry tomato fruits firmness of as influenced by the postharvest treatments and the polythene packages. The maximum firmness was recorded in fruits treated with 2 per cent $CaCl_2$ and in 150 and 200 gauge ventilated(5%) polyethylene bag (3.14, 2.90, 2.90 and 2.00 and; 2.75, 2.8 and 1.51kg/cm^2) at 1st, 5th, 10th and 15th days of storage respectively followed by fruits treated with 4 per cent $KMnO_4$ and stored in 150 gauges of ventilated(5%) polyethylene bag (2.27, 1.67 and 1.36 and; 2.51, 2.00 and 1.40kg/cm^2) at 5th, 10th and 15th days of storage respectively. While the minimum firmness of cherry tomato was recorded in control fruits packed in 150 and 200 polyethylene bags (2.33, 2.00, 1.33 and

Table 2. Effects of postharvest treatments and packaging on fruit firmness (kg/cm²) during storage

Treatments	Treatment details	Firmness (Kg/cm²)			
		Days of storage			
		At harvest	5	10	15
T_1	Control	2.37	2.13	1.36	1.12
T_2	Cold water	2.32	2.25	1.42	1.24
T_3	2% $CaCl_2$	2.35	2.90	2.15	1.52
T_4	4% $KMnO_4$	2.35	2.40	1.56	1.24
	F Test	NS	*	*	*
	S.Em ±	-	0.03	0.04	0.09
	CD at 5%	-	0.10	0.14	0.26
Packages(P)					
P_1	150 gauge WV	2.80	2.26	1.76	1.25
P_2	150 gauge V 0.5%	2.90	2.41	1.79	1.37
P_3	200 gauge WV	2.66	2.23	1.40	1.19
P_4	200 gauge V 0.5%	2.71	2.39	1.50	1.30
	F Test	NS	*	*	*
	S. Em ±	-	0.03	0.04	0.09
	CD at 5%	-	0.10	0.14	0.26
Interactions(TxP)					
T_1P_1	Control + 150 gauge WV	3.12	2.00	1.33	1.10
T_1P_2	Control + 150 gauge V 0.5%	3.14	2.12	1.43	1.20
T_1P_3	Control + 200 gauge WV	3.9 0	2.02	1.25	1.06
T_1P_4	Control + 200 gauge V 0.5%	3.10	2.40	1.42	1.13
T_2P_1	Cold water + 150 gauge WV	3.08	2.21	1.37	1.16
T_2P_2	Cold water + 150 gauge V 0.5%	3.20	2.32	1.63	1.30
T_2P_3	Cold water + 200 gauge WV	3.11	2.2	1.25	1.08
T_2P_4	Cold water + 200 gauge V 0.5%	3.12	2.26	1.42	1.25
T_3P_1	2% $CaCl_2$ + 150 gauge WV	3.7 0	2.33	1.50	1.25
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	3.14	2.90	2.90	2.00
T_3P_3	2% $CaCl_2$ + 200 gauge WV	3.13	2.50	1.63	1.33
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	3.05	2.75	2.80	1.51
T_4P_1	4% $KMnO_4$ + 150 gauge WV	3.07	2.26	1.57	1.20
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	3.06	2.27	1.67	1.36
T_4P_3	4% $KMnO_4$ + 150 gauge WV	3.03	2.17	1.48	1.16
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	3.06	2.51	2.00	1.40
	F Test	NS	*	*	*
	S. Em ±	-	0.07	0.09	0.18
	CD at 5%	-	0.21	0.28	0.33

* = Significant at 5%, NS = Non-significant, WV= without ventilation, V= with ventilation

1.10kg/cm^2 and; 2.02, 1.25 and 1.06kg/cm^2) at the 5th, 10th and 15th days of storage period respectively.

4.1.4 Spoilage (%)

The data pertaining to the number of cherry tomato fruits spoiled during storage are presented in table 3.

The number of fruits spoiled was differed significantly over the storage period irrespective of the postharvest treatments, packages and their interaction.

The minimum number of fruits spoiled throughout the storage period was found in the fruits treated with 2 per cent CaCl2 (2.08, 4.08,6, 7.5, 10.08, 12.25 and15.83) which was on par with fruits treated with 4 per cent $KMnO_4$ (2.25, 5.5, 7.5, 10.33, 12.83, 14.16 and 16.66) at 3rd, 5th, 7^{th,} 9th, 11th and 15th days of storage respectively. While the maximum spoilage was found in fruits without any treatment (2.75, 6, 9.5, 14.08,15,41, 16.91 and 21.5) at the 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively.

The minimum spoilage was recorded in fruits packed in 150 and 200 gauge polyethylene bags with 0.5 per cent ventilation throughout the storage period (2.08, 4.33, 6.58, 9.58, 11.25,12.58 and 16,75 and; 2.83, 5.5, 8.16, 10.47, 13.75,15.41 and 18.83) at 3^{rs}, 5th, 7th , 9th,11th and 15th day of storage respectively. The maximum spoilage was recorded in fruits packed in 200 gauge polythene bags without ventilation (3.08, 6.00, 8.66, 11.66, 14.08, 15.50 and 19.66) at 3rd, 5th, 7^{th,} 9th, 11th and 15th days of storages respectively.

In the interaction the lowest number of spoiled fruits was recorded in fruits treated with 2 per cent $CaCl_2$ fruits stored at 150 and 200 gauge polyethylene bag with 0.5 per cent ventilation (1.66,3.33, 4.00, 5.66,

Table 3: Effect of postharvest treatments and packaging on spoilage of fruits (%) during storage

Treatments	Treatment details	Spoilage (%)							
		Days after Storage							
		At harvest	3	5	7	9	11	13	15
T_1	Control	-	2.75	6.00	9.50	14.08	15.41	16.91	21.50
T_2	Cold water	-	2.66	5.58	8.33	11.16	14.16	15.08	19.66
T_3	2% $CaCl_2$	-	2.08	4.08	6.00	7.50	10.08	12.25	15.83
T_4	4% $KMnO_4$	-	2.25	5.50	7.50	10.33	12.83	14.16	16.66
	F Test	-	*	*	*	*	*	*	*
	S. Em ±	-	0.13	0.15	0.17	0.23	0.19	0.18	0.17
	CD at 5%	-	0.37	0.43	0.5	0.68	0.56	0.53	0.49
Packages(P)									
P_1	150 gauge WV	-	2.75	5.33	7.91	11.41	13.14	14.91	18.41
P_2	150 gauge V 0.5%	-	2.08	4.33	6.58	9.58	11.25	12.58	16.75
P_3	200 gauge WV	-	3.08	6.00	8.66	11.66	14.08	15.50	19.66
P_4	200 gauge V 0.5%	-	2.83	5.50	8.16	10.47	13.75	15.41	18.83
	F Test	-	*	*	*	*	*	*	*
	S. Em ±	-	0.13	0.15	0.17	0.23	0.19	0.18	0.17
	CD at 5%	-	0.37	0.43	0.5	0.68	0.56	0.53	0.49
Interactions(TxP)									
T_1P_1	Control + 150 gauge WV	-	3.00	6.33	9.00	15.00	16.00	17.33	20.66
T_1P_2	Control + 150 gauge V 0.5%	-	2.33	5.33	8.00	13.00	13.33	14.66	19.33
T_1P_3	Control + 200 gauge WV	-	3.00	6.66	11.00	15.00	16.66	18.33	24.00
T_1P_4	Control + 200 gauge V 0.5%	-	2.66	5.66	10.00	13.33	15.66	17.33	22.00
T_2P_1	Cold water + 150 gauge WV	-	2.33	5.33	9.00	12.66	13.66	14.66	19.66
T_2P_2	Cold water + 150 gauge V 0.5%	-	2.00	3.66	7.66	10.33	12.66	13.66	19.33
T_2P_3	Cold water + 200 gauge WV	-	3.33	6.66	8.66	11.33	15.00	15.66	20.00
T_2P_4	Cold water + 200 gauge V 0.5%	-	3.00	6.66	8.00	10.33	15.33	16.33	19.66
T_3P_1	2% $CaCl_2$ + 150 gauge WV	-	2.33	4.33	6.33	8.33	10.66	12.66	16.66
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	-	1.66	3.33	4.00	5.66	8.33	10.00	13.33
T_3P_3	2% $CaCl_2$ + 200 gauge WV	-	2.00	4.66	7.00	8.33	11.00	13.33	17.33
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	-	2.33	4.00	6.66	7.66	10.33	13.00	16.00
T_4P_1	4% $KMnO_4$ + 150 gauge WV	-	3.33	5.33	7.33	9.66	13.33	15.00	16.66
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	-	2.33	5.00	6.66	9.33	10.66	12.00	15.00
T_4P_3	4% $KMnO_4$ + 150 gauge WV	-	4.00	6.00	8.00	12.00	13.66	14.66	17.33
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	-	3.33	5.66	8.00	10.33	13.66	15.00	17.66
	F Test	-	NS	*	*	*	*	*	*
	S. Em ±	-	-	0.30	0.35	0.47	0.39	0.37	0.34
	CD at 5%	-	-	0.86	1.01	1.37	1.12	1.07	0.98

* = Significant at 5%, NS= Non Significant, WV= without ventilation, V= with ventilation

8.33, 10.00 and 13.33 and ,4.00, 6.66, 7.66,10.33, 13.00 and 17.33)at the 3rd, 5th , 7th, 9th, 11th and 15th days of storage period respectively, While the maximum fruit spoilage was recorded in control packed in 200 gauges of polyethylene bag (6.33, 9.00,15.00, 16.00, 17.33 and 20.66) at the 3rd, 5th , 7th, 9th, 11th and 15th days of storage period respectively.

4.1.5 Organoleptic characters

The data pertaining to organoleptic characters during storage period are presented in table 4-5.

A panel of five judges evaluated the fruits at the 1st, 5th, 10th and 15th day of storage by giving score from maximum 5.00. The fruits kept at various interactions of postharvest treatments and polyethylene packages with or without ventilation were examined for organoleptic characters such as taste, color, flavour and overall acceptance of fruits.

4.1.5.1 Color

The data pertaining to effect of postharvest treatments, polyethylene bags and their interactions on colour are presented in table 4.

The colour of the fruits was differed significantly over storage period irrespective of the postharvest treatments, packaging and their interaction.

The highest color was found in fruits treated with calcium chloride (3.33, 3.75 and 2.73 /5.0 score point) followed with cold water (2.41, 3.08 and 2.16 /5.0 score point) at 5th, 10th and 15th days after storage while the lowest colour was observed with control (2.25, 2.66 and1.33/5.0) at 5th, 10th and 15th days after storage as compared to other treatments.

Table 4. Effect of postharvest treatments and packaging on sensory quality of fruits during storage

Treatments	Treatment details	Colour				Taste			
		Days after storage							
		At harvest	5	10	15	At harvest	5	10	15
T_1	Control	1.00	2.25	2.66	1.33	2.00	2.58	3.33	1.91
T_2	Cold water	1.00	2.33	3.08	2.16	2.16	3.08	3.58	2.41
T_3	2% $CaCl_2$	1.00	3.33	3.75	2.83	2.16	3.73	4.00	3.16
T_4	4% $KMnO_4$	1.00	2.41	3.00	1.83	2.08	3.36	3.10	3.00
	F Test	-	*	*	*	NS	*	*	*
	S. Em ±	-	0.13	0.13	0.15	-	0.13	0.16	0.12
	CD at 5%	-	0.39	0.39	0.43	-	0.37	0.48	0.36
Packages(P)									
P_1	150 gauge WV	1.00	2.25	3.08	1.83	2.08	2.91	2.91	2.66
P_2	150 gauge V 0.5%	1.00	3.08	3.58	2.58	2.08	3.25	4.16	3.08
P_3	200 gauge WV	1.00	2.33	2.66	1.75	2.08	2.91	3.33	2.16
P_4	200 gauge V 0.5%	1.00	2.66	3.16	2.00	2.16	3.08	3.66	2.58
	F Test	-	*	*	*	NS	NS	*	*
	S. Em ±	-	0.13	0.13	0.15	-	-	0.16	0.25
	CD at 5%	-	0.39	0.39	0.43	-	-	0.48	0.72
Interactions(TxP)									
T_1P_1	Control + 150 gauge WV	1.00	1.66	2.33	1.33	2.00	2.33	3.33	2.00
T_1P_2	Control + 150 gauge V 0.5%	1.00	3.00	3.33	1.66	2.00	2.66	3.66	2.33
T_1P_3	Control + 200 gauge WV	1.00	2.00	2.00	1.00	2.00	2.66	3.00	1.33
T_1P_4	Control + 200 gauge V 0.5%	1.00	2.33	3.00	1.33	2.00	2.66	3.33	2.00
T_2P_1	Cold water + 150 gauge WV	1.00	2.33	3.33	1.33	2.00	3.00	3.33	2.33
T_2P_2	Cold water + 150 gauge V 0.5%	1.00	2.66	3.33	2.66	2.33	3.33	4.00	3.00
T_2P_3	Cold water + 200 gauge WV	1.00	2.66	2.66	2.33	2.33	3.00	3.33	2.00
T_2P_4	Cold water + 200 gauge V 0.5%	1.00	2.33	3.00	2.00	2.00	3.00	3.66	2.33
T_3P_1	2% $CaCl_2$ + 150 gauge WV	1.00	2.66	3.66	2.66	2.33	3.33	3.66	3.33
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	1.00	4.00	4.33	3.33	2.00	3.66	4.66	4.30
T_3P_3	2% $CaCl_2$ + 200 gauge WV	1.00	3.33	3.33	2.33	2.00	3.00	3.66	2.66
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	1.00	3.33	3.66	3.00	2.33	3.33	4.00	3.00
T_4P_1	4% $KMnO_4$ + 150 gauge WV	1.00	2.33	3.00	1.66	2.00	3.00	1.33	3.00
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	1.00	2.33	3.33	2.66	2.00	3.33	4.33	3.33
T_4P_3	4% $KMnO_4$ + 150 gauge WV	1.00	2.00	2.66	1.33	2.00	3.00	3.33	2.66
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	1.00	2.66	3.00	1.66	2.33	3.33	3.66	3.00
	F Test	-	*	*	*	NS	NS	*	*
	S. Em ±	-	0.27	0.27	0.3	-	-	0.33	0.25
	CD at 5%	-	0.79	0.79	0.86	-	-	0.96	0.72

* = Significant at 5%, NS= Non Significant, WV= without ventilation, V= with ventilation

Plate 2. Control +150 gauges of PE without ventilation (T_1P_1)

Plate 3. Control+ 150 gauges PE with 5% per cent ventilation (T_1P_2)

Plate 4. Control + 200 gauges of PE without ventilation (T_1 P_3)

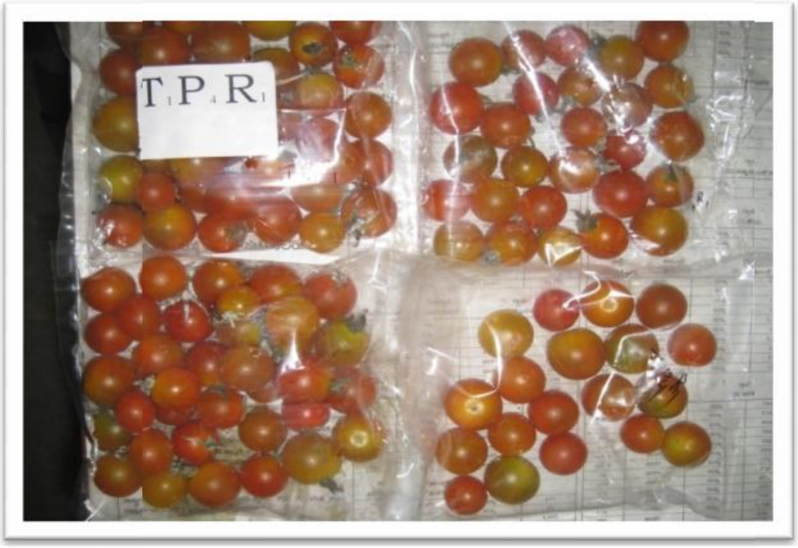

Plate 5. Control +200 gauges PE with 0.5% ventilation (T_1P_4)

Plate 6. Cold water +150 gauges of PE without ventilation (T_1P_3)

Plate 7. Cold water + 150 gauges PE 0.5% ventilation (T_2P_2)

Plate 8. Cold water+ 200 gauges PE without ventilation (T_2P_3)

Plate 9. Cold water+ 200 gauges PE with 0.5% ventilation (T_2P_4)

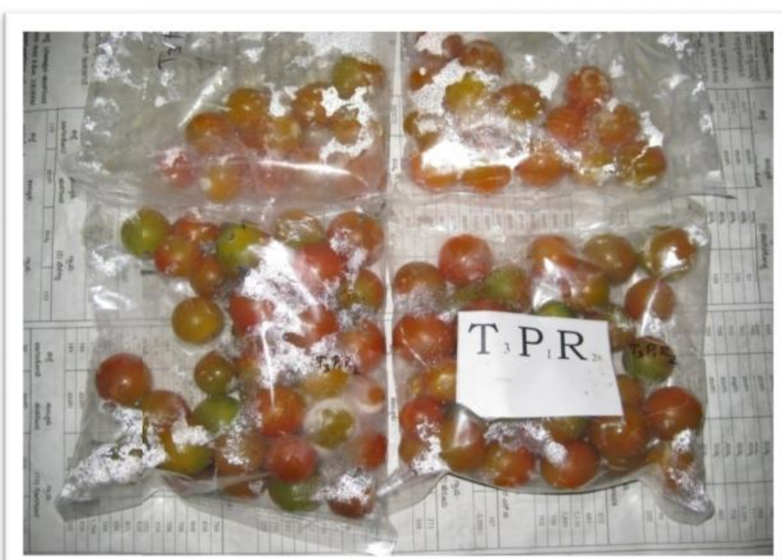

Plate 10. 2% $CaCl_2$+ 150 gauges PE without ventilation (T_3P_1)

Plate 11. 2% $CaCl_2$ + 150 gauges PE with 0.5% ventilation (T_3P_2)

Plate 12. 2% $CaCl_2$ + 200 gauges PE without ventilation (T_3P_3)

Plate 13. 2% $CaCl_2$ +200 gauges PE with 0.5% ventilation (T_3P_4)

Plate 14. 4% $KMnO_4$ + 150 gauges PE without ventilation (T_4P_1)

Plate 15. 4% $KMnO_4$ + 150 gauges PE with 0.5% ventilation (T_4P_2)

Plate 16. 4% $KMnO_4$ + 200 gauges PE without ventilation (T_4P_3)

Plate 17. 4% $KMnO_4$ + 200 gauge with 0.5% ventilation (T_4P_4)

Among the packages the highest color (3.08, 3.58 and 2.58/5.0 and, 2.66, 3.16 and 2.00 /5.0 score point) was recorded in fruits packed in150 and 200 gauge polyethylene bag with ventilation(0.5%) at 5^{th},10^{th} and 15^{th} days after storage respectively. The lowest color was noticed in (2.25, 3.08 and 1.83/5.0) 200 gauge polyethylene bag without ventilation at 5^{th}, 10th and 15^{th} days after storage

In interaction effect the highest color was found in fruits treated with calcium chloride at 2 per cent and packed in 150 gauge and 200 gauge of polyethylene bag with 0.5 per cent ventilation (1.33, 4.00, 4.33 and 3.33/5.00 score point) at 1^{st}, 5^{th}, 10^{th} and 15^{th} days of storage respectively. The lowest color was observed (1.00, 1.66, 2.33 and 1.33 and; 1.00, 2.00, 2.00 and 1.00/5.0) in control packed in 200 and 150 gauges of polyethylene bags and fruits stored at 150 gauge polyethylene bag without ventilation.

4.1.5.2 Taste

The data pertaining to effect of postharvest treatments, polyethylene bags and their interactions on taste of fruits are presented in table 4.

The taste of fruit's pulp differed significantly over the storage period irrespective of the postharvest treatments, packaging and their interactions. However, there was no significant difference between packaging and interaction of treatments at 5^{th} days after storage.

The highest taste was found in fruits treated with 2 per cent calcium chloride following by 4 per cent $KMnO_4$ (3.73, 4.00 and 3.16/5.0 score point at the day 5^{th}, 10^{th} and 3.36, 3.00 /5.0 score point at 5^{th} and 15^{th} day respectively. The lowest taste was observed with control (2.45/5.0) and fruits dipped in cold water (2.80/5.0).

Among the packaging the highest test was recorded in fruits packed in 150 gauges of polyethylene bag with ventilation (0.5%) (3.25,4.16 and 3.08/5.0 score point) followed by fruits packed in 200 gauges of polyethylene with ventilation(0.5%) bags(3.08 and 3.66 /5.0 score point) at the 5th, 10th and 15th days of storage respectively. The lowest taste was found in fruits packed in 150 gauges of polyethylene bags without ventilation(2.91,2.91 and 2.66/5.0 score point) which was on par with 2.91,3.33 and 2.16/5.0 score point) at the 5th, 10th and 15th days of storage respectively.

With respect to interaction the highest taste obtained in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauges with ventilation (0.5%) (4.66 and 4.30/5.0 score point) at 10th and 15th days after storage which was on par with cherry tomato fruits treated with 4 per cent $KMnO_4$ packed in 150 gauges with ventilation (0.5%) (4.33 and 3.33 /5.0) at 10th and 15th days of storage period respectively. The lowest taste was observed with control packed in 200 gauges of polyethylene bags (2.33 and 2.00/5.0) at 5th and 15th days of storage and fruits packed in150 gauges of polyethylene bags without ventilation (2.66 and 1.33/5.0 score point) at 5th and 15th days after storage respectively.

4.1.5.3 Flavours

The data pertaining to flavour of the cherry tomatoes are presented in table 5**.**

The flavour of fruits differed significantly over the storage period irrespective of the postharvest treatments, packaging and their interactions. However, there was no significant difference between packaging at 5th days of storage.

With respect to postharvest treatments the highest flavour was recorded in fruit treated with $CaCl_2$ (3.16, 4.10 and 3.83/5.0 score point)

Table 5. Effect of postharvest treatments and polyethylene packaging on sensory quality of fruits during storage

Treatments	Treatment details	Flavour				Over all acceptability			
		Days after storage							
		At harvest	5	10	15	At harvest	5	10	15
T_1	Control	1.91	2.33	2.66	1.66	1.91	3.00	3.08	1.14
T_2	Cold water	1.83	2.33	3.33	2.66	1.91	2.91	3.16	2.08
T_3	2% $CaCl_2$	1.75	3.16	4.10	3.83	2.00	3.25	3.83	3.00
T_4	4% $KMnO_4$	1.66	2.33	3.16	2.19	2.08	3.10	3.16	2.33
	F Test	NS	*	*	*	*	NS	*	*
	S. Em ±	-	0.15	0.12	0.13	0.13	-	0.13	0.15
	CD at 5%	-	0.44	0.36	0.39	0.39	-	0.37	0.43
Packages(P)									
P_1	150 gauge WV	1.75	2.58	3.08	2.75	2.08	2.91	3.16	2.25
P_2	150 gauge V 0.5%	1.91	2.66	3.75	3.08	2.08	3.41	3.75	2.66
P_3	200 gauge WV	1.66	2.41	3.00	2.33	1.97	2.83	3.00	1.83
P_4	200 gauge V 0.5%	1.83	2.50	3.50	2.91	1.83	3.10	3.33	2.08
	F Test	NS	NS	*	*	*	*	*	*
	S. Em ±	-	-	0.12	0.13	0.13	0.12	0.26	0.15
	CD at 5%	-	-	0.36	0.39	0.39	0.36	0.75	0.43
Interactions(TxP)									
T_1P_1	Control + 150 gauge WV	1.00	2.66	2.33	1.66	1.66	3.00	3.00	1.33
T_1P_2	Control + 150 gauge V 0.5%	1.00	2.33	3.00	1.66	1.66	3.33	3.33	1.66
T_1P_3	Control + 200 gauge WV	1.66	2.33	2.33	1.33	2.00	2.66	3.00	1.33
T_1P_4	Control + 200 gauge V 0.5%	1.00	2.00	3.00	2.33	2.33	3.00	3.00	1.33
T_2P_1	Cold water + 150 gauge WV	1.66	2.33	3.33	3.00	2.33	2.66	3.00	2.00
T_2P_2	Cold water + 150 gauge V 0.5%	1.00	2.33	3.33	2.66	2.00	3.33	3.66	2.66
T_2P_3	Cold water + 200 gauge WV	1.66	2.33	3.00	2.33	1.66	2.66	2.66	1.66
T_2P_4	Cold water + 200 gauge V 0.5%	1.00	2.33	3.66	2.66	1.66	3.00	3.33	2.00
T_3P_1	2% $CaCl_2$ + 150 gauge WV	1.66	3.00	4.00	3.33	2.00	3.00	3.66	3.00
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	1.00	3.66	5.00	4.66	2.33	4.66	4.66	4.00
T_3P_3	2% $CaCl_2$ + 200 gauge WV	1.66	2.66	3.66	3.33	2.00	3.00	3.33	2.66
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	1.66	3.33	4.00	4.00	1.66	3.33	3.66	2.66
T_4P_1	4% $KMnO_4$ + 150 gauge WV	1.66	2.33	2.66	3.00	2.33	3.00	3.00	2.66
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	1.66	2.33	3.66	3.33	2.33	4.00	4.00	3.00
T_4P_3	4% $KMnO_4$ + 150 gauge WV	1.66	2.33	3.00	2.33	2.00	3.00	3.00	1.66
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	1.66	2.33	3.33	3.00	1.66	3.33	3.33	2.33
	F Test	NS	*	*	*	NS	NS	*	*
	S. Em ±	-	0.31	0.25	0.27	-	-	0.26	0.3
	CD at 5%	-	0.89	0.72	0.79	-	-	0.75	0.86

* = Significant at 5%, NS= Non Significant, WV= without ventilation, V= with ventilation

which is on par with dipped in cold water (2.33, 3.33 and 2.66 out of 5.0 score point) at 5^{th}, 10^{th} and 15^{th} days after storage. The lowest flavour was observed in control (2.33, 2.66 and 1.66/5.0).

With respect to packages, the highest flavour was found in 150 gauge and 200 gauge package with 0.5 per cent ventilation (1.91, 2.66, 3.75/5.0 and, 2.5, 3.5 and 2.91/5.0 score point) at 5^{th}, 10^{th} and 15^{th} days of storage. The lowest flavour was observed (2.41, 3.00 and 2.33/5.0) in 200 gauge polyethylene bag without ventilation at 5^{th}, 10^{th} and 15^{th} days of storage period.

In interaction there was significant difference among treatments. The highest flavour was noticed in fruits treated with calcium chloride and fruits packed in 150 and 200 gauges with ventilation (3.66, 5.00 and 4.66 and, 3.33, 4.00 and 4.00 /5.0 score point) at 5^{th}, 10^{th} and 15^{th} days after storage respectively. The lowest flavour was observed in control fruit which was packed in 150 gauges (2.66, 2.33 and 1.66/5.0) which was on par with fruits packed in 200 gauge polyethylene bag without ventilation (2.33, 2.33 and 1.33/5.0) at 5^{th}, 10^{th} and 15^{th} days after storage respectively.

4.1.5.4 Overall acceptance

The data pertaining to overall acceptability of the cherry tomato fruits are presented in table 5**.**

The overall acceptability of the cherry tomato fruits differed significantly over the storage period irrespective of the postharvest treatments, packaging and their interactions. However, there was no significant difference to pretreatment and interactions at 5^{th} days after storage.

The highest overall acceptance was recorded in cherry tomato fruits treated with calcium chloride at 2 per cent which was on par with potassium permanganate 4 per cent level (3.83, 3.00 and 3.16,2.33/5.0 score point) at 10^{th} and 15^{th} days of storage. The lowest Overall acceptance was observed in control without any treatments (3.08 and 1.14/5.0) at the 10^{th} and 15^{th} days after storage.

Packages of the treatment showed significant difference the highest overall acceptance observed in fruit packed 150 gauges and 200 gauge with 0.5 per cent ventilation (3.41, 3.75, 2.66 and 3.1, 3.33 and 2.08/5.0 score point) at the 5^{th}, 10th and 15^{th} of storage respectively. The lowest Overall acceptance was observed in 200 gauges of polyethylene bags (2.83, 3.00 and 1.83/5.0) and fruits stored at 150 gauge polyethylene bag with o.5 per cent ventilation (2.91, 3.16 and 2.25/5) at 5^{th}, 10th and 15^{th} of storage respectively.

The interaction effects of post harvest treatments and polyethylene packages shows significant results. The highest overall acceptance was recorded in fruits treated with 2 per cent calcium chloride which was on par with 4 per cent potassium permanganate, and fruits packed in 150 and 200 gauge with 0.5 per cent ventilation (4.66, 4.66 and 4 and 4.00, 4.33 and 3.00/5.0 score point) at 5^{th}, 10th and 15^{th} days after storage respectively. The lowest Overall acceptance was observed in control (3.00, 3.00 1.33/5.0 and, 3.00/5.0) and fruits packed in 150 and 200 gauge polyethylene bags without ventilation at 5^{th},10^{th} and 15^{th} days after storage respectively.

4.2 Chemical parameters

4.2.1 Total soluble solids (°Brix)

The data pertaining to change in total soluble solids (TSS) during storage are presented in (Table 6 and Figure 4).

The total soluble solids (TSS) differed significantly over the period of storage irrespective of postharvest treatments, packaging and their interactions. However, there was no significant effect on packaging and their interaction with postharvest treatments at 13^{th} and 15^{th} days after storage.

With respect to the postharvest treatments, the highest TSS was recorded in fruits treated with 2 per cent $CaCl_2$ (3.06, 3.35, 3.53, 4.27, 4.99, 5.56, 5.54, 4.53 and 4.43 °Brix) followed by fruits treated with 4 per cent $KMnO_4$ (3.00, 3.36, 3.74, 4.18, 4.77, 4.70, 3.80 and 3.65 °Brix) at $3r^{d}$ 5^{th}, 7^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively. And the lowest TSS was observed in control fruits (3.03, 3.23, 3.51, 4.18, 4.59, 4.66, 3.85 and 3.08 °Brix).

With respect to the packages the highest TSS was observed in cherry tomatoes packed in 150 gauges of polyethylene packages with 0.5 per cent ventilation (3.04, 3.46, 3.97, 4.82, 5.25, 5.21, 4.73 and 3.95°Brix) followed by cherry tomatoes packed in 150 polyethylene bag without ventilation (3.35, 3.74, 4.59, 4.91, 4.94, 3.35 and 3.51°Brix) at the 3^{rd}, 5^{th}, 7^{th}, 9^{th}, 10^{th} and 15^{th} days after storage respectively. The lowest TSS was observed in fruits packed in 200 gauges of polyethylene bag without ventilation (3.06, 3.30, 3.56, 4.04, 4.5, 4.64, 4.04 and 3.35 Brix) at the 3^{rd}, 5^{th}, 7^{th}, 9th, 10^{th} and 15^{th} days after storage respectively.

However, in the interaction there was significant difference among the treatments as affected by postharvest treatments and polythene packages except for the 13^{th} and 15^{th} day of storage. The highest TSS (3.7, 4.83, 5.67, 6.26, 6.1,5.53 and 4.80 °Brix) was recorded in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauge polythene bag with 0.5 per cent ventilation followed by fruits treated with 2 per cent $CaCl_2$ (4.3, 4.66, 5.66 and 5.4 °Brix) stored at 200 gauge polythene with 0.5 ventilation at 5^{th}, 7^{th}, 9^{th}, and 11^{th} of storage. While the lowest total

Table 6. Effects of postharvest treatments and packaging on TSS (%) of fruits during storage

Treatments	Treatment details	Total soloubble solid(TSS °Brix)							
		Days after storage							
		At harvest	3	5	7	9	11	13	15
T_1	Control	3.03	3.23	3.51	4.18	4.59	4.66	3.85	3.08
T_2	Cold water	3.06	3.35	3.53	4.21	4.45	4.7	4.20	3.24
T_3	2% $CaCl_2$	3.06	3.51	4.27	4.99	5.56	5.54	3.53	4.43
T_4	4% $KMnO_4$	3.00	3.36	3.74	4.18	4.77	4.7	3.8	3.65
	F Test	NS	*	*	*	*	*	*	*
	SEm ±	-	0.02	0.05	0.05	0.05	0.05	0.04	0.08
	CD at 5%	-	0.07	0.17	0.16	0.17	0.16	0.13	0.25
Packages (P)									
P_1	150 gauge WV	3.02	3.35	3.74	4.59	4.91	4.94	3.35	3.51
P_2	150 gauge V 0.5%	3.04	3.46	3.97	4.82	5.25	5.21	4.73	3.95
P_3	200 gauge WV	3.06	3.30	3.56	4.04	4.50	4.64	4.04	3.38
P_4	200 gauge V 0.5%	3.06	3.35	3.78	4.11	4.7	4.81	4.14	3.55
	F Test	NS	*	*	*	*	*	*	NS
	SEm ±	-	0.02	0.05	0.05	0.05	0.05	0.04	-
	CD at 5%	-	0.07	0.17	0.16	0.17	0.16	0.13	-
Interactions (TxP)									
T_1P_1	Control + 150 gauge WV	3.00	3.23	3.46	4.43	4.7	4.63	3.83	3.16
T_1P_2	Control + 150 gauge V 0.5%	3.06	3.36	3.6	4.62	4.94	4.76	4.26	3.50
T_1P_3	Control + 200 gauge WV	3.06	3.16	3.46	3.68	4.31	4.43	3.53	2.66
T_1P_4	Control + 200 gauge V 0.5%	3.00	3.16	3.53	4.00	4.43	4.83	3.8	3.00
T_2P_1	Cold water + 150 gauge WV	3.03	3.33	3.5	4.50	4.50	4.70	4.13	3.20
T_2P_2	Cold water + 150 gauge V 0.5%	3.03	3.46	3.63	4.66	4.56	4.93	4.53	3.43
T_2P_3	Cold water + 200 gauge WV	3.10	3.26	3.46	3.86	4.46	4.60	4.00	2.96
T_2P_4	Cold water + 200 gauge V 0.5%	3.06	3.36	3.53	3.83	4.31	4.56	4.16	3.36
T_3P_1	2% $CaCl_2$ + 150 gauge WV	3.06	3.53	4.20	4.96	5.46	5.60	5.03	4.20
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	3.06	3.70	4.83	5.67	6.26	6.10	5.53	4.80
T_3P_3	2% $CaCl_2$ + 200 gauge WV	3.06	3.43	3.76	4.66	5.13	5.16	4.80	4.53
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	3.03	3.40	4.30	4.66	5.40	5.30	4.73	4.20
T_4P_1	4% $KMnO_4$ + 150 gauge WV	3.00	3.30	3.83	4.46	5.00	4.83	4.40	3.50
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	3.00	3.33	3.56	4.33	5.26	5.06	4.60	4.10
T_4P_3	4% $KMnO_4$ + 150 gauge WV	3.03	3.36	3.83	3.96	4.13	4.36	3.83	3.36
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	3.16	3.46	3.76	3.96	4.70	4.56	3.86	3.63
	F Test	NS	*	*	*	*	*	NS	NS
	S. Em ±	-	0.04	0.11	0.11	0.11	0.11	-	-
	CD at 5%	-	0.14	0.17	0.33	0.34	0.33	-	-

* = Significant at 5%, NS= Non Significant, WV= without ventilation, V= with ventilation

soluble solid was recorded in control and fruits packed in 200 gauges of polyethylene bags (3.26, 3.46, 3.86, 4.46, and 4.60, °Brix) followed by 150 gauge polythene bags without ventilation (3.23, 3.46, 4.43, 4.7, and 4.63 °Brix) at 3rd, 5th, 7th, 9th and 11th of storages day of cherry tomatoes.

4.2.2. Titratable acidity (%)

The data pertaining to Titratable acidity (%) during storage is presented in (Table 7).

The Titratable acidity (%) differed significantly over the storage period irrespective of postharvest treatments, packaging and their interactions. However there was no significant difference between the interaction effects on 3rd, 5th, 7th, 9th, and 11th days after storage.

With respect to the postharvest treatments the highest per cent of Titratable acidity was found in the fruits treated with 2 per cent $CaCl_2$ (0.3, 0.32, 0.32, 0.33 %) at the 3rd, 9th, and 11th days of storage respectively. The lowest Titratable acidity was recorded in control without any pretreatment (0.28, 0.28, 0.29, 0.28, 0.29, 0.28, 0.28, 0.26and 0.18 %) at 3nd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively.

With respect to the packages the highest Titratable acidity(%) was found in fruits packed in 150 gauges of polyethylene bags (0.3, 0.31, 0.31, 0.31, 0.31, 0.33 and 0.25%) at 3rd, 5th, 7th, 9th, 11th, and 13th days after storage which was on par with fruits packed in 200 gauges of polyethylene bags with 0.5 per cent ventilation (0.29, 0.29, 0.30, 0.29, 0.29 and 0.23 %) and fruits packed in 150 gauges of polyethylene bags without ventilation(0.29, 0.29, 0.30, 0.29, 0.28 and 0.24%) at the 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively. The lowest Titratable acidity (%) was found in 200 gauge of polyethylene bags (0.28, 0.28, 0.28, 0.29, 0.28, 0.28 and 0.22%) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days respectively.

Table 7. Effects of postharvest treatments and packaging on titratable acidity (mg/100g) of fruits during storage

Treatments	Treatment details	Titratable Acidity (mg/100g)							
		Days after storage							
		At harvest	3	5	7	9	11	13	15
T_1	Control	0.27	0.28	0.28	0.29	0.28	0.28	0.26	0.18
T_2	Cold water	0.27	0.28	0.29	0.30	0.30	0.29	0.27	0.19
T_3	2% $CaCl_2$	0.29	0.30	0.28	0.28	0.32	0.32	0.26	0.33
T_4	4% $KMnO_4$	0.28	0.29	0.28	0.29	0.29	0.28	0.26	0.23
	F Test	NS	*	*	*	*	*	*	*
	SEm ±	-	0.002	0.001	0.002	0.002	0.003	0.004	0.006
	CD at 5%	-	0.006	0.005	0.007	0.006	0.009	0.01	0.01
Packages(P)									
P_1	150 gauge WV	0.28	0.28	0.29	0.30	0.29	0.29	0.28	0.23
P_2	150 gauge V 0.5%	0.28	0.30	0.31	0.31	0.31	0.31	0.33	0.25
P_3	200 gauge WV	0.28	0.28	0.28	0.28	0.29	0.28	0.28	0.22
P_4	200 gauge V 0.5%	0.28	0.29	0.29	0.30	0.29	0.29	0.29	0.23
	F Test	NS	*	*	*	*	*	*	*
	SEm ±	-	0.002	0.001	0.002	0.002	0.003	0.004	0.006
	CD at 5%	-	0.006	0.005	0.007	0.006	0.009	0.01	0.01
Interactions(TxP)									
T_1P_1	Control + 150 gauge WV	0.27	0.28	0.29	0.28	0.28	0.28	0.26	0.20
T_1P_2	Control + 150 gauge V 0.5%	0.27	0.28	0.29	0.30	0.29	0.29	0.27	0.19
T_1P_3	Control + 200 gauge WV	0.28	0.28	0.28	0.28	0.28	0.27	0.26	0.17
T_1P_4	Control + 200 gauge V 0.5%	0.27	0.27	0.28	0.29	1.22	0.29	0.26	0.18
T_2P_1	Cold water + 150 gauge WV	0.27	0.28	0.28	0.29	0.30	0.29	0.27	0.18
T_2P_2	Cold water + 150 gauge V 0.5%	0.29	0.30	0.31	0.31	0.30	0.30	0.30	0.17
T_2P_3	Cold water + 200 gauge WV	0.28	0.28	0.29	0.30	0.30	0.29	0.28	0.19
T_2P_4	Cold water + 200 gauge V 0.5%	0.27	0.28	0.29	0.30	0.29	0.29	0.27	0.21
T_3P_1	2% $CaCl_2$ + 150 gauge WV	0.29	0.29	0.31	0.31	0.32	0.32	0.31	0.29
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	0.29	0.31	0.32	0.33	0.34	0.34	0.46	0.39
T_3P_3	2% $CaCl_2$ + 200 gauge WV	0.28	0.30	0.32	0.32	0.32	0.31	0.32	0.32
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	0.29	0.30	0.31	0.31	0.31	0.31	0.34	0.32
T_4P_1	4% $KMnO_4$ + 150 gauge WV	0.28	0.29	0.29	0.30	0.28	0.27	0.27	0.24
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	0.29	0.30	0.31	0.30	0.31	0.30	0.29	0.26
T_4P_3	4% $KMnO_4$ + 150 gauge WV	0.28	0.29	0.30	0.29	0.28	0.27	0.25	0.21
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	0.29	0.30	0.30	0.29	0.28	0.28	0.22	0.21
	F Test	NS	NS	NS	NS	NS	NS	*	*
	S. Em ±	-	-	-	-	-	-	0.08	0.03
	CD at 5%	-	-	-	-	-	-	0.02	0.01

* = Significant at 5%, NS= Non Significant, WV= without ventilation, V= with ventilation

In interaction, the highest Titratable acidity(%) was found in cherry tomatoes pretreated with 2 per cent $CaCl_2$ (0.31, 0.32, 0.33, 0.34, 0.34, 0.46, and 0.39%), and stored in 150 gauge polythene package with ventilation followed by fruits treated with 2 per cent $CaCl_2$ and 4 per cent $KMnO_4$ and packed in 150 gauges of polyethylene bags without ventilation (0.31, 0.31, 0.32, 0.32, 0.31 and 0.29%) which was on par with 200 gauges bag with 0.5 per cent ventilation(0.3, 0.31, 0.31, 0.31, 0.31, 0.31, 0.43 and 0.32%)at 5th,7th,9th, 11th, 13th and 15th respectively. The lowest acidity was found in fruits packed in 200 gauges of polyethylene without any treatments (0.28, 0.28, 0.28, 0.28, 0.28, 0.27, 0.27and 0.17%) at 3rd, 5th, 7th, 9th, 13th and 15th days after storage in ambient temperature.

4.2.3 Reducing Sugar (%)

The data pertaining to the reducing sugar (%) during storage period are presented in table 8.

The reducing sugar content of the cherry tomato fruits differed significantly over the storage period irrespective of the postharvest treatments, polythene packages and their interaction. However, there is no significant difference to the packaging materials on 5th day of storage.

With respect to postharvest treatments the highest reducing sugar content was recorded in cherry tomato fruits treated with 2 per cent $CaCl_2$ (2.95, 4.00, and 4.63%) followed by fruits treated with 4 per cent $KMnO_4$ (2.93, 3.69, and 3.51%) at 1st, 5th, 10th and 15th days of storage respectively. The lowest reducing sugar was observed in control without any pretreatment (2.79, 3.51 and 1.82 %) at 1st, 5th, 10th and 15th days of storage respectively.

With respect to the polyethylene packages used the highest reducing sugar content was observed in fruits packed in I50 gauges of

Table 8. Effect of postharvest treatments and packaging on reducing sugar (mg/100g) of fruits during storage

Treatments	Treatment's details	Reducing Sugar (mg/100g)			
		Days after storage			
		A harvest	5	10	15
T_1	Control	2.41	2.79	3.51	1.82
T_2	Cold water	2.36	2.90	3.66	2.82
T_3	2% $CaCl_2$	2.43	2.95	4.00	4.63
T_4	4% $KMnO_4$	2.34	2.93	3.69	3.51
	F Test	NS	*	*	*
	SEm ±	-	0.03	0.04	0.06
	CD at 5%	-	0.11	0.13	0.17
Packages(P)					
P_1	150 gauge WV	2.36	2.8	3.51	2.98
P_2	150 gauge V 0.5%	2.36	2.92	3.87	3.09
P_3	200 gauge WV	2.43	2.85	3.71	3.26
P_4	200 gauge V 0.5%	2.40	2.75	3.77	3.26
	F Test	NS	NS	*	*
	SEm ±	-	-	0.04	0.06
	CD at 5%	-	-	0.13	0.17
Interactions(TxP)					
T_1P_1	Control + 150 gauge WV	2.35	2.73	3.36	1.96
T_1P_2	Control + 150 gauge V 0.5%	2.37	2.83	3.46	2.2
T_1P_3	Control + 200 gauge WV	2.41	2.9	3.66	1.63
T_1P_4	Control + 200 gauge V 0.5%	2.53	2.69	3.56	1.49
T_2P_1	Cold water + 150 gauge WV	2.39	2.93	3.66	1.99
T_2P_2	Cold water + 150 gauge V 0.5%	2.38	3.10	3.73	2.98
T_2P_3	Cold water + 200 gauge WV	2.35	2.87	3.76	2.93
T_2P_4	Cold water + 200 gauge V 0.5%	2.34	2.91	3.49	3.39
T_3P_1	2% $CaCl_2$ + 150 gauge WV	2.36	2.97	3.97	4.64
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	2.37	3.50	4.53	4.93
T_3P_3	2% $CaCl_2$ + 200 gauge WV	2.63	2.90	3.78	4.52
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	2.36	2.98	3.72	4.44
T_4P_1	4% $KMnO_4$ + 150 gauge WV	2.34	3.30	3.85	3.33
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	2.34	3.50	4.10	4.75
T_4P_3	4% $KMnO_4$ + 150 gauge WV	2.32	2.95	2.85	3.95
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	2.37	2.88	3.26	3.73
	F Test	NS	*	*	*
	S. Em ±	-	0.03	0.09	0.12
	CD @ 5%	-	0.11	0.26	0.34

* = Significant at 5%, NS = Non-significant, V= with ventilation, WV= without ventilation

polyethylene bag with 0.5 per cent ventilation (2.93, 3.87, and 3.09%) at 1st, 5th, 10th and 15th days of storage respectively. The lowest reducing sugar (%) in cherry tomato fruits was recorded in fruits packed in 150 gauge polyethylene bag without ventilation (2.36, 2.80, 3.51 and 2.98 %) at 1st, 5th, 10th and 15th days of storage respectively.

In the interaction, the highest reducing sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ and stored in 150 gauge polyethylene package with 0.5 per cent ventilation (3.5, 4.53 and 4.93%) followed by fruits treated with 4 per cent potassium permanganate and stored in 150 gauge polyethylene with ventilation (3.30, 4.10, and 4.75%) at the 1st, 5th, 10th and 15th days of storage respectively. The lowest reducing sugar content was recorded in fruits without any pretreatment and fruits packed in 150 gauge Polyethylene without ventilation (2.35, 2.73, 3.36 and 1.96 %) at 1st, 5th, 10th and 15th days of storage respectively.

4.2.4. Non reducing sugar (%)

The data pertaining to the non-reducing sugar (%) is presented in table 9. Non reducing sugar differed significantly over the storage period irrespective of the pretreatment, packages and their interactions. However, there are no significant differences in the interactions.

With respect to the postharvest treatments the highest non reducing sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ (1.58, 1.74 and 0.9 %) followed by fruits treated with 4 per cent $KMnO_4$ (1.44, 1.51 and 0.85%) at 5th, 10th and 15th days of storage respectively. The lowest non reducing sugar was recorded in fruits without any pre treatment (1.42, 1.49, and 0.71 %) at 5th, 10th, and 15th day of storage respectively.

Table 9: Effect of postharvest treatments and packaging on non-reducing sugar (mg/100g) of fruits during storage

Treatments	Treatment details	Non- Reducing Sugar(mg/100gr)			
		Days after storage			
		At harvest	5	10	15
T_1	Control	0.93	1.42	1.49	0.71
T_2	Cold water	0.93	1.42	1.5	0.85
T_3	2% $CaCl_2$	0.94	1.58	1.74	0.9
T_4	4% $KMnO_4$	0.94	1.44	1.51	0.88
	F Test	NS	*	*	*
	S. Em ±	-	0.03	0.01	0.01
	CD at 5%	-	0.11	0.03	0.03
Packages(P)					
P_1	150 gauge WV	0.93	1.46	1.57	0.85
P_2	150 gauge V 0.5%	0.94	1.55	1.69	0.91
P_3	200 gauge WV	0.93	1.39	1.48	0.76
P_4	200 gauge V 0.5%	0.94	1.45	1.52	0.8
	F Test	NS	*	*	*
	SEm ±	-	0.03	0.01	0.01
	CD at 5%	-	0.11	0.03	0.03
Interactions(TxP)					
T_1P_1	Control + 150 gauge WV	0.94	1.43	1.47	0.88
T_1P_2	Control + 150 gauge V 0.5%	0.94	1.56	1.66	0.96
T_1P_3	Control + 200 gauge WV	0.92	1.33	1.41	0.83
T_1P_4	Control + 200 gauge V 0.5%	0.75	1.37	1.43	0.84
T_2P_1	Cold water + 150 gauge WV	0.93	1.4	1.56	0.86
T_2P_2	Cold water + 150 gauge V 0.5%	0.94	1.5	1.63	0.91
T_2P_3	Cold water + 200 gauge WV	0.92	1.33	1.39	0.77
T_2P_4	Cold water + 200 gauge V 0.5%	0.94	1.45	1.5	0.87
T_3P_1	2% $CaCl_2$ + 150 gauge WV	0.94	1.6	1.7	0.92
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	0.95	1.8	1.86	0.96
T_3P_3	2% $CaCl_2$ + 200 gauge WV	0.68	1.53	1.66	0.84
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	0.93	1.63	1.72	0.85
T_4P_1	4% $KMnO_4$ + 150 gauge WV	0.93	1.41	1.51	0.73
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	0.93	1.6	1.62	0.8
T_4P_3	4% $KMnO_4$ + 150 gauge WV	0.95	1.38	1.45	0.62
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	0.95	1.38	1.46	0.66
	F Test	NS	NS	NS	NS
	S. Em ±	-	-	-	-
	CD @ 5%	-	-	-	-

* = Significant at 5%, NS = Non-significant, V= with ventilation, WV= without ventilation

With respect to polythene packages the highest non reducing sugar content was recorded in fruits packed in 150 gauge polythene bags with 0.5 per cent ventilation with non reducing sugar content (0.94, 1.55, 1.69 and 1.91 %) at 5th, 10th and 15th days of storage respectively followed by fruits stored in 200 gauge polythene with 0.5 per cent ventilation with non reducing sugar content (1.45, 0.52 and 0.85 %) at 5th, 10th and 15th days of storage respectively. The lowest reducing sugar was observed in fruits packed in 200 gauges of polyethylene bags without ventilation (1.39, 1.48, and 0.76 %) at 1st, 5th, 10th and 15th days of storage respectively.

In interaction the highest non reducing sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ and stored in 150 gauge polythene package with 5 per cent ventilation (1.8, 1.86 and 0.96%) at 5th, 10th and 15 days of storage respectively. Followed by fruits treated with 2 per cent $CaCl_2$ and packed in 200 gauge polythene bag with 0.5 per cent ventilation (1.63, 1.72 and 0.85 %) at 5th, 10th and 15th days of storage respectively. The lowest non reducing sugar content was recorded in control and fruits packed in 200 gauge polythene bag without ventilation at all the days of storage (1.33, 1.41 and 0.83%) at 5th, 10th and 15th days after storage respectively.

4.2.5 Total sugar (%)

The data pertaining to the fruit total sugar (%) is presented in table 10 and figure 5.

The total sugar (%) differed significantly over the storage period irrespective of pre treatments, packages and their interaction.

With respect to the postharvest treatments the higher total sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ (4.57, 5.75 and 5.5%) followed by fruits treated with 4 per cent $KMnO_4$ (4.35, 5.31

Table 10. Effect of postharvest treatments and packaging on total sugar (mg/100g) of fruits during storage

Treatments	Treatment details	Total Sugar(mg/100gr)			
		Days after storage			
		At harvest	5	10	15
T_1	Control	3.30	4.21	5.01	2.7
T_2	Cold water	3.30	4.37	5.17	3.65
T_3	2% $CaCl_2$	3.31	4.57	5.75	5.5
T_4	4% $KMnO_4$	3.29	4.35	5.31	4.2
	F Test	NS	*	*	*
	S. Em ±	-	0.03	0.03	0.06
	CD at 5%	-	0.09	0.09	0.17
Packages(P)					
P_1	150 gauge WV	3.30	4.39	5.26	3.76
P_2	150 gauge V 0.5%	3.31	4.50	5.55	4.36
P_3	200 gauge WV	3.30	4.28	5.2	3.77
P_4	200 gauge V 0.5%	3.29	4.34	5.2	4.03
	F Test	NS	*	*	*
	S. Em ±	-	0.03	0.03	0.06
	CD at 5%	-	0.09	0.09	0.17
Interactions(TxP)					
T_1P_1	Control + 150 gauge WV	3.29	4.16	4.83	2.83
T_1P_2	Control + 150 gauge V 0.5%	3.31	4.40	5.16	3.16
T_1P_3	Control + 200 gauge WV	3.33	4.23	5.06	2.46
T_1P_4	Control + 200 gauge V 0.5%	3.28	4.06	5.00	2.33
T_2P_1	Cold water + 150 gauge WV	3.32	4.33	5.23	2.76
T_2P_2	Cold water + 150 gauge V 0.5%	3.33	4.60	5.36	3.90
T_2P_3	Cold water + 200 gauge WV	3.28	4.20	5.10	3.70
T_2P_4	Cold water + 200 gauge V 0.5%	3.28	4.36	5.00	4.26
T_3P_1	2% $CaCl_2$ + 150 gauge WV	3.30	4.60	5.70	5.56
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	3.33	4.73	6.33	5.90
T_3P_3	2% $CaCl_2$ + 200 gauge WV	3.32	4.43	5.46	5.33
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	3.30	4.53	5.50	5.23
T_4P_1	4% $KMnO_4$ + 150 gauge WV	3.27	4.46	5.36	3.93
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	3.28	4.26	5.36	4.50
T_4P_3	4% $KMnO_4$ + 150 gauge WV	3.28	4.26	5.26	4.10
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	3.32	4.40	5.00	4.30
	F Test	NS	*	*	*
	S. Em ±	-	0.06	0.06	0.12
	CD at 5%	-	0.09	0.18	0.35

* = Significant at 5%, NS = Non-significant, V= with ventilation, WV= without ventilation

and 4.2 %) at 5th, 10th and 15th days of storage respectively. The lowest total sugar was recorded in fruits without any treatment (3.30, 4.21, 5.01 and 2.07 %) at 5th, 10th and 15th days of storage respectively.

With respect to the polyethylene packages used, higher total sugar content was recorded in fruits packed in 150 gauge polyethylene bag with 0.5 per cent ventilation (3.31, 4.50,4.55 and 4.36 %) followed by 200 gauge of polyethylene bag without ventilation (4.34, 5.20 and 4.03 %) at 5th, 10th, and 15th days of storage respectively. The lowest total sugar was recorded in fruits packed with 200 gauges without ventilation (4.28, 5.22 and 3.77 %) at 5th, 10th and 15th days of storage respectively.

In interactions the highest total sugar was observed in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauges of polyethylene bags with 0.5 per cent ventilation (4.73, 6.33 and 5.9*%)* followed by fruits treated 2 per cent $CaCl_2$ and stored in 200 gauge polyethylene with 0.5 per cent ventilation with total sugar content (4.53, 5.5, and 5.23%) at 5th, 10th and 15th days after storage. The lowest total sugar content was recorded in fruit without any treatment which was on par with fruits dipped in cold water in 200 gauge polyethylene without ventilation (3.29, 4.16, 4.83 and 2.83%) at 5th,10th, and 15th days of storage respectively.

4.2.6 pH

The data pertaining to the pH content of cherry tomato fruit during storage is presented in table 11.

The pH of cherry tomato fruits differed significantly over the storage period irrespective of the postharvest treatments, packages and their interaction. However, there were no significant differences to packaging materials at 5th and 15th and in interaction effect at 3rd and 5th days after storage.

Table 11. Effect of postharvest treatments and packaging on pH of fruits during storage

Treatments	Treatments details	pH							
		Days after storage							
		At harvest	3	5	7	9	11	13	15
T_1	Control	3.96	4.14	4.30	4.4	4.47	4.25	3.27	3.06
T_2	Cold water	3.99	4.15	4.25	4.44	4.61	4.45	3.36	3.34
T_3	2% $CaCl_2$	3.95	4.30	4.46	4.67	4.75	4.75	4.51	4.39
T_4	4% $KMnO_4$	3.86	4.19	4.33	4.49	4.55	4.51	3.98	4.53
F Test		NS	*	*	*	*	*	*	*
S. Em ±		-	0.03	0.03	0.01	0.01	0.02	0.05	0.05
CD at 5%		-	0.09	0.08	0.05	0.04	0.06	0.14	0.14
Packages(P)									
P_1	150 gauge WV	3.95	4.15	4.33	4.48	4.57	4.43	3.89	3.60
P_2	150 gauge V 0.5%	3.96	4.27	4.37	4.59	4.70	4.60	4.14	3.62
P_3	200 gauge WV	3.95	4.07	4.30	4.45	4.51	4.40	3.60	3.58
P_4	200 gauge V 0.5%	3.95	4.17	4.34	4.49	4.60	4.54	3.80	3.51
F Test		NS	*	NS	*	*	*	*	NS
S. Em ±		-	0.03	-	0.01	0.01	0.02	0.05	-
CD at 5%		-	0.09	-	0.05	0.04	0.06	0.14	-
Interactions(TxP)									
T_1P_1	Control + 150 gauge WV	3.90	4.20	4.36	4.36	4.40	4.30	3.36	3.00
T_1P_2	Control + 150 gauge V 0.5%	3.90	4.16	4.33	4.53	4.53	4.30	3.43	3.26
T_1P_3	Control + 200 gauge WV	3.96	4.03	4.30	4.36	4.43	4.30	3.13	3.00
T_1P_4	Control + 200 gauge V 0.5%	3.93	4.16	4.23	4.36	4.53	4.36	3.16	3.00
T_2P_1	Cold water + 150 gauge WV	3.96	3.96	4.20	4.43	4.53	4.43	3.66	2.96
T_2P_2	Cold water + 150 gauge V 0.5%	3.93	4.16	4.33	4.53	4.66	4.60	4.06	3.10
T_2P_3	Cold water + 200 gauge WV	3.90	3.96	4.33	4.43	4.56	4.30	3.36	3.80
T_2P_4	Cold water + 200 gauge V 0.5%	3.86	4.10	4.40	4.56	4.70	4.50	3.60	3.50
T_3P_1	2% $CaCl_2$ + 150 gauge WV	3.96	4.33	4.53	4.63	4.80	4.76	4.30	4.40
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	3.96	4.43	4.50	4.80	4.96	4.90	4.80	4.56
T_3P_3	2% $CaCl_2$ + 200 gauge WV	3.93	4.23	4.46	4.60	4.60	4.60	4.40	4.26
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	3.96	4.20	4.36	4.66	4.66	4.73	4.56	4.33
T_4P_1	4% $KMnO_4$ + 150 gauge WV	3.96	4.20	4.33	4.50	4.56	4.50	4.23	4.06
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	3.96	4.33	4.20	4.50	4.63	4.60	4.26	3.56
T_4P_3	4% $KMnO_4$ + 150 gauge WV	3.94	4.06	4.13	4.40	4.46	4.40	3.53	3.26
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	3.93	4.16	4.33	4.36	4.5	4.56	3.9	3.23
F Test		NS	NS	NS	*	*	*	*	*
S. Em ±		-	-	-	0.03	0.03	0.13	0.1	0.1
CD at 5%		-	-	-	0.1	0.09	0.04	0.29	0.29

* = Significant at 5%, NS = Non-significant, V= with ventilation, WV= without ventilation

The higher pH content was recorded in fruits treated with 2 per cent $CaCl_2$ (4.3 ,4.46 ,4.67,4.75,4.75,4.51 and 4.39) followed by fruits treated with (4.19,4.33,4.49,4.55,4.51,3.98 and 4.53) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days after storage. The lowest was pH recorded in fruits without any treatment (4.14, 4.15, 4.25, 4.44, 4.47, 4.25, 3.37 and 3.06) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days after storage respectively.

With respect to the polyethylene packages used the highest pH was recorded in fruits packed in 150 and 200 gauge polyethylene with 0.5% ventilation(4.27,4.37,4.59,4.70,4.60,4.14,and; 3.62 and 4.15, 4.17, 4.34, 4.49, 4.60, 4.54, 3.8 and 3.51) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively. .The lowest was pH recorded in cherry tomato fruits packed in 200 gauge without ventilation (4.07, 4.30, 4.41, 4.51, 4.40, 3.60and 3.58) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively.

However, in the interaction effect highest pH was recorded in fruit treated with 2 per cent $CaCl_2$ and packed in 150 gauge polyethylene package with 0.5 per cent ventilation (4.80, 4.96, 4.90, 4.8 and 4.56) at 7th, 9th, 11th, 13th and 15th days of storage respectively, followed by fruits treated with same treatment (4.66, 4.66, 4.73, 456 and 4.33) and stored in 200 gauge polyethylene bag with ventilation. The lowest pH content was recorded in case of control stored 200 gauge polyethylene without ventilation (4.33, 4.36, 4.43, 4.30, 3.13 and 3.00) at 7th,9th,11th,13th and 15th days of storage respectively.

4.2.7 Ascorbic acid (mg/ 100g)

The data pertaining to the Ascorbic acid content (mg/l00g) during storage period is presented in Table 12 and figure 6.

Ascorbic acid content (mg/l00g) of cherry tomato fruits differed significantly over the storage period irrespective of postharvest treatments, packages and their interactions. However, the is no significant difference to the postharvest treatments and packaging materials at 7^{th} day of storage and for interaction effect on at 5^{th} and 11^{th} days after storage period.

The highest Ascorbic acid (18.50, 18.93, 21.00, 22.11,2245, 22.45, 22.50 and 19.16 mg/ l00g) content was recorded in fruits treated with 2 per cent $CaCl_2$ followed by fruits treated with 4 per cent $KMnO_4$ (18.35, 18.86, 19.73, 20.50, 20.20 and 16.5 mg/100g) at 3^{rd}, 5^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively. The lowest Ascorbic acid (17,71, 18.33, 20.02, 20.83,17,15,14 mg/l00g) was recorded in fruits treated with cold water at 3^{rd},5^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively.

Similarly with respect to the polythene bags the highest Ascorbic acid content (19.36, 21.1, 22.11, 22.45, 22.5 and 19.16 mg/l00g) was recorded in fruits packed in 150 gauge with 0.5 per cent ventilation followed by fruits packed in 200 gauge bags with 0.5 per cent ventilation (17.96, 18.57, 20.39, 21.35, 19.70, 19.60, and 16.00 mg/100g) at 3^{rd}, 5^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively.. The lowest Ascorbic acid (17.85, 18.46, 20.06, 20.07, 17.04, 19.60 and 14.91 mg/100g) was recorded in fruits packed with 150 gauge without ventilation at 3^{rd},5^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively.

However, in the interaction the highest ascorbic acid content was recorded in fruits treated with 2 per cent CaCl2 (18.43, 19.93, 22.33, 22.76, 22.76, 22.90 and 20.00mg/100g) and packed in 150 gauge polythene with ventilation, followed by fruits treated with 4 per cent $KMnO_4$ stored in 150 gauges polythene with 0.5 per cent ventilation (17.83, 18.93, 20.33, 20.90, 20.96, 21.60 and 18.60 mg/l00g) at 3rd, 5^{th},

Table 12. Effect of postharvest treatments and packaging on ascorbic acid (mg/100g) of fruits during storage

Treatments	Treatment details	Ascorbic acid (mg/100)							
		Days after storage							
		At harvest	3	5	7	9	11	13	15
T_1	Control	17.83	18.28	18.85	20.71	19.95	18.04	16.66	15.66
T_2	Cold water	17.47	17.71	18.33	20.02	20.83	17.00	15.00	14.00
T_3	2% $CaCl_2$	16.5	18.50	18.93	21.00	22.11	22.45	22.5	19.16
T_4	4% $KMnO_4$	17.74	18.35	18.86	19.73	20.50	20.20	20.02	16.50
	F Test	NS	*	*	NS	*	*	*	*
	S. Em ±	-	0.11	0.14	-	0.1	0.27	0.15	0.25
	CD at 5%	-	0.32	0.42	-	0.31	0.78	0.46	0.73
Packages (P)									
P_1	150 gauge WV	17.58	17.86	18.46	20.06	20.07	17.04	19.6	14.91
P_2	150 gauge V 0.5%	17.58	18.37	19.36	21.1	20.88	20.52	20.53	16.25
P_3	200 gauge WV	17.65	17.5	18.05	19.91	21.1	19.58	18.47	15.16
P_4	200 gauge V 0.5%	17.70	17.96	18.57	20.39	21.35	19.7	19.6	16.00
	F Test	NS	*	*	NS	*	*	*	*
	S. Em ±	-	0.11	0.14	-	0.1	0.1	0.15	0.25
	CD at 5%	-	0.32	0.42	-	0.31	0.31	0.46	0.73
Interactions (TxP)									
T_1P_1	Control + 150 gauge WV	17.62	17.50	18.23	20.16	18.00	16.00	16.00	12.33
T_1P_2	Control + 150 gauge V 0.5%	17.61	18.80	19.30	20.86	18.33	18.16	18.00	13.33
T_1P_3	Control + 200 gauge WV	17.50	17.60	18.23	20.66	21.8	17.66	16.00	11.66
T_1P_4	Control + 200 gauge V 0.5%	17.56	18.13	18.63	20.76	21.70	16.33	16.00	13.33
T_2P_1	Cold water + 150 gauge WV	17.51	17.46	18.13	19.23	20.26	19.73	19.20	12.66
T_2P_2	Cold water + 150 gauge V 0.5%	17.51	18.43	19.30	20.90	21.53	20.2	19.53	13.00
T_2P_3	Cold water + 200 gauge WV	17.50	17.60	18.66	19.50	20.30	19.2	18.43	15.00
T_2P_4	Cold water + 200 gauge V 0.5%	17.56	17.96	18.23	20.46	21.23	19.56	18.80	15.33
T_3P_1	2% $CaCl_2$ + 150 gauge WV	17.56	17.13	18.06	20.80	21.80	22.26	22.40	18.00
T_3P_2	2% $CaCl_2$ + 150 gauge V 0.5%	17.56	18.43	19.93	22.33	22.76	22.76	22.90	20.00
T_3P_3	2% $CaCl_2$ + 200 gauge WV	17.63	17.70	18.46	20.23	21.83	22.26	22.13	18.66
T_3P_4	2% $CaCl_2$+ 200 gauge V 0.5%	17.62	18.46	19.26	20.66	20.23	22.50	22.60	21.40
T_4P_1	4% $KMnO_4$ + 150 gauge WV	17.63	18.26	18.43	19.66	20.40	20.20	20.16	16.66
T_4P_2	4% $KMnO_4$ + 150 gauge V 0.5%	17.56	17.83	18.93	20.33	20.90	20.96	21.60	18.66
T_4P_3	4% $KMnO_4$ + 150 gauge WV	17.66	17.70	17.83	19.26	20.46	19.20	17.33	15.00
T_4P_4	4% $KMnO_4$ + 200 gauge V 0.5%	17.60	17.33	18.16	19.66	20.4	20.43	21.00	15.66
	F Test	NS	*	NS	NS	*	NS	*	*
	S. Em ±	-	0.22	-	-	0.21	-	0.31	0.50
	CD at 5%	-	0.64	-	-	0.63	-	0.92	1.40

* = Significant at 5%, NS = Non-significant, V= with ventilation, WV= without ventilation

7th, 9th, 11th, 13th and 15th days of storage respectively. The lowest ascorbic content (17.5, 18.23, 20.16, 18.00, 16.00, 16.00 and 12.33 mg/l00g) was recorded in control and packed in 150 gauge polythene without ventilation at the 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively.

