Research Article

EFFECTS OF CHEMICAL ADDITIVES ON SHELF LIFE OF TOMATO *(Solanum lycopersicum)* DURING STORAGE

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ABSTRACT

The study on effect of chemical additives on shelf life of tomato (*Solanum lycopersicum*) at the time of storage was done in Nuwakot, Nepal during March to April, 2019. Tomato (Dr-3 variety) fruit with stem stalk were harvested at pink stage and dipped either in distilled water as control, or in different concentration of Gibberellic acid [(GA_3) (0.1, 0.3 and 0.5%)], and calcium chloride [($CaCl_2$) (0.5, 1 and 1.5%)] for 20 minutes. Fruit were then air dried and stored at ambient condition. The experiment was laid out in Completely Randomized Design (CRD) with 3 replications and 7 treatments. The shelf life and physicochemical characteristics of tomato fruit were studied at 3 days interval during storage. The post harvested treatment with GA and $CaCl_2$ resulted in delay in the change of weight loss, decaying loss, total soluble solids, and titratable acidity in tomato fruit along with higher amount of ascorbic acid. The least decay percentage in the fruit was obtained with 0.1% GA_3 and 1.5% $CaCl_2$. Hence, it could be concluded that post-harvest treatment with GA_3 and $CaCl_2$ has the potential to control decay, prolong the storage life, and preserve valuable attributes of tomato fruit.

Keywords: Calcium chloride, Gibberellic acid, Post-harvest treatment, Tomato

INTRODUCTION

Tomato (*Solanum lycopersicum*) is an edible red fruit/berry that belongs to Solanaceae family. Losses of tomato are a major problem in the post-harvest value chain in Nepal. It can be caused by a variety of factors, ranging from growing condition to handling practices at market. Being a climacteric and perishable vegetable, tomato has a very short life span, usually 2-3 weeks. So, an increase in the storage life and improvement of tomato fruit quality is really desirable (Sammi & Masud, 2007).

Worldwide postharvest fruit and vegetables losses are as high as 30 to 40% and even much higher in developing countries like Nepal (Bhattarai et al., 2013). Since fruit and vegetables are consumed fresh, their postharvest qualities are of crucial importance. In market chain, tomato encounters several problems in its transportation, storage and marketing (Arie, 2018). Post-harvest losses of tomato have been reported up to 50% in Nepal (Bistha, 2002). Due to lack of information on appropriate post-harvest treatