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Full Length Research Paper

Post harvest treatments on quality of tomatoes

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Tomato (Lycopersicon esculentum Mill) is one of the most important vegetable crops cultivated all over the world for its fleshy fruits. In this work, the influence of various post harvest treatments and storage conditions on the various physico-chemical changes associated with tomatoes was investigated. The treatments consisted of sodium metabisulphite, calcium chloride dip, citric acid dip, lemon juice dip, Shea butter coating, hot water dip treatments kept in two storage conditions, viz., ambient and cold storage. The storage spans over 28 days. Significant differences were observed among the physico-chemical parameters due to various post harvest treatments and storage conditions. The physiological loss in weight (PLW) was less under cold storage as compared to ambient storage in all the treatments. The PLW was lowest in sodium metabisulphite dip (SMB 0.73) which was significantly lower over all other treatments under both cold (0.31) and ambient (1.15) storage conditions. There were no significant differences in pH between the post-harvest treatments and the storage conditions both at 7 and 14 days of storage. A similar trend was observed at 21 and 28 days of storage. Total soluble solids (TSS) was lowest in sodium metabisulphite dip (SMB 4.14) which was at par with CaCl2 (4.17) at 7 days of storage. Among the storage conditions, no significant differences were observed at both 7 and 14 days of storage. Significant low titratable acidity was recorded in control fruits at 21 and 28. Among the post-harvest treatments, Sodium metabisulphite dip (SMB) recorded significantly higher ascorbic acid content (31.4) at 7 days and 14 days (27.3).

Key words: Tomatoes, post harvest, treatment, ambient, cold storage.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetable crops cultivated all over the world for its fleshy fruits. It belongs to the family solanaceae. The cultivated tomatoes originated as wild forms in the Peru-Ecuador-Bolivia area of South America. Earlier, tomatoes were thought to be poisonous and long before it was considered fit to eat, it was grown only as an ornamental garden plant. Today, tomato is recognized as one of the important commercial and dietary vegetable Crops (Bauer et al., 2004). The fruit may or may not be peeled, but stems and calices should be removed. Canned tomatoes maybe packed with or without added liquid. Calcium salts, varying from 0.045 to 0.08% by weight of the finished products, can also be added. Other ingredients such as organic acids, spices, oil, and flavorings can be added up to 10%. There are three categories of canned tomatoes. The label tomatoes are valid only for peeled and canned tomato. Unpeeled tomatoes are labeled accordingly. Stewed tomatoes are canned tomatoes containing onion, celery, and peppers (Hui, 2006).

Tomatoes are important source of vitamins A and C and antioxidants such as lycopene. In tomato and tomato products, color serves as a measure of total quality. Consumers notice color first and their observation often supplements preconceived idea about other quality attributes such as aroma and flavor. Color in tomato is due to carotenoids, a class of isoprenoid compounds varying from yellow to red color (Hui, 2006).

Lycopene is the major carotenoid of tomato and comprises about 83% of the total pigments present in the ripe fruit (Thakur et al., 1996). Therefore the levels of

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lycopene are very important in determining the quality of processed tomato products. It not only determines the color of tomato products, but also provides antioxidant properties to them. Lycopene is considered as a preventive agent against coronary heart disease and cancers (Gerster, 1991; Clinton, 1998).

The major quality attribute of ripe tomato is its red color, which is due to the lycopene content of the fruit. Other important physicochemical parameters, which determine the quality of tomato are Brix, acidity, pH, vitamin C, ash, dry matter, firmness, fruit weight, and flavor volatiles. For processed tomato products, the required quality attributes are precipitate weight ratio, serum viscosity, total viscosity (Brookfield), and lycopene content. Several quality attributes of tomato and tomato products can be improved by genetic modification of tomatoes (Oke et al., 2003)

Consumer's increasing desire for high quality and nutritional foods has created a need for longer market season for both domestic as well as export markets. This is especially true of tomatoes, which ranks number one among vegetables contributing vitamins and minerals (Rick, 2008).

Fresh tomato quality is a function of appearance, colour, texture and flavour. Optimum quality is attained through vine ripening; but ripe tomatoes are perishable and very labile to shipping damage, which consequently leads to loss of quality and waste. This research work is therefore aimed to determine the effect of post-harvest treatments on the shelf stability of processed tomatoes stored at ambient and refrigerating temperature.

MATERIALS AND METHODS

Processing of unpeeled tomatoes

Fully ripe tomatoes with a firm pulp were purchased from Mushin market, washed with clean water and allowed to dry. The tomatoes were divided into seven sets, the first set were dipped and withdraw in a mixture of calcium chloride, second set in lemon juice, third set in citric acid, fourth set in sodium metabisulphite and the fifth set in pure Shea butter, sixth set in hot water, while seventh set were placed in glass jar as control sample. Each set were made in duplicate, while one set were stored at ambient temperature and the other at refrigerating temperatures.

Physiological loss in weight

For determining the physiological loss in weight, fruits weights were taken before imposing the treatment, which served as the initial fruit weight. The loss in weight was recorded at 7 days interval until 28 days which served as the final weight. The physiological loss in weight was determined by the following formula and expressed as percentage.

pH

Fresh tomato fruits were cut into small pieces and macerated with blender and were filtered through muslin cloth. The filtrate was used for measuring the pH using pH meter.

Total soluble solids (TSS)

Total soluble solids were determined using Erma hand refractrometer (0 to 32). A drop of juice was used to record the TSS and values were expressed as degree Brix.

Ascorbic acid content

It was determined according to method describe in AOAC 2000.

Titratable acidity

It was determined according to method describe in AOAC 2000

RESULTS AND DISCUSSION

A laboratory experiment was conducted to investigate the influence of various post harvest treatments and the storage conditions in tomato. Fruits imposed with post harvest treatments were subjected to both ambient and cold storage conditions. Observations on various physical and chemical, changes during storage were recorded at weekly intervals for four weeks. Results obtained from the investigation are thus presented.

Physiological loss in weight

The data on physiological loss in weight (PLW) as influenced by post-harvest treatments and the storage conditions presented in Table 1 indicated significant differences between both post-harvest treatments and storage conditions at both stages. It was observed in general, that the PLW was less under cold storage compared to ambient storage in all the treatments. Among post-harvest treatments, PLW was lowest in Sodium metabisulphite dip (SMB 0.73) which was significantly lower over all other treatments under both cold (0.31) and ambient (1.15) storage conditions. The next best treatment in terms of low PLW was citric acid (CTA). The PLW progressively increased with an increase in the storage period, irrespective of the storage condition and the treatments. Among the treatments, PLW was maximum in control under both ambient and cold storage conditions both at 7 and 14 days. Cold stored fruits had a low weight loss due to temperature effects on vapour pressure difference and increased water retention (Tasdelen and Bayindirli, 1998). Similar results were reported by Bussel and Kenigsberger (1975) in green bell pepper and Efiuvwevwere et al. (1991). The PLW recorded at 21 and 28 days of storage differed significantly from the treatments and storage conditions (Table 2). Among the storage conditions, PLW was higher with ambient storage compared to cold storage at

Table 1. Influence of post-harvest treatments and storage conditions on physiological loss in weight (%) in tomato at 7 and 14 days of storage.

Treatment	7 days		14 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	5.37 ± 0.01	1.62 ±0.015	8.64 ± 0.02	3.14± 0.01
T_2 HTH	7.77 ± 0.02	2.53 ± 0.0252	14.23 ± 0.0173	4.47± 0.02
T_3 SMB	1.15 ± 0.02	0.31±0.01	2.67 ± 0.02	0.75± 0.01
T_4 SHB	6.10 ± 0.1	1.84±0.01	12.48 ± 0.02	3.58± 0.01
T_5 CTA	4.65 ± 0.02	1.64±0.01	10.17 ± 0.0058	2.85± 0.02
T_6 LMN	7.30 ± 0.2	3.10 ± 0.1	13.25 ± 0.01	6.57± 0.02
T_7 CONTROL	8.69 ± 0.01	3.48±0.02	15.75 ± 0.02	6.87± 0.01
MEAN	5.86 ± 2.5059	2.0742±1.0645	11.027 ± 4.394	4.0329± 2.1547

T_1= Cacl$_2$ (1%), T_2= Hot water, T_3= sodium metabisulphite, T_4= Shea Butter, T_5= Citric Acid, T_6= Lemon.

Table 2. Influence of post harvest treatments and storage conditions on physiological loss in weight (%) in tomato at 21 and 28 days of storage.