DISCUSSION

V. DISCUSSION

Cherry tomato (Cv. Marilee Cherry Red) is typical cultivar of tomato fruit which is belonged to Solanaceae family, characterized by very short life and highly perishable under ambient condition. Since it is highly perishable it encounters several problems in its transportation, storage and marketing. Owing to lack of information on appropriate postharvest treatments, packaging, temperature etc, fruits not only lose their quality but also encounter a substantial postharvest loss.

The dynamic transformation of cherry tomato fruit is mainly due to rapid degradation and metabolism. In this context experiment were carried out to identify suitable postharvest treatments, packaging materials that can increase the shelf life of fruit. The result associated physico-chemical changes during postharvest storage are discussed in this chapter.

5.1 Physical parameters

5.1.1 Physiological loss in weight (%)

Physiological loss in weight (%) was differed significantly over the storage period irrespective of postharvest treatment, packaging materials and their interactions (Table 1 and figure 1). This could be due to increase the rate of physiological process like transpiration and respiration Mustafa and Mughrabi (1994) and Badshah *et al.* (1997) in tomato. This is mainly attributed to continuous moisture and other nutrient loss as the cherry tomato fruits are alive (Nirupama, *et al.,* 2010). The cherry tomato stored under ambient condition shows significantly higher PLW fruit were exposed to high temperature and lower relative humidity thus all the physiological and metabolic activities might have increasing (Mondal *et al.,* 2006).

Similarly with respect to the postharvest treatment significant difference was noticed on physiological loss in weight among the different treatments. The lowest Physiological Loss in Weight throughout the period at storage days was found in the fruits treated with 2 per cent $CaCl_2$ (1.73, 1.9, 2.96, 3.37, 5.15 and, 6.14 %), %) at 3rd, 5th, 7th, 9th, 11th, 13th, and 15th day of storage respectively. While the highest Physiological loss in weight was found in fruits without any treatment and cold water treated cherry tomato fruits.

The significant difference was noticed with respect to the different gauges of polythene packages. The fruits stored in 150 and 200 gauge polyethylene bag with 0.5 per cent ventilation showed lowest PLW throughout the storage period with (1.81, 2.61, 3.37, 3.73, 4.74, 5.44 and 6.2 % and; 2,13, 2.81,3.63,4.03, 5.43,6,10 and 6.76) at 3rd, 5th, 7th , 9th,11th and 15th day of storage respectively.

This could be attributed to the fact that polyethylene packages created modified atmosphere with 0.5 per cent ventilation. It was observed that fruit develop chilling injury as a result failed ripen normally and act as a physical barrier for transpiration losses. Similar findings were also reported by Mondal *et al.* (2006), Akath Singh *et al.* (2008) in strawberry, Kariyanna *et al.* (1992) in sapota, Jadav *et al.* (1992) custard apple, Prasad *et al.*(1994) and restricting diffusion of gasses and feedback mechanism (Naik and Rokhade 1997).

In interaction there was significant effect of the treatments as influenced by the postharvest treatment and the polythene packages, the lowest physiological weight loss in fruits was recorded in fruits treated with 2 per cent $CaCl_2$ (1.73, 1.93, 3.03, 3.43, 4.36, 5.40 and 6, 16 and 1.73,1.93, 3.16, 3.43, 4.56, 5.4 and 6.6 %) fruits stored at 150 and 200 gauge polyethylene bag with 0.5 per cent ventilation at 3rd, 5th, 7th, 9th, 11th and 15th day of storage respectively.

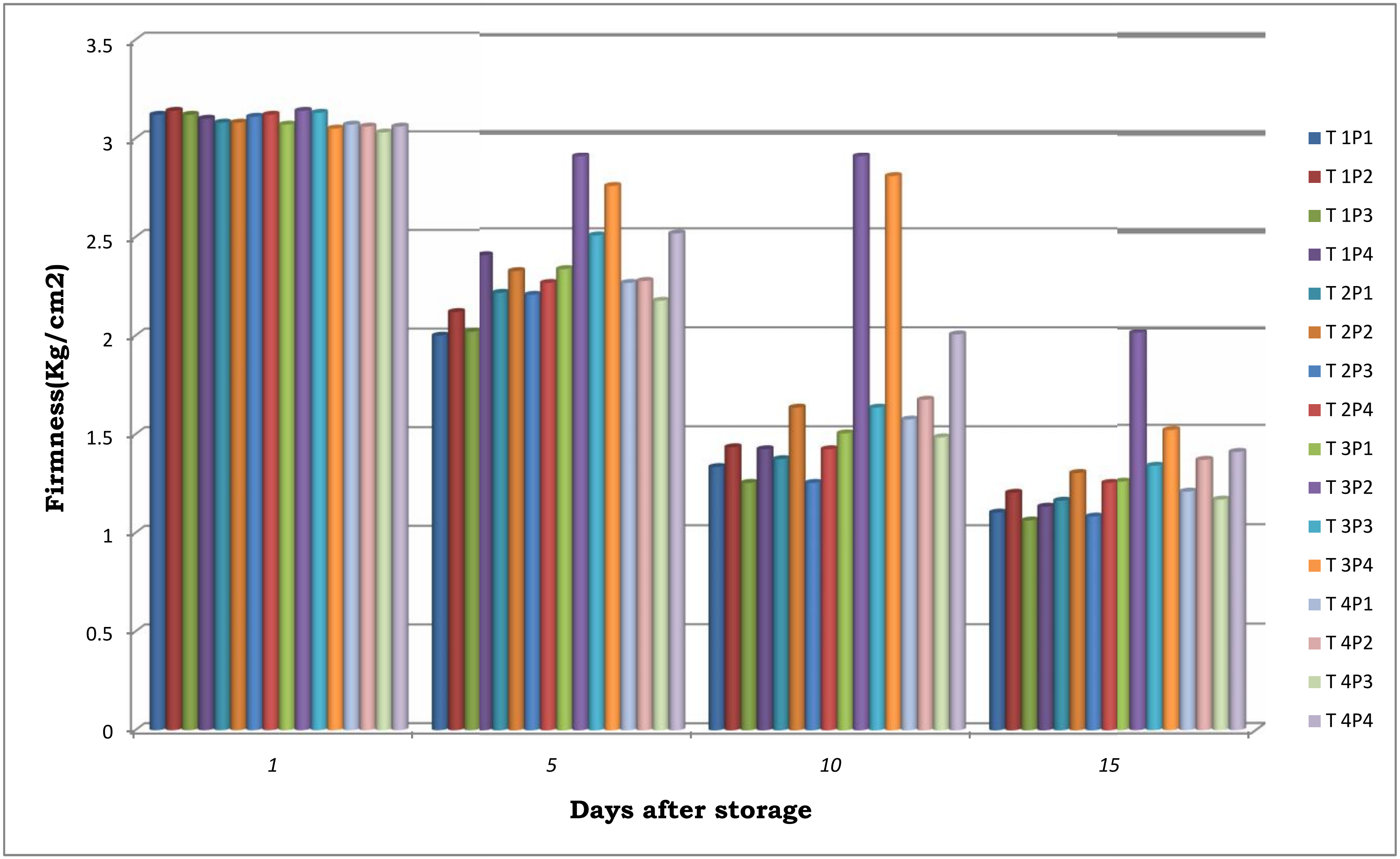

Figure 3. Effect of postharvest treatments and packaging on firmness (kg/cm^2) of fruits during storage

This could be attributed to the chemicals and polyethylene bag effect; fruit maintained turgidity arresting process of ripening in poly bag. Similar trends were reported by, fruits stored at low temperature between 10-15°C least loss in weight (Steven 1996) in okra and Elif Das *et al.* (2002) in tomato. Enhanced PLW rate of loss was due to acceleration of physiological process and minimum transpiration, respiration and ripening process. These result are in conformity with the finding of Shehla Sammi and Tariq Masud (2007) in tomato, (Mustafa and Mughrabi, 1994) in tomato, Praveen Jholgiker and Reddy (2002) in custard apple, Masalkar and Grande (2003) custard apple, Sihag *et al.* (2005) in peach fruit, Ingawale (2005) in custard apple and Deepak *et al.* (2008) in Banana, Waskar and Nikam (1997) in custard apple.

5.1.2 Shelf life (Days)

Data revealed that there was a significant difference between the treatments as influenced by the postharvest treatment and polythene package and their interactions (Table 1 and Figure 2).

Cherry tomato subjected to postharvest treatment 2 per cent $CaCl_2$ showed longer shelf life (13.25 days) followed by fruits treated with 4 per cent $KMnO_4$ (10.45 days). However, the shortest shelf life of fruits was recorded in fruits without any postharvest treatment (8.5 days) and fruits treated with cold water (9.79 days).

With respect to polythene package the longest shelf life (11.29 days) was recorded in fruits packed in 150 gauge polythene bags with 0.5 per cent ventilation followed by fruits stored in 200 gauge polythene without ventilation (10.66 days). Similar results were also reported by Dinesh Singh *et al.* (2005) peach fruit, Ingwale (2005) custard apple, Shivani Jindal *et al.* (2005) sapota. Akath Singh *et al.* (2008) in strawberry.

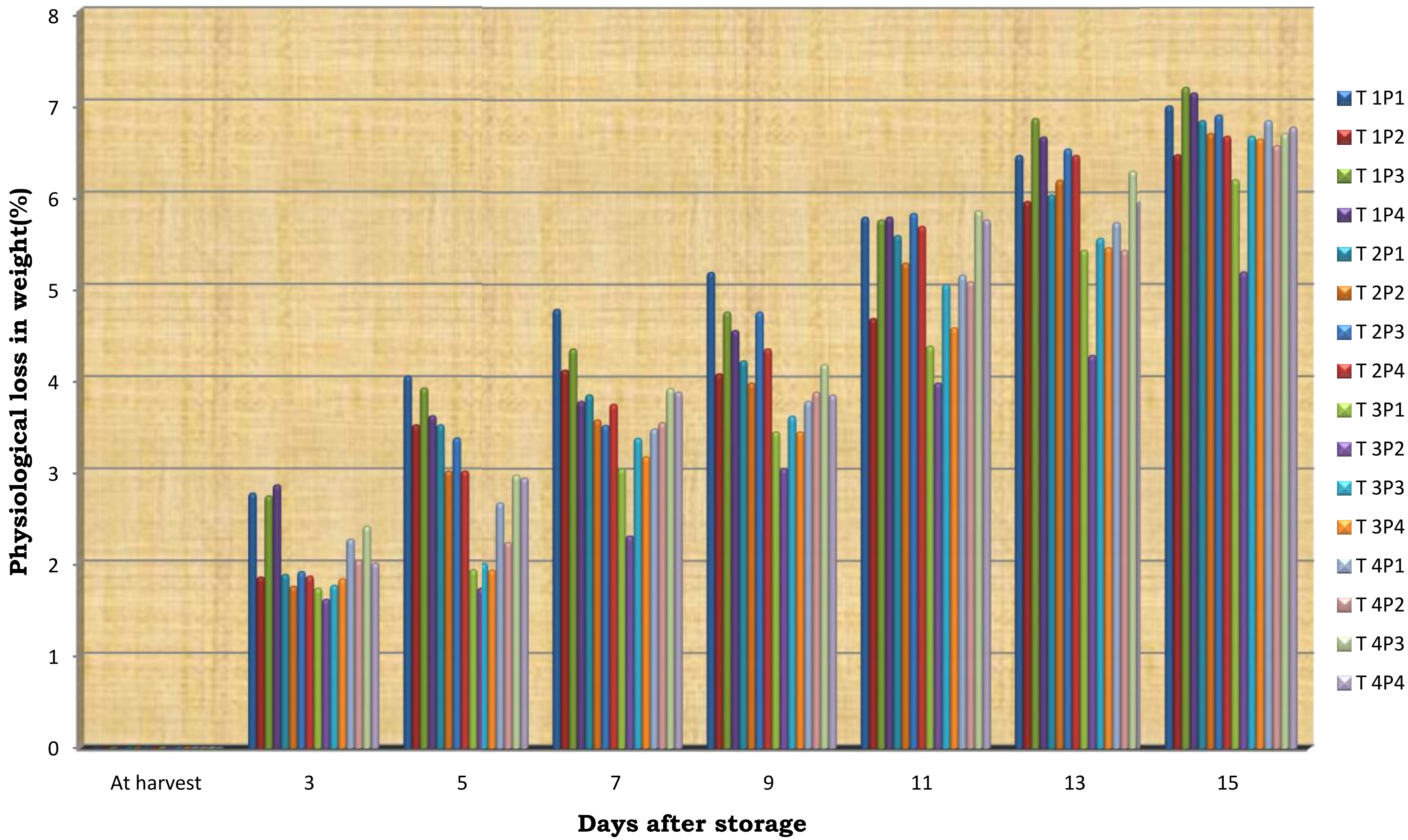

Figure 1. Effects of postharvest treatments and packaging on PLW (%) of fruits during storage

Between interaction effect there was a significant difference among the interactions where the highest shelf life was recorded in the cherry tomato treated with 2 per cent $CaCl_2$ and packed in 150 gauge polythene bag with 0.5 per cent ventilation (15.33 days) followed by fruits treated with *2* per cent $CaCl_2$ and stored in 200 gauge polythene with 0.5 per cent ventilation (13.33 days). Similar results were reported by Mondal *et al.,* (2006) in tomato, Jadav *et al,* (1992) Praveen Jhalgiker (1997), Naryana *et al.,* (2002) in papaya, Akath Singh *et al.* (2008) strawberry fruit.

This could be attributed to lower rate of metabolic activities as polyethylene cover creates modified atmosphere condition so that high relative humidity and low temperature. Calcium chloride maintaining fruit firmness and reduces bio chemical changes, delay changes associated with softening, reducing rate of respiration respiratory substrate and catabolic process which reduces delaying senescence. It was observed that untreated fruits kept at ambient condition ripen rapidly within 6 days as compared to all the other treatments. The finding was in conformity with observation by Shehla Sammi and Tariq Masud(2007) Ali Batu and Keith Thomson (1998), Naryana *et al.* (2002) in banana and Jadav *et al,* (1992) custard apple.

5.1.3 Firmness (Kg/cm^2)

The firmness of the cherry tomato fruits (Kg/cm^2) was differed significantly over the storage period irrespective of the postharvest treatment, packaging and their interactions table 2 and figure 3. This could be due to increase in the rate of physiological process like transpiration and respiration. This is mainly attributed to continuous moisture and other nutrient loss as fruits are alive (Nirupama *et al.,* 2010).

With respect to the postharvest treatments the maximum firmness throughout the storage period was found in the fruits treated with 2 per cent $CaCl_2$ followed by fruits treated with 4 per cent $KMnO_4$ at 1^{st}, 5^{th}, 10^{th} and 15^{th} days of storage respectively. This could be attributed to the absorption of Ca by cherry tomato which in return strengthens the cell wall and decreases the transpiration and other bio-physical process. Our finding was confirmed by Durba *et al.* 2003, Vishalnath and Bhargava, (1998) and Nirupama *et al.* (2010) in tomato.

There was significant different among the treatments cherry tomato as influenced by the different gauges of polythene packages. The cherry tomato stored in 150 and 200 gauge polyethylene bag with 0.5 per cent ventilation recorded maximum firmness throughout the storage period (2.41,1.79 and 1.37kg/$cm^{2)}$ and;(2.39, 1.50 and 1.40 kg/cm^2) at 5^{th}, 10^{th} and 15^{th} day of storage respectively. This could be attributed to nature of polyethylene bags where they can act as a barrier against moisture loss. Ventilated polyethylene bags reduce the transpiration by restricting the diffusion of gases and feedback mechanism and other bio-chemical process in cherry tomato and also allow the CO_2 and C_2H_4 out, thus prevent from condensation of these gases. Our observation was confirmed by Badshah *et al.* (1997) in cherry tomato, Mustafa and Mughrabi, (1994) in tomato, Ali Batu and Keith Thomson (1998) in tomato, Shehla Sammi and Tariq Masud (2007) in tomato, Naik *et al.* (1993) in tomato, Benyehoshua, *et al.* (1991) in lemon and Jadhav *et al.* (1992) in custard apple.

Similarly in interaction significant differences were noticed on firmness of cherry tomato fruits as influenced by the postharvest treatments and the polythene packages. The maximum firmness was recorded in cherry tomato treated with 2 per cent $CaCl_2$ and packed in 150 and 200 gauge polyethylene bag with 0.5 per cent ventilation(3.14,

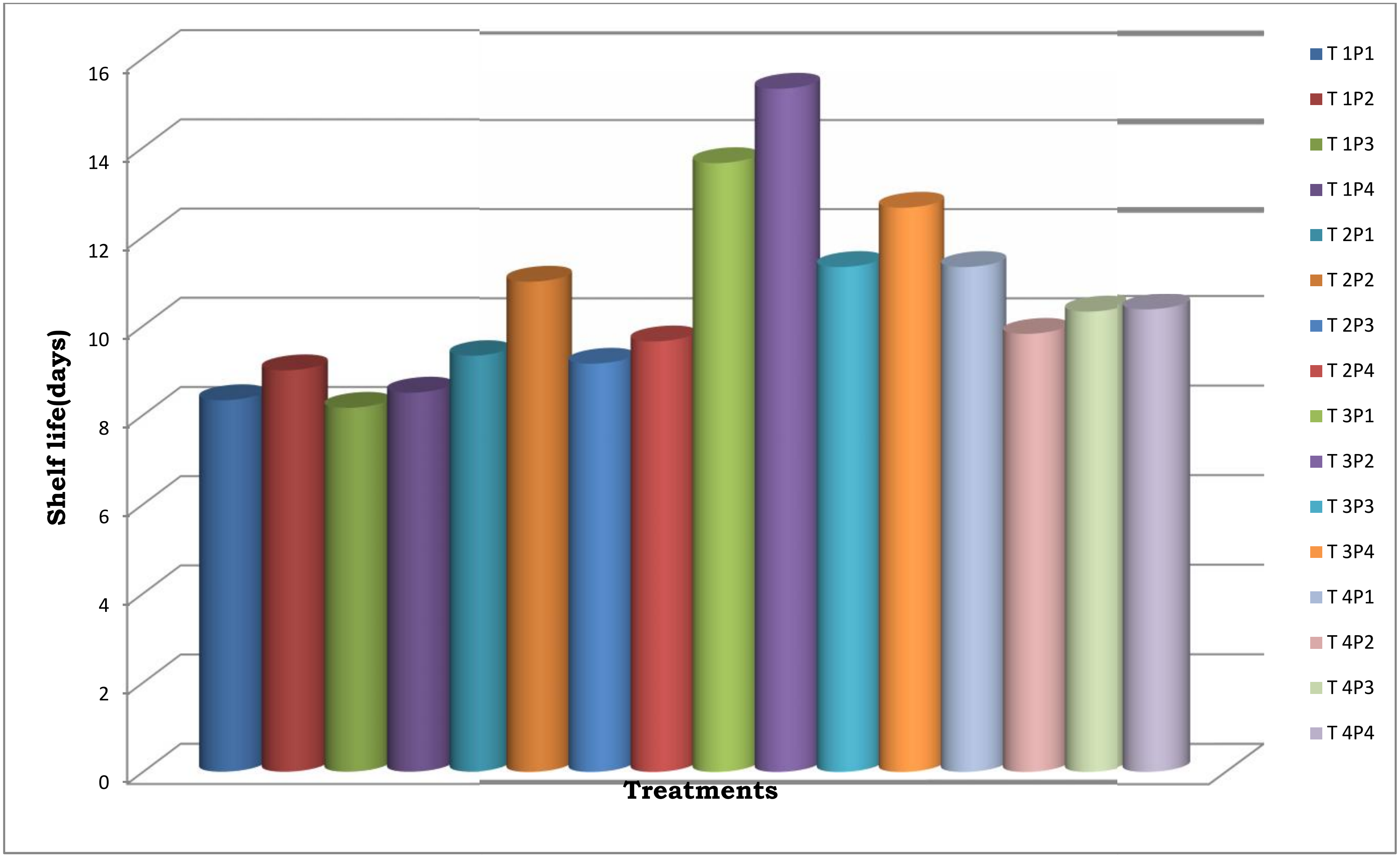

Figure 2. Effects of postharvest treatments and packaging on shelf life (%) of fruits during storage

2.90, 2.90 and 2.00 and; and 2.75, 2.8 and 1.51kg/cm^2) at 5th, 10th and 15th day of storage respectively. This could be attributed to delaying of physico-chemical process by checking the transpiration and respiration inside polyethylene bags and also maintaining firmness by 2 per cent $CaCl_2$ as Ca is the main component of cell wall and prevent softening also act as barrier against micro-organism enzyme which are responsible for softening and decay of cherry tomato and all other fruits. The results were in conformity with the finding by Badshah *et al.* (1997) in cherry tomato, Mustafa and Mughrabi, (1994) in tomato, Ali Batu and Keith Thomson (1998) in tomato, Shehla Sammi and Tariq Masud(2007) in tomato,(Naik *et al.,* 1993 in tomato and Benyehoshua *et al.,* 1991) in lemon.

5.1.4 Spoilage

The data pertaining to the spoilage of fruits revealed that there was an increased in the number of spoiled fruits over the storage period irrespective of the postharvest treatments, packages and their interactions (Table.3).

The minimum spoilage throughout the storage period was found in the fruits treated with 2 per cent $CaCl_2$ (2.08, 4.08, 6.80 7.5, 10.08, 12.25, 15.83) which is on par with fruits treated with 4 per cent $KMnO_4$ (2.25, 5.5, 7.5, 10.33, 12.83, 14.16 and 16.66) at 3rd, 5th, 7^{th,} 9th, 11th and 15th days of storage respectively. This could be attributed to postharvest treatment 2 per cent $CaCl_2$ which is contributed to the strengthening the cell wall and skin of fruit so that micro-organism cannot get enter to spoil the cherry tomato fruits. 4 per cent $KMnO_4$ also has anti microbial property which might help the inhibition of spoilage to some extent. Our observation was confirmed by Nirupama *et al.* 2010) in tomato, Vishalnath and Bhargava (1998) in ber fruits and Muneruzzaman *et al.,* (2009) in tomato.

The cherry tomato fruits packed in 150 and 200 gauge polyethylene bag with ventilation showed minimum fruits spoilage throughout the storage period (2.08, 4.33, 6.58, 9.58, 11.25,12.58 and 16,75 and, 2.83,5.5, 8.16, 10.47, 13.75,15.41 and 18.83) at 3rd, 5th, 7th , 9th,11th and 15th day of storage respectively. This may be attributed to polyethylene bags with ventilation which act as a barrier against micro-organism from the environment of storage also provide enough oxygen a result prevent from non-aerobic respiration. The results were also confirmed by Shehla Sammi and Tariq Masud(2007) Ali Batu and Keith Thomson (1998), Naryana *et al.* (2002) in banana and Jadav *et al.* (1992) custard apple.

In interaction, the lowest spoilage was recorded in cherry tomato treated with 2 per cent $CaCl_2$ (1.66, 3.33, 4.00, 5.66, 8.33, 10.00 and 13.33 and, 4.00, 6.66, 7.66, 10.33, 13.00 and 17.33) fruits stored in 150 and 200 gauge polyethylene bag with ventilation respectively.

Packaging plays a dominant role in storage and marketing activities of fruit industry. The increase in consumer demand for good quality fruits necessitated to search for suitable packaging material which can preserve the quality, the sensory and nutritive value of fruits till consumption and is also economically proficient and safe. The quality deterioration during storage in most of the cases are of chemical, physico-chemical, physical and microbiological origin and rate of changes many be influenced by packaging material (Puri 1989).$CaCl_2$ also contribute to the strengthening the cell wall and skin of fruit so that micro-organism cannot get enter to spoil the cherry tomato fruits. 4 per cent $KMnO_4$ also has anti microbial property which might help the inhibition of spoilage to some extent. Similar results were also reported by Nirupama *et al.* (2010), Vishalnath and Bhargava (1998), in ber

Shehla Sammi and Tariq Masud(2007), Ali Batu and Keith Thomson (1998), and Muneruzzaman *et al.* (2009) in tomato.

5.1.5 Organoleptic character

The physical properties of cherry tomato organoleptic characters evaluation for assessing the taste, colour, flavor and overall acceptance were done by Panel judges 0 to 5.0 point scale presented in (table 4-5). At the end of the storage day fruit must be maximum firmness, freshness and disease free. Organoleptic quality during storage different packaging material reveals that increased up to 10 days with subsequent decline. The results are in conformity with the findings by Ali and Thompson, 1998 in tomato, Ali Batu and Keith Thomson (1998) in pink and plum tomato, Sudhir Yadav *et al.* (2005) in Ber fruit.

5.1.5.1 Colour

The physical properties of cherry tomato organoleptic characters of color are presented in (Table 4). Postharvest treatment showed significant differences. The highest color was found in fruits treated with calcium chloride (3.33, 3.75 and 2.73 /5.0 score point) followed with fruits dipped in cold water (2.41, 3.08 and 2.16 /5.0 score point) at 5th, 10th, and 15th days of storage.

Among the packages the highest color was recorded (3.08, 3.58 and 2.58/5.0 and, 2.66, 3.16 and 2.00 /5.0 score point) in cherry tomato fruits stored in 150 and 200 gauges of polyethylene bags with ventilation (5%).

With respect to interaction effect the highest color was recorded in cherry tomato fruits treated with calcium chloride at 2 per cent level 150 gauges and 200 gauges with 0.5 per cent ventilation (4.00, 4.33 and 3.33/5.00 score point) at 5th, 10th and 15th days of storage respectively.

The lowest color was observed in control store in 200 and 150 gauges of polyethylene bags (1.66, 2.33 and 1.33 and; 1.00, 2.00, 2.00 and 1.00/5.0) at 5th, 10th and 15th days of storage respectively.

Discoloration was noted in fruits treated with potassium permanganate and the fruits become blackish to brown in colour. As a result, the market value of the few fruits decreased and the fruits become harder. Better colour was noticed with 2 per cent $CaCl_2$. This could be attributed to the calcium that maintained greater green life, firmness and minimized the rate of respiration, protein breakdown and rotting incidence. The results were in conformity with finding by Ali Batu and Keith Thomson (1998) in pink tomato, Shehla Sammi and Tariq Masud (2007) in tomato and Sigge *et al.* (2007) in bell pepper.

5.1.5.2 Taste

The taste of cherry tomato fruits pulp differed significantly over the storage period irrespective of the postharvest treatment, packaging and their interactions (Table 4). The highest taste was found in fruits treated with calcium chloride following with fruits treated with 4 per cent $KMnO_4$ (3.73, 4.00 and 3.16/5.0 score point at the day 5th, 10th and 3.36, 3.00 /5.0 score point at 5th and 15th day respectively.

Similar trend followed in packaging material. The highest taste obtained in fruits treated with 2 per cent $CaCl_2$ and stored in 150 gauges with 0.5 per cent ventilation (4.66 and 4.30/5.0 score point) at 10th and 15th after storage respectively.

Postharvest treatment and polyethylene effect on interaction shows that there is significant difference among the treatments. The highest taste was found in fruits treated with calcium chloride at 2 per cent and stored in 150 gauge of polyethylene bag with 0.5 per cent ventilation (3.24 and 2.16 of 5.0 score point) and which was on par with 200 gauge polyethylene bag with ventilation (3.33, 4.00 and 3.00 of 5.0 score point) at 5th, 10th and 15th days after storage respectively. The results were in conformity with finding by Shehla Sammi and Tariq Masud(2007) in tomato, Waskar *et al.* (1997) in sapota fruits and Tamil Selvan and Bal (2005) in Guava. In general taste were superior in fruits stored in calcium chloride and polyethylene packaging material due to changes in volatile compounds of fruit pulp of fruits influenced by storage condition.

5.1.5.3 Flavour

Postharvest treatment of cherry tomato fruits showed significant differences over the treatments received calcium chloride. The highest flavour in cherry tomato fruits treated with 2 per cent $CaCl_2$ (3.16, 4.10 and 3.83/5.0 score point) which was on par with dipped in cold water (2.33, 3.33 and 2.66 out of 5.0 score point) at 5th, 10th and 15th days and storage in 150 gauges of polyethylene bags.

The effect of postharvest treatments and polyethylene packages was significantly different among the treatments. The highest flavour was found in 150 gauge and 200 gauge packages with 0.5 per cent ventilation (1.91, 2.66, 3.75/5.0 and, 2.5, 3.5 and 2.91/5.0 score point) at 5th, 10th and 15th days of storage. The lowest flavour was observed (2.41, 3 and 2.33/5.0) 200 gauge polyethylene bag without ventilation.

In the interaction, the highest flavour was noticed in fruits treated calcium chloride and packed in150 and 200 gauges polyethylene bag with 0.5 per cent ventilation (3.66, 5.00 and 4.66 and, 3.33, 4.00 and 4.00 /5.0 score point) at 5th, 10th and 15th days after storage respectively. Similar results were also reported by Mustafa and Mughrabi, (1994) in tomato, Shehla Sammi and Tariq Masud(2007) in tomato Shashirekha Mysore *et al.*(2008) in custard apple, in sapota, Yuvaraj and Ughreja (2003) in mango. This could be attributed as cherry tomato fruits stored at ambient temperature (polyethylene bag create modified atmosphere) will gain optimum biochemical composition as a result it has better sugar to acid ratio, less consumption of energy by respiration thus it has reasonable flavour.

5.1.5.4 Overall acceptability

The overall acceptability of cherry tomato fruits was differed significantly over the storage period (Table 5). In postharvest treatment of the treatments shows significant differences. The highest overall acceptance received in treatment calcium chloride at 2 per cent on par with potassium permanganate at 4 per cent level (3.83, 3.00 and 3.16, 2.33/5.0 score point) during storage period.

Packages also showed significant difference the highest overall acceptance recorded in fruit packed in 150 gauge and 200 gauge of polyethylene bags with 0.5 per cent ventilation (3.41, 3.75 and 2.66 and; 3.1, 3.33 and 2.08/5.0 score point) at 5^{th}, 10^{th} and 15^{th} days after storage respectively.

The interaction effects of postharvest treatments and polyethylene packages recorded significant differences among the treatments. The highest organoleptic score on overall acceptance revealed that higher TSS, total sugar and acidity has a great impact on overall acceptance. Polyethylene package act as refrigerator, the highest overall acceptance was recorded in fruits treated with calcium chloride which is on par with potassium permanganate, and fruits stored at 150 and 200 gauge with ventilation (4.66, 4.66 and 4 and 4.00, 4.33 and 3.00/5.0 score point) at 5^{th}, 10^{th} and 15^{th} days after storage respectively. The results were confirmed with finding by Shehla Sammi and Tariq Masud (2007) in tomato, Mustaffa *et al.* (1994) in tomato, Hafinan *et al.* (2001) in custard apple, Sihag *et al.* (2005) in peach.

This could be attributed to the ripening of cherry tomato was significantly affected by postharvest treatments and packages colour, taste, flavors are superior at 10th days of storage it depends on sugar, total soluble solid acids, phonetics and volatile compounds are mainly Ester, Alcohol Aldehydes and ketones compounds are improves organoleptic rating of fruits in terms of overall acceptance.

5.2 Chemical parameters

5.2.1 Total Soluble Solid (°Brix)

The TSS of cherry tomato fruits differed significantly over the storage period to postharvest treatment, packaging materials and their interactions (Table 6 and Figure 4).

With respect to the postharvest treatment, the highest TSS was recorded in fruits treated with 2 per cent $CaCl_2$ (3.06, 3.35, 3.53, 4.27, 4.99, 5.56, 5.54, 4.53 and 4.43 °Brix) followed by fruits treated with 4 per cent $KMn0_4$ (3.00, 3.36, 3.74, 4.18, 4.77, 4.70, 3.80 and 3.65°Brix) at 3r^{d} 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively. The increase TSS could be attributed to conversion of starch and other in soluble compounds (Wasker *et al., 1997*) in sapota, Sudhir Yadav *et al.* (2005) and Mahajan and Sharma (1996) in mango.

While in the polythene packages used there was no significant difference among the treatments with respect to the different gauge of polythene used with or without ventilation among the entire period of storage. The highest TSS was observed in cherry tomatoes packed in 150 gauges of polyethylene packages with 0.5 per cent ventilation (3.04, 3.46, 3.97, 4.82, 5.25, 5.21, 4.73 and 3.95°Brix) followed by cherry tomatoes packed in 150 polyethylene without ventilation (3.35, 3.74, 4.59, 4.91, 4.94, 3.35 and 3.51°Brix) at the 3rd, 5th, 7th,9th, 10th and 15th days after storage respectively.