Treatment	21days		28 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	12.55 ± 0.01	5.91 ± 0.08	16.55 ± 0.03	12.15 ± 0.96
T_2 HTH	19.35 ± 0.01	7.25 ± 0.03	22.24 ± 0.03	8.38 ± 0.13
T_3 SMB	3.56 ± 0.05	1.62 ± 0.02	4.65 ± 0.08	1.73 ± 0.16
T_4 SHB	17.26 ± 0.04	5.55 ± 0.02	19.58 ± 0.06	6.76 ± 0.17
T_5 CTA	13.75 ± 0.02	4.68 ± 0.10	17.39 ± 0.09	5.55 ± 0.68
T_6 LMN	15.60 ± 0.03	8.17 ± 0.02	19.66 ± 1.59	10.36 ± 0.78
T_7 CONTROL	21.71 ± 0.39	9.37 ± 0.10	23. 93 ± 1.04	11.62 ± 0.48
MEAN	14.83 ± 5.88	6.09 ± 2.54	17.58 ± 6.16	8.08 ± 3.72

T_1 = Cacl$_2$ (1%), T_2 = Hot water, T_3= sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

both the days of observation and significant differences were noticed between these two storage conditions. Among the treatments, the PLW was least in SMB, which was lower over all other treatments under both ambient and cold storage both at 21 and 28 days. The SMB treatment almost recorded four to five times lower PLW over other treatments. The mean PLW was almost half under cold storage compared to ambient storage. However, the control fruits recorded significantly higher PLW over all other treatments under both ambient and cold storage conditions.

Weight loss of fresh tomatoes is primarily due to transpiration and respiration. Transpiration is a mechanism in which water is lost due to differences in vapour pressure of water in the atmosphere and the transpiring surface. Respiration causes a weight reduction because a carbon atom is lost from the fruit each time a carbon-dioxide molecule is produced from an absorbed oxygen molecule and evolved into atmosphere (Bhowmik and Pan, 1992). Heat treatment of 33°C for 5 days was able to lower the respiration rate and decrease the chilling injury in tomato fruits (Ping et al., 1996). Temperature is an effective environmental factor involved in fruit ripening as it has a direct effect on respiration rate. Management of temperature through cold storage reduces the respiration rates and extends the shelf life of the products.

But often the fruits become susceptible to chilling injury. The formation of water soaked lesions occurs in tomatoes held in cold storage, before removal of fruits to non-chilling temperatures (Hong and Gross, 1998).

Calcium compounds have shown promising results in the quality retention of fruits and vegetables through maintenance of firmness and reducing the respiration rates (Poovaiah, 1986).

Apple cv. Red delicious fruits treated with $CaCl_2$ (2%) recorded the lowest physiological loss in weight after 90 days of storage (Bhartiya et al., 1998).

pH

The data on pH as influenced by post-harvest treatments and the storage conditions at 7 and 14 days are presented in Table 3. There were no significant

Table 3. Influence of post harvest treatments and storage conditions on P^H in tomato at 7 and 14 days of storage.

Treatment	7days		14 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	3.81 ± 0.01	3.85 ± 0.03	4.03 ± 0.02	4.05 ± 0.03
T_2 HTH	3.97 ± 0.04	3.88 ± 0.03	4.07 ± 0.01	4.06 ± 0.01
T_3 SMB	3.88 ± 0.03	3.89 ± 0.01	4.03 ± 0.02	4.04 ± 0.02
T_4 SHB	3.91 ± 0.01	3.9 ± 0.06	4.02 ± 0.02	4.00 ± 0.01
T_5 CTA	3.75 ± 0.03	3.82 ± 0.02	3.98 ± 0.01	4.00 ± 0.03
T_6 LMN	3.70 ± 0.04	3.84 ± 0.03	4.02 ± 0.04	4.03 ± 0.03
T_7 CONTROL	3.86 ± 0.03	3.88 ± 0.01	4.09 ± 0.01	4.05 ± 0.01
MEAN	3.84 ± 0.09	3.88 ± 0.09	4.03 ± 0.04	4.03 ± 0.02

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

Table 4. Influence of post harvest treatments and storage conditions on P^H in tomato at 21 and 28 days of storage.