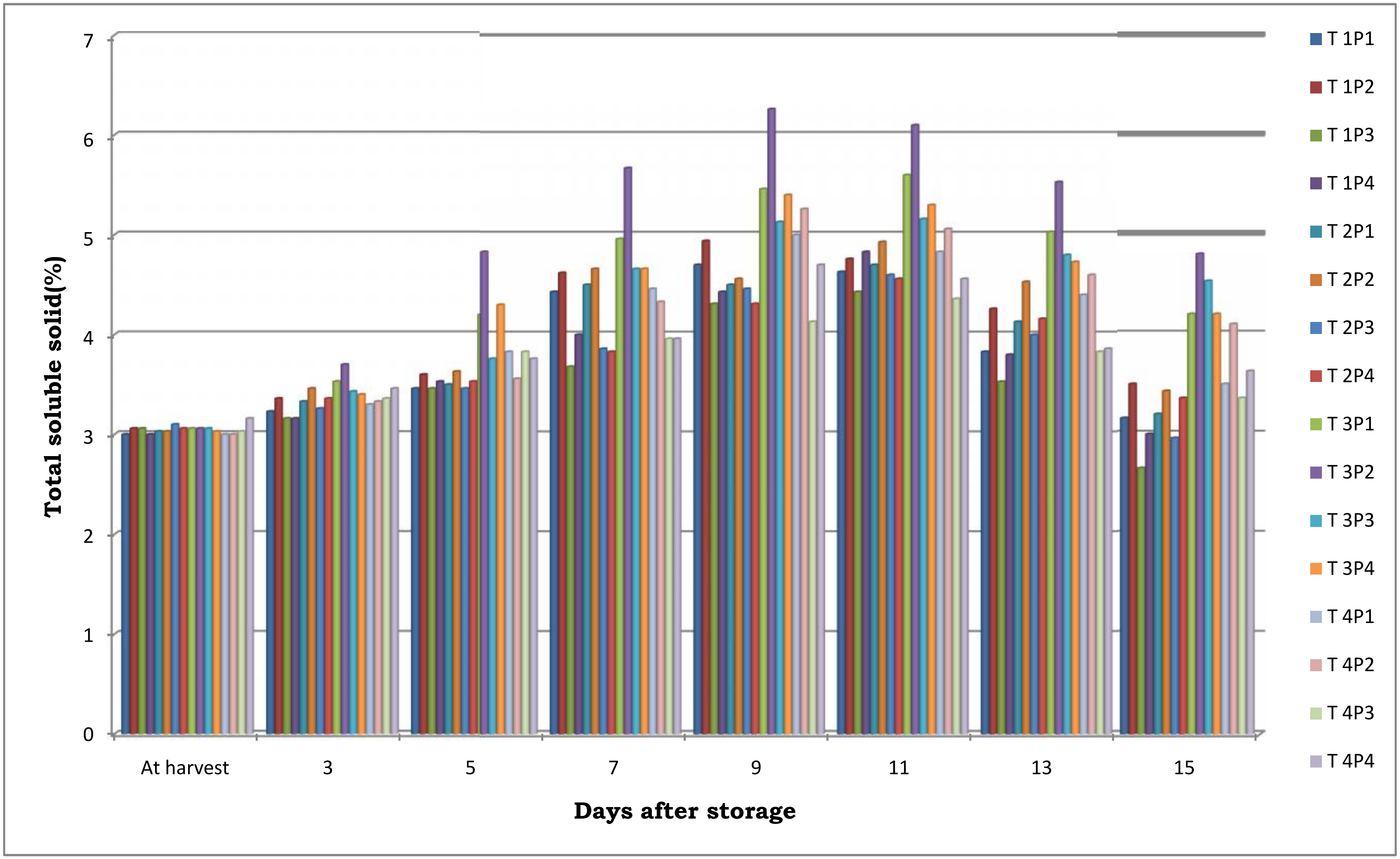

Figure 4. Effects of post-harvest treatments and packaging on TSS (%) of fruits during storage

In interaction effect between the postharvest treatment and the polythene packages used, there was significant difference among the treatments as affected by postharvest treatment and polythene packages except at 15th day. The highest TSS (3.7, 4.83, 5.67, 6.26 and, 6.1°Brix) was recorded in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauge polythene bag with 0.5 per cent ventilation at 3rd, 5th, 7th, 9th and 11th of storages day respectively followed by 2 per cent $CaCl_2$ treated fruits (4.3, 4.66, 5.66 and 5.4 °Brix) and stored in 200 gauge polythene with 0.5 ventilation at 3rd, 5th, 7th, 9th and 11th after storage respectively.

This may attribute to reduce the rate of transparent loss, which create micro climate surrounding the fruit as result retain higher TSS Similar finding were reported by Nirupama *et al.* (2010) in tomato, Yallaraddi, (1996) in ber fruits, Ingawale (2005) in custard apple, Sihag *et al.* (2005) in peach, Asrey Ram, *et al.* (2008) in strawberry and Ali Batu and Keith Thomson (1998) in tomato. Increase in TSS mainly due to reduction in activities of various enzymes disorganization of cellular structure, microbial activities (Tamil Selvan and Bal, 2005) and hydrolysis of starch and other poly saccharides to soluble solid concentration.

5.2.2 Titratable acidity (%)

The Titratable acidity of cherry tomato fruits differed significantly to postharvest treatment, packaging and their interaction during the storage period (Table 7).

Postharvest treatment was recorded significant difference among the treatments where highest percent of acidity was found in cherry tomato treated with 2 per cent $CaCl_2$ (0.3, 0.32, 0.32, 0.33 %) at 3rd, 9th, and 11th days of storage respectively. Similar finding were noticed by

Tamil Selvan and Bal 92005) in Guava, Praveen Jhalgikar (2005) in custard apple fruit and Upadhayaya and Sanghavi, 2001) in strawberry.

With respect to the polyethylene packages used. The highest Titratable acidity content was observed in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauge polyethylene with 0.5 per cent ventilation(0.3, 0.31, 0.31, 0.31, 0.31, 0.33 and 0.25%) at the 3rd, 5th, 7th, 9th, 11th, and 13th days respectively.

In interaction effect the highest acidity was recorded in fruits treated with 2 per cent $CaCl_2$ (0.46, and 0.39%) and stored in 150 gauge polythene package with 0.5 per cent ventilation at 5th and 15th days after storage respectively.

The results were in conformity with (Kwon *et al.* 1999) in cucumber, Naik *et al.* (1993) in tomato, Pal and Kumar (1995) Ingawale (2005) in custard apple. The differential changes in acidity value in fruits packed different packages and storage condition may be attributed to the differential water loss from fruits internal utilization of some of the organic acids with fast metabolic changes. It was clear that acidity of cherry tomato slightly declined during the last days of storage period in all treatments at room temperature. This decrease in acidity might be due to acid hydrolysis of polysaccharides and non-reducing sugars to their simpler components where acid is utilized for converting them to hexose sugars or complexes in the presence of metal ions (Wasker *et at.,* (1999) degradation of organic acid was in conformity with results by Shehla Sammi and Tariq Masud (2007) and Erip Roberts *et al.* (2002) in tomato.

5.2.3 Reducing sugar (%)

The Reducing sugar content of fruits expressed in terms of percentage showed that increasing trend over the storage period in (Table 8).

In case of postharvest treatment, the highest reducing sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ ((2.95, 4.00, and 4.63%) followed by fruits treated with 4 per cent $KMnO_4$ (2.93, 3.69, and 3.51%) at 5th, 10th and 15th days of storage respectively. This result is in conformity with finding by Moneruzzaman.*et al* (2009) in tomato.

With respect to the polyethylene packages used, the highest reducing sugar content was observed in cherry tomatoes stored at I50 gauges of polyethylene with 0.5 per cent ventilation(2.93, 3.87, and 3.09%) and lowest in fruits 150 gauge polyethylene without ventilation (2.80, 3.51 and 2.98 %) at 5th, 10th and 15th days of storage respectively.

In interaction the highest reducing sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ and stored in 150 gauge polyethylene package with ventilation (3.5, 4.53 and 4.93%) followed by fruits treated with 4 per cent potassium permanganate and stored in 150 gauge polyethylene bag with 0.5 per cent ventilation (3.30, 4.10, and 4.75%) at the 5th, 10th and 15th days of storage respectively. Several researchers provided efficiency of polyethylene packages and chemical like Muneruzzaman *et al.* (2009) in tomato and Nagaraju *et al.* (1992) sapota.

This could be attributed to lower rate of metabolic process and involve a serious of bio-chemical changes, well coordinated process of organ differentiation and is genetically programmed in many climacteric fruit Starch being the primary energy reserve is synthesized in amloplast during storage (Narayana and Mustaffa, 2007) in Banana. Sugar content of fruit increased during the period of ripening. This increase was observed till climacteric peak was observed by and Praveen jholigiker (2002), in custard apple and Moneruzzaman.*et al* (2009) in tomato, Dhillon *et al.* (1981) in pear, Nagaraju *et al.*(1992) in sapota, Yallaraddi, (1996) in ber fruits and Naresh Kumar *et al.* (2001) in guava.

5.2.4 Non- reducing sugar (%)

Non- reducing sugar expressed in terms of percentage presented in (Table 9). The highest non reducing sugar content was recorded in cherry tomato treated with 2 per cent $CaCl_2$ (1.58, 1.74 and 0.9 %) followed by treated with 4 per cent $KMnO_4$ (1.44, 1.51 and 0.85%) at 5th, 10th and 15th days of storage respectively.

The highest non reducing sugar content was recorded in fruits pre-stored in 150 gauge polythene bags with 0.5 per cent ventilation(0.94, 1.55, 1.69 and 1.91 %) at 5th, 10th and 15th days of storage respectively and followed by fruits stored in 200 gauge polythene with ventilation with non reducing sugar content (1.45, 0.52 and 0.85 %) at 5th, 10th and 15th days of storage respectively.

The highest non-reducing sugar content was recorded in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauge polythene package with 0.5 percent ventilation (1.8, 1.86 and 0.96%) at 5th, 10th and 15 days of storage respectively followed by fruits treated with 2 per cent $CaCl_2$ and packed in 200 gauge polythene bag with 0.5 per cent ventilation (1.63, 1.72 and 0.85 %) at 5th, 10th and 15th days of storage respectively. This result is in conformity with finding by Jadav *et al.* (1992) custard apple, Praveen Jhalgiker (2005) and Moneruzzaman.*et al* (2009) in tomato. This could be attributed to lower rate of metabolic activities reduced as results polyethylene bag created modified atmosphere condition.

5.2.5 Total Sugar (%)

The chemical properties of cherry tomato total sugar expressed in terms of percentage presented in (table 10 and figure 5).The total sugar increased significantly throughout the storage period till it reached the peak followed by gradual decline at the end of storage. These results were in conformity with finding by Moneruzzaman.*et al* (2009) in tomato.

Postharvest treatment significantly recorded the higher total sugar content. The highest total sugar was recorded in fruits treated with 2 per cent $CaCl_2$ (4.57, 5.75 and 5.5%) followed by fruits treated with $KMn0_4$ (4.35, 5.31 and 4.2 %.) at 5th, 10th, and 15th days of storage respectively.

The highest total sugar content was recorded in cherry tomato packed in 150 gauges polyethylene bag with 0.5% ventilation (4.50,4.55 and 4.36 %) followed by 200 gauge with 0.5 per cent ventilation(4.34, 5.20 and 4.03 %) at 5th, 10th, and 15th days of storage respectively.

Combination effect of postharvest treatments and polyethylene packages shows that the highest total sugar was observed in cherry tomatoes treated with 2 per cent $CaCl_2$ and packed in 150 gauges of polyethylene bags with 0.5 ventilation (4.73, 6.33 and 5.9*%)* followed by fruits treated 2 per cent $CaCl_2$ and stored in 200 gauge polyethylene with 0.5 per cent ventilation (4.53, 5.5, and 5.23%) at 5th, 10th and 15th days after storage. The lowest content of total sugar was recorded in cherry tomato without any treatment and fruits dipped in cold water and packed in 200 gauge polyethylene without ventilation (3.29, 4.16, 4.83 and 2.83%) at 5th, 10th and 15th days of storage respectively. The other researchers have also reported that similar with finding by Moneruzzaman *et al.* (2009) in tomato. Increasing in sugar can be attributed to conversion of starch other insoluble carbohydrates in to sugar the changes were slower in fruits treated with calcium chloride and

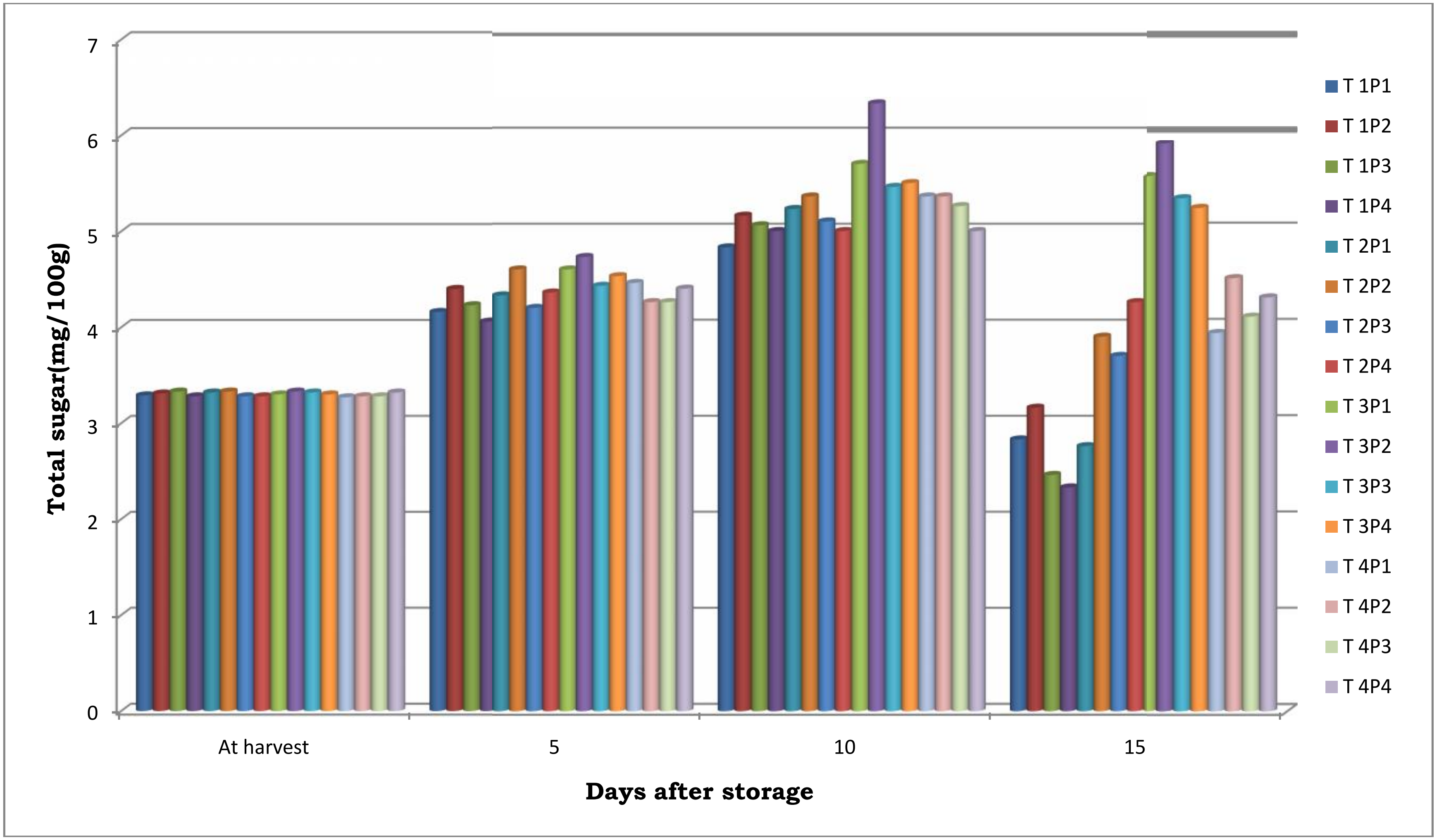

Figure 5. Effect of postharvest treatments and packaging on total sugar (mg/100g) of fruits during storage

potassium permanganate. Similar findings were noticed by Naresh Kumar *et al.* (2001) in guava fruits, Sanjay *et al.* (2008), Jadhav *et at.* (1992) and Moneruzzaman *et al.* (2009) in tomato.

5.2.6 pH

The chemical properties of cherry tomato pH presented in table 11. 1t showed increasing trend up to 6th day gradually decline at 8th days of storage. The highest pH was recorded in fruits treated with 2 per cent $CaCl_2$ (4.3, 4.46, 4.67, 4.75, 4.75, 4.51 and 4.39) followed by fruits treated with 4 per cent $KMnO_4$ (4.19, 4.33, 4.49, 4.55, 4.51, 3.98 and 4.53) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days after storage.

Polyethylene packages show significant difference. The highest pH content was recorded in cherry tomato packed in 150 and 200 gauge polyethylene with 0.5% ventilation (4.27, 4.37, 4.59, 4.70, 4.60, 4.14 and 3.62 and 4.15, 4.17, 4.34, 4.49, 4.60, 4.54, 3.8 and 3.51) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively.