Treatment	21 days		28 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	4.15 ± 0.01	4.14 ± 0.02	4.20 ± 0.01	4.19 ± 0.03
T_2 HTH	4.14 ± 0.03	4.13 ± 0.01	4.23 ± 0.30	4.21 ± 0.02
T_3 SMB	4.16 ± 0.01	4.15 ± 0.04	4.24 ± 0.01	4.21 ± 0.05
T_4 SHB	4.15 ± 0.02	4.13 ± 0.05	4.45 ± 0.03	4.22 ± 0.01
T_5 CTA	4.14 ± 0.02	4.13 ± 0.01	4.22 ± 0.02	4.19 ± 0.02
T_6 LMN	4.12 ± 0.03	4.10 ± 0.02	4.15 ± 0.01	4.14 ± 0.02
T_7 CONTROL	4.18 ± 0.01	4.15 ± 0.01	4.20 ± 0.03	4.17 ± 0.03
MEAN	4.15 ± 0.02	4.13 ± 0.02	4.24 ± 0.09	4.19 ± 0.03

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4= Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

differences in pH between the post-harvest treatments and the storage conditions both at 7 and 14 days of storage. A similar trend was followed at 21 and 28 days of storage (Table 4). Acidity or alkalinity of a food is usually expressed as pH, which is on a scale of 1 to 14, with 1 being highly acidic and 14 being highly alkaline. The pH of a food can dramatically alter the growth of microbes. Escalona et al. (2003) reported that kohlrabi (German Turnip) stored in modified atmosphere package (MAP) maintained the pH over the storage period. However, Smittle and Miller (1988) reported that pH of

blueberries stored in high CO_2 atmospheres was not affected by either storage duration or storage atmosphere.

Total soluble solids

The data on total soluble solids (TSS) presented in Table 5 indicated significant differences between the post-harvest treatments both at 7 and 14 days. Among the post-harvest treatments, TSS was lowest in Sodium metabisulphite dip (SMB 4.14) which was at par with

$CaCl_2$ (4.17) at 7 days of storage. Among the storage conditions, no significant differences were observed at both 7 and14 days of storage.

The fruits treated with $CaCl_2$ (0.5%) + S (0.5%) showed the highest sugar, TSS and organoleptic ratings after the storage period (Bhartiya et al., 1998) However, significant differences were recorded between storage conditions only at 21 days with cold storage recording significantly lower TSS over ambient storage (5.11). But no significant differences were observed at 28 days of observation. Among the treatments, significantly lower TSS (5.06, 5.19) was recorded in SMB over all other treatments at both 21 and 28 days, respectively (Table 6). The control fruits recorded significantly higher TSS (5.28, 5.57). The total soluble solids acts as a rough index of the amount of sugars present in fruits. It is the amount of sugar and soluble minerals present in fruits and vegetables. Sugars constitute 80 to 85% of soluble solids. The total soluble solids increased during the ripening due to degradation of polysaccharides to simple sugars thereby causing a rise in TSS (Naik et al., 1993).

Intermittent warming of tomato fruits at 20°C for one day at 7 days interval reduced the fruit titratable acidity, but no significant differences were observed in soluble solid content. Fruits with good quality and shelf life were

Table 5. Influence of post harvest treatments and storage conditions on TSS (°Brix) in tomato at 7 and 14 days of storage.

Treatment	7days		14 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	4.21 ± 0.05	4.14 ± 0.09	4.54 ± 0.01	4.51 ± 0.02
T_2 HTH	4.21 ± 0.02	4.31 ± 0.01	4.51 ± 0.01	4.61 ± 0.04
T_3 SMB	4.17 ± 0.03	4.11 ± 0.05	4.41 ± 0.03	4.57 ± 0.01
T_4 SHB	4.31 ± 0.01	4.24 ± 0.08	4.57 ± 0.06	4.54 ± 0.02
T_5 CTA	4.21 ± 0.02	4.14 ± 0.10	4.44 ± 0.05	4.47 ± 0.01
T_6 LMN	4.27 ± 0.25	4.21 ± 0.10	4.61 ± 0.02	4.67 ± 0.01
T_7 CONTROL	4.37 ± 0.01	4.34 ± 0.10	4.74 ± 0.03	4.71 ± 0.02
MEAN	4.25 ± 0.07	4.21 ± 0.09	4.55 ± 0.11	4.58 ± 0.09

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6= Lemon.

Table 6. Influence of post harvest treatments and storage conditions on TSS (°Brix) in tomato at 21 and 28 days of storage.

Treatment	21 days		28 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	5.21 ± 0.02	5.11 ± 0.05	5.34 ± 0.01	5.34 ± 0.03
T_2 HTH	5.24 ± 0.03	5.14 ± 0.02	5.37 ± 0.08	5.41 ± 0.10
T_3 SMB	5.11 ± 0.01	5.01 ± 0.03	5.24 ± 0.01	5.14 ± 0.10
T_4 SHB	5.17 ± 0.04	5.14 ± 0.05	5.34 ± 0.03	5.31 ± 0.02
T_5 CTA	5.14 ± 0.03	5.07±0.01	5.31 ± 0.01	5.24 ± 0.10
T_6 LMN	5.24 ± 0.01	5.11 ± 0.01	5.14 ± 0.02	5.17 ± 0.02
T_7 CONTROL	5.31 ± 0.03	5.24 ± 0.02	5.57 ± 0.01	5.56 ± 0.02
MEAN	5.20 ± 0.07	5.12 ± 0.01	5.33 ± 0.13	5.34 ± 0.14

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

Table 7. Influence of post harvest treatments and storage conditions on Titratable Acidity in tomato at 21 and 28 days of storage.

Treatment	7 days		14 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	0.576 ± 0.02	0.565 ± 0.01	0.437 ± 0.01	0.448 ± 0.10
T_2 HTH	0.565 ± 0.01	0.544 ± 0.01	0.427 ± 0.02	0.437 ± 0.04
T_3 SMB	0.587 ± 0.10	0.597 ± 0.01	0.459 ± 0.02	0.480 ± 0.04
T_4 SHB	0.533 ± 0.02	0.544 ± 0.01	0.437 ± 0.10	0.427 ± 0.05
T_5 CTA	0.576 ± 0.04	0.576 ± 0.02	0.448 ± 0.01	0.469 ± 0.02
T_6 LMN	0.512 ± 0.01	0.523 ± 0.10	0.416 ± 0.02	0.427 ± 0.01
T_7 CONTROL	0.512 ± 0.01	0.512 ± 0.02	0.384 ± 0.01	0.405 ± 0.02
MEAN	0.551 ± 0.03	0.551 ± 0.03	0.430 ± 0.02	0.442 ± 0.03

T_1 = $Cacl_2$ (1%), T_2= Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

obtained following 3 cycles of intermittent warming at 6°C (Artes et al., 1998).

Titratable acidity

No significant differences in titratable acidity were observed among the post-harvest treatments at 7 and 14 days of storage (Table 7). However, the control fruits recorded significantly lower titratable acidity at both days of observation. Among the treatments, significantly higher titratable acidity was recorded in SMB over all other treatments at 21 days (0.379) and 28 days (0.315) of storage. The next best treatment was citric acid (CTA 0.341, 0.283) which was at par with $CaCl_2$ at both days of observation. Significantly lower titratable acidity was

Table 8. Influence of post harvest treatments and storage conditions on Titratable Acidity in tomato at 21 and 28 days of storage.

Treatment	21 days		28 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	0.309 ± 0.01	0.341 ± 0.01	0.256 ± 0.05	0.288 ± 0.01
T_2 HTH	0.309 ± 0.02	0.299 ± 0.03	0.245 ± 0.03	0.267 ± 0.02
T_3 SMB	0.373 ± 0.01	0.384 ± 0.01	0.309 ± 0.10	0.320 ± 0.01
T_4 SHB	0.320 ± 0.02	0.320 ± 0.01	0.256 ± 0.02	0.267 ± 0.02
T_5 CTA	0.381 ± 0.01	0.352 ± 0.01	0.277 ± 0.02	0.288 ± 0.02
T_6 LMN	0.267 ± 0.01	0.267 ± 0.02	0.224 ± 0.02	0.224 ± 0.01
T_7 CONTROL	0.256 ± 0.01	0.267 ± 0.02	0.192 ± 0.01	0.224 ± 0.02
MEAN	0.136 ± 0.05	0.319 ± 0.04	0.2513 ± 0.04	0.2683 ± 0.04

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

Table 9. Influence of post harvest treatments and storage conditions on Ascorbic Acid in tomato at 21 and 28 days of storage.