Combination effect of postharvest treatments and polyethylene packages shows significant values after 7th days of storage. The highest pH was recorded in fruit treated with 2 per cent $CaCl_2$ and packed in 150 gauge polyethylene package with 0.5 per cent ventilation (4.43, 4.50, 4.80, 4.96, 4.90, 4.8and 4.56) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively followed by fruits treated with same treatment (4.2, 4.36, 4.66, 4.66, 4.73, 456 and 4.33) and packed in 200 gauge polyethylene bag with 0.5 per cent ventilation respectively. The pH is ideal when fruit treated with 2 per cent $CaCl_2$ and packed in polyethylene package with 0.5 per cent ventilation. The results are in conformity with finding by Shehla Sammi and Tariq Masud (2007) in tomato and Nirupama *et al.* (2010) in tomato.

This could be attributed, the increase in pH of fruit during ripening, corresponding decrease in acidity caused by degradation of acids during ripening and senescence.

5.2.7 Ascorbic acid (mg/100g)

The chemical properties of cherry tomato expressed in terms of (mg/100g) and presented in (Table 12 and Figure 6). There were significant changes in the ascorbic acid content of the cherry tomato as influenced by the postharvest treatment, polythene package and their interaction effect at 3rd, 9th, 13th and 15th days of storage.

In the postharvest treatment the highest Ascorbic acid (18.50, 18.93, 21.00, 22.11, 2245, 22.45, 22.50 and 19.16 mg/ l00g) was recorded in fruits treated with 2 per cent $CaCl_2$ followed by fruits treated with 4 per cent $KMn0_4$ (18.35, 18.86, 19.73, 20.5, 20.2 and 16.5 mg/100g) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively.

The highest Ascorbic acid content (19.36, 21.1, 22.11, 22.45, 22.5 and 19.16 mg/l00g) was recorded in fruits packed in 150 gauge polyethylene bag with 0.5 per cent ventilation followed by fruits packed in 200 gauge with ventilation bags (17.96,18.57, 20.39, 21.35, 19.70, 19.60, and 16.00 mg/100g).

In interaction, the highest ascorbic acid content was recorded in fruits treated with 2 per cent $CaCl_2$ (18.43, 19.93, 22.33, 22.76, 22.76, 22.90 and 20.00mg/100g) and stored in 150 gauge polythene with 0.5 per cent ventilation followed by fruits treated with 4 per cent $KMnO_4$ and packed in 150 gauges polythene with 0.5 per cent ventilation(17.83, 18.93, 20.33, 20.90, 20.96, 21.60 and 18.60 mg/l00g) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively. Similar ascorbic acid content were reported by Shehla Sammi and Tariq Masud (2007) in

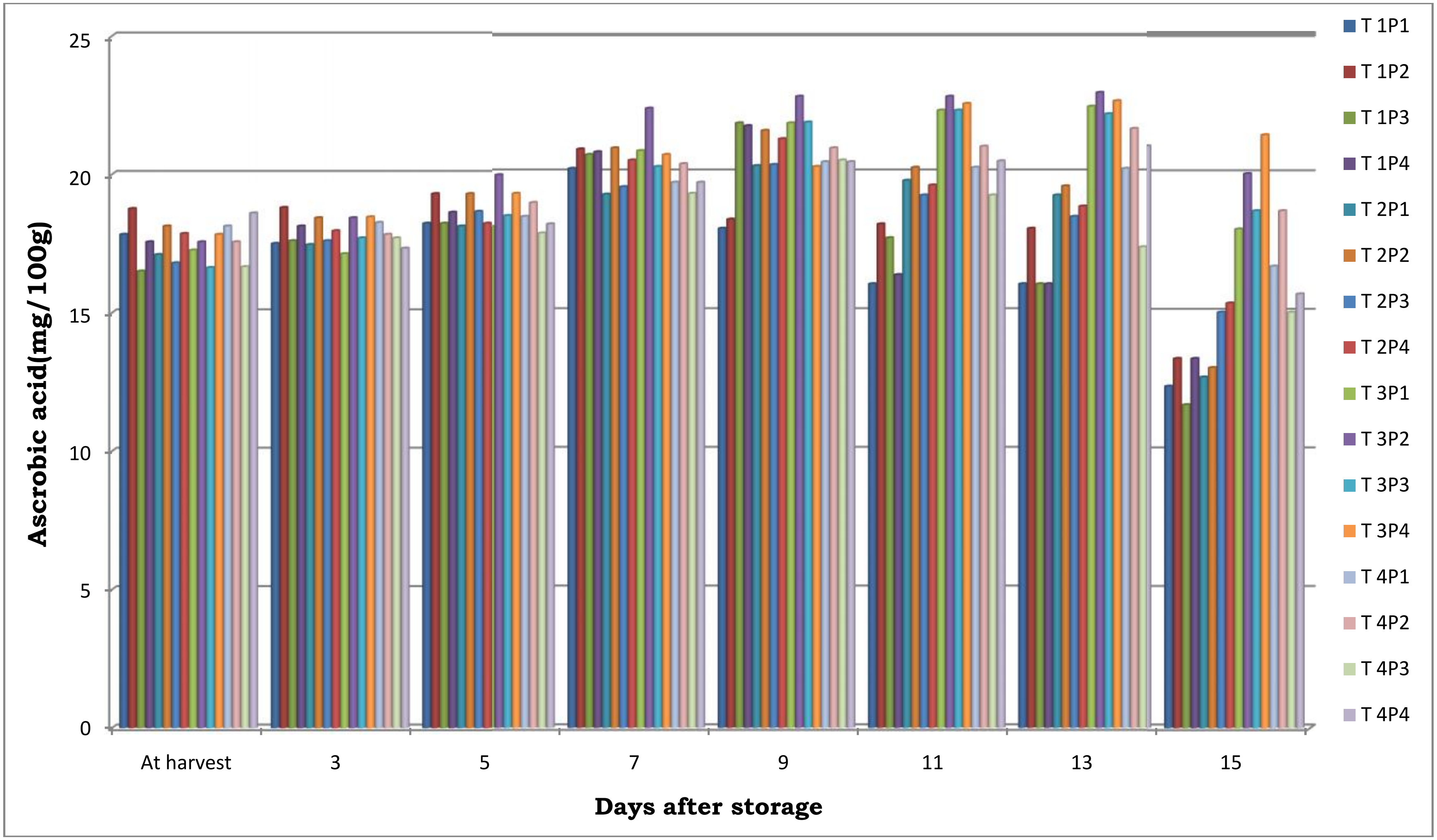

Figure 6. Effect of postharvest treatments and packaging on ascorbic acid (mg/100g) of fruits during storage

tomato, Moneruzzaman *et al.* (2009) in tomato, Sompoch and Chanthaporn, (2006) in tomato and (Upadhayaya and Sanghavi, 2001) in strawberry. Biochemical changes during storage under different polyethylene sealed packages increases ascorbic acid content in conformity with Sudhir yadhav *et al.* (2008). This could be due to lower rate of conversion of ascorbic acid to dehydro-ascorbic acid.

SUMMARY

VI. SUMMARY

The experiment was conducted to increase the shelf life of cherry tomato without distorting quality characters. The different treatments performed well with various qualitative parameters both physically and chemically. Freshly harvested cherry tomato fruits treated with Calcium chloride at two per cent, Potassium permanganate at four per cent and dipped in cold water and one kilogram of cherry tomato packed in150 and 200 gauge polyethylene bag with or without ventilation.

The salient findings in respect of physico-chemical changes during storage, Firmness, Physiological loss in weight, shelf life, spoilage, organoleptic qualities, shelf life, total soluble solid, Titerable acidity, Reducing and non reducing sugar, total sugar, pH and ascorbic acid of the fruit investigation under ambient conditions are summarized below.

6.1 Effect of post harvest treatments and packaging on physical parameters of fruits during storage

The maximum firmness was recorded in cherry tomato treated with 2 per cent $CaCl_2$ and packed in 150 gauge ventilated(0.5%) polyethylene bag (2.90, 2.90 and 2.00kg/cm$^{2)}$ at 5th, 10th and 15th days of storage respectively. The minimum firmness of fruits was recorded in control packed in 150 polyethylene bag (2.33, 2.00, 1.33 and 1.10kg/cm^2) at 5th, 10th and 15th days of storage period respectively.

Similarly the postharvest treatments of 2 per cent $CaCl_2$ with 150 gauges of polyethylene bags with 0.5 per cent ventilation recorded minimum physiological loss in weight (1.81, 2.61, 3.37, 3.73, 4.74, 5.44 and 6.2 %) and the maximum physiological loss in weight was recorded in control packed in 200 gauges of polyethylene bags without ventilation

(1.42, 1.80, 3.13 and 4.60 %), at 3rd, 5th, 7th, 9th, 11th and 15th days of storages.

The fruits treated with $CaCl_2$ and packed in 150 gauges of polyethylene bags recorded highest shelf life (15.33 days). While the lowest shelf life was recorded in fruits without any treatment and packed in 200 gauge polythene bags without ventilation (8.16 days).

The lowest spoilage was recorded in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauges of polyethylene bags with 0.5 percent ventilation (1.66, 3.33, 4.00, 5.66, 8.33, 10.00 and 13.33) While the maximum spoilage was recorded in control fruits packed in 200 gauge of polyethylene bags without ventilation (6.33, 9.00, 15.00, 16.00, 17.33 and 20.66) at 3rd, 5th, 7th, 9th, 11th and 15th days of storage period respectively.

The highest colour was found in cherry tomato treated with 2 per cent calcium chloride and packed in 150 gauges of polyethylene bags with 0.5 per cent ventilation (4.00, 4.33 and 3.33/5.00 score point) at 5th, 10th and 15th days of storage respectively. The lowest color was observed (1.66, 2.33 and 1.33/5.0) in control fruits packed in 200 gauges of polyethylene bags and fruits packed in 150 gauge polyethylene bag without ventilation 5th, 10th and 15th days of storage respectively.

The highest taste was found in fruits treated with calcium chloride at 2 per cent and packed in 150 gauges of polyethylene bags with 0.5 per cent ventilation (3.66, 4.66 and 4.30 of 5.0 score point) at 5th, 10th and 15th days after storage respectively. The lowest taste was observed (3.00 and 1.33/5.00) in control cherry tomato fruits packed in 200 gauges of polyethylene bags at 10th and 15th days after storage.

The highest flavour was noticed in fruits treated with calcium chloride and packed in 150 gauges of polyethylene bags with 0.5 per cent ventilation (3.66, 5.00 and 4.66/5.0 score point) respectively at 5^{th}, 10^{th} and 15^{th} days after storage. The lowest flavour was observed in control packed in 200 gauges without ventilation (2.33, 2.33 and 1.1.33/5.0) at 5^{th}, 10^{th} and 15^{th} days after storage respectively.

The highest overall acceptance was seen in fruits treated with calcium chloride which is on par with potassium permanganate and packed in 150 gauges with 0.5 per cent ventilation (4.66, 4.66 and 4.00 /5.0 score point) at 5^{th}, 10^{th} and 15^{th} days of storage respectively. The lowest Overall acceptance was observed in control which is on par with cold water treated fruits (3.00, 3.00 1.33/5.0 and, 3.00, 3.00 and 1.33/5.0) and packed at 150 and 200 gauge polyethylene bags without ventilation at 5^{th},10^{th} and 15^{th} days after storage respectively.

Effect of postharvest treatments and packaging on chemical parameters of fruits during storage

The highest TSS was recorded in fruits treated with $CaCl_2$ and packed in 150 gauge polythene bag with 0.5 per cent ventilation (3.7, 4.83, 5.67, 6.26, 6.1, 5.53 and 4.80 °Brix) at 3^{rd}, 5^{th}, 7th, 9th, 11^{th}, 13^{th} and 15^{th} days of storage. While the lowest total soluble solid was recorded in control fruits packed in 200 gauges without ventilation (3.26, 3.46, 3.86, 4.46, and 4.60, °Brix) at 3^{rd}, 5^{th}, 7^{th}, 9^{th} and 11^{th} of storages day of cherry tomatoes.

The highest acidity was found in fruits treated with $CaCl_2$ and packed in 150 gauge polythene package with 0.5 per cent ventilation (0.31, 0.31, 0.32, 0.32, 0.31, 0.29, 0.46 and 0.39%) at 3^{rd}, 5^{th}, 7^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} respectively. The lowest acidity was found in control fruits packed in 150 gauges of polyethylene (0.28, 0.29, 0.28, 0.28, 0.28, 0.26 and 0.20%) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days after storage in ambient temperature.

The highest reducing sugar content was recorded in fruits treated with $CaCl_2$ and packed in 150 gauge polyethylene package with 0.5 per cent ventilation (3.5, 4.53 and 4.93%) at 1st, 5th, 10th and 15th days of storage respectively. The lowest reducing sugar content was recorded in fruits without any pretreatment and packed in 150 gauges Polyethylene without ventilation (2.35, 2.73, 3.36 and 1.96 %) at 1st, 5th, 10th and 15th days of storage respectively.

The highest non reducing sugar was recorded in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauge polythene package with 0.5 per cent ventilation (0.95, 1.8, 1.86 and 0.96%) at 1st, 5th, 10th and 15 days of storage respectively. The lowest non reducing sugar was recorded in control and packed in 200 gauge polythene bags without ventilation at all the days of storage period (0.92, 1.33, 1.41 and 0.83%) at 1st, 5th, 10th and 15th days after storage respectively.

The highest total sugar was observed in fruits treated with 2 per cent $CaCl_2$ and packed in 150 gauges of polyethylene bags with 0.5 ventilation (4.73, 6.33 and 5.9%) at 5th, 10th and 15th days after storage. The lowest total sugar content was recorded in fruit without any treatment and packed in 150 gauges of polyethylene bag without ventilation (3.29, 4.16, 4.83 and 2.83%) at 5th, 10th, and 15th days of storage respectively.

The highest pH content was recorded in fruit treated with 2 per cent $CaCl_2$ and packed in 150 gauge polyethylene package with 0.5 per cent ventilation(4.43, 4.50, 4.80, 4.96, 4.90, 4.8and 4.56) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th days of storage respectively. The lowest pH was recorded in case of control fruits packed in 200 gauge polyethylene bags without ventilation (4.03, 4.3, 4.33, 4.36, 4.43, 4.30, 3.13 and 3.00) at 3^{rd}, 5^{th}, 7^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively.

The highest ascorbic acid content was recorded in fruits treated with 2 per cent $CaCl_2$ (18.43, 19.93, 22.33, 22.76, 22.76, 22.90 and 20.00mg/100g) and packed in 150 gauge polythene with 0.5 per cent ventilation. The lowest ascorbic was recorded in control packed in 150 gauge polythene bags without ventilation (17.5, 18.23, 20.16, 18.00, 16.00, 16.00 and 12.33 mg/l00g) at 3^{rd}, 5^{th}, 7^{th}, 9^{th}, 11^{th}, 13^{th} and 15^{th} days of storage respectively.

Polyethylene packages performed well in case of appearance of fruit, reduces the moisture loss, attained firmness, freshness, without ethylene absorbent retained quality of fruit under ambient condition, least physiological biochemical and pathological deterioration, reduces the ripening, maintained turgidity besides oxygen depilation and carbon dioxide increases. At very low concentration of chemicals effectively retard ripening process it may be associated with natural antifungal activities, controls pathogen and act as fungicide also control the physiological deterioration of fruits. The production of ethylene has to be observed so that further ripening process arrested.

CONCULSION

Breaker stage harvested cherry tomato fruits treated with 2 per cent $CaCl_2$ for 5 minutes and packed in 150 gauges of polyethylene bags with ventilation (0. 5%) found better retention of firmness, overall acceptability, taste and delayed colour development in ambient storage condition.

Breaker stage harvested cherry tomato fruits treated with 2 per cent $CaCl_2$ for 5 minutes and packed in 150 gauges of polyethylene bags with ventilation (0.5%) found better retention of appearance with minimum physiological loss in weight and reduced percent spoilage rate in ambient storage condition.

Breaker stage harvested cherry tomato fruits treated with 2 per cent $CaCl_2$ for 5 minutes and packed in 150 gauges of polyethylene bags with ventilation (0.5%) found better retention of shelf life with better retention of chemical quality parameters under ambient condition even after 15 days of storage.

Future line of work

Based on the findings of the present investigation the following future line of work is proposed:

1- To study the effect of $CaCl_2$ on cherry tomato fruits with different concentrations and packages in different gauges of polythene under CA and modified atmosphere storages.

2- Study on different concentration of $KMnO_4$ on cherry tomato fruits and their effect in relation with temperature.

3- Study the effect of 1-MCP and wax emulsion on cherry tomato to increase the shelf life of cherry tomato fruits.

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APPENDIX

APPENDIX

Temperature and Relative humidity recorded during storage of cherry tomato under ambient condition

STORAGE DAYS	TEMPRETURE(°C)		RELATIVE HUMIDITY (%)	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
1st day	20	27	63	80
2nd day	19	26	65	77
3rd day	18	26	70	82
4th day	18	27	68	79
5th day	19	25	66	81
6th day	18	25	70	82
7th day	19	24	71	82
8th day	19	25	68	79
9th day	18	26	69	82
10th day	20	26	70	81
11th day	20	24	71	80
12th day	19	24	72	78
13th day	18	23	68	80
14th day	17	24	68	79
15th day	19	25	69	81