Treatment	7 days		14 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	26.39±0.02	30.03±0.01	24.57±0.02	25.48±0.05
T_2 HTH	28.23±0.02	28.21±0.01	24.57±0.01	24.57±0.08
T_3 SMB	30.94±0.10	31.85±0.01	26.39±0.05	28.21±0.10
T_4 SHB	25.48±0.10	27.30±0.02	22.75±0.04	23.66±0.10
T_5 CTA	30.03±0.08	29.12±0.01	25.48±0.01	26.39±0.01
T_6 LMN	24.57±0.01	25.48±0.02	21.84±0.02	21.84±0.02
T_7 CONTROL	23.66±0.02	24.57±0.02	19.11±0.06	21.54±0.01
MEAN	27.04±2.540.01	28.08±2.54	23.53±2.49	24.53±2.41

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

recorded in control fruits at 21 and 28 days.(Table 8)

Acidity in fruits is an important factor in determining maturity. Titratable acidity gives the total or potential acidity, rather than indicating the number of free protons in any particular sample. It is a measure of all aggregate acids and sum of all volatile and fixed acids (Naik et al., 1993)

Ascorbic acid content (mg/100 g fr.wt)

Ascorbic acid content differed significantly between the post-harvest treatments and storage conditions both at 7 and 14 days of storage (Table 9). Among the post-harvest treatments, sodium metabisulphite dip (SMB) recorded significantly higher ascorbic acid content (31.4) at 7 and 14 days (27.3). The control fruits recorded significantly lower ascorbic acid at both days of observation. Among the storage conditions, ascorbic acid content was higher in cold storage (28.08) over ambient storage (27.04) at 7 days, but no significant differences were observed at 14 days of storage. Calcium chloride treated cucumbers 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).

Among the storage conditions, cold storage recorded significantly higher ascorbic acid content compared to ambient storage both at 21 and 28 days. Among the treatments, significantly higher ascorbic acid content was recorded in SMB at both days of observation. The next best treatment was CTA in terms of higher ascorbic acid content. Significantly lower ascorbic acid content was recorded in control fruits both at 21 and 28 days (Table 10). Tomatoes are rich source of vitamin C. The vitamin C content of ripe tomato ranges from 15 to 23 mg/100 g fruit (Grierson and Kader, 1986). Ascorbic acid (vitamin C) content has been found to have a significant role in the assimilation of proteins obtained from other sources. It is essential for the formation of normal teeth and bones. Absence of vitamin C results in scurvy. Preservation of ascorbic acid content during storage is a difficult task since it undergoes oxidation. The presence of higher O_2 concentrations in the storage atmosphere hastens this process. However in the present investigation, the ascorbic acid content of fruits was significantly influenced by various post harvest treatments and storage conditions.

Treating of strawberry fruits with 1, 2 and 3% $Cacl_2$ retained the highest level of total sugars, acidity and

Table 10. Influence of post harvest treatments and storage conditions on Ascorbic Acid in tomato at 21 and 28 days of storage.

Treatment	21 days		28 days	
	Ambient	Cold	Ambient	Cold
T_1 CCL	20.22 ± 0.01	21.84 ± 0.01	16.38 ± 0.02	17.29 ± 0.02
T_2 HTH	19.11 ± 0.01	20.02 ± 0.02	14.56 ± 0.02	16.38 ± 0.01
T_3 SMB	23.66 ± 0.02	26.48 ± 0.02	21.84 ± 0.01	23.66 ± 0.01
T_4 SHB	19.11 ± 0.01	21.84 ± 0.08	16.38 ± 0.10	17.29 ± 0.08
T_5 CTA	21.84 ± 0.05	23.66 ± 0.03	19.16 ± 0.01	21.84 ± 0.02
T_6 LMN	16.38 ± 0.01	19.11 ± 0.01	15.47 ± 0.02	16.38 ± 0.03
T_7 CONTROL	16.38 ± 0.08	19.11 ± 0.01	13.65 ± 0.01	13.60 ± 0.01
MEAN	19.53 ± 2.68	21.72 ± 2.68	16.77 ± 2.83	18.06 ± 3.47

T_1 = $Cacl_2$ (1%), T_2 = Hot water, T_3 = sodium metabisulphite, T_4 = Shea Butter, T_5 = Citric Acid, T_6 = Lemon.

ascorbic acid and exhibited the highest overall acceptability. The shelf life was extended to 7 days but the control fruit had a shelf life of one day (Upadhayaya and Sanghavi, 2001).

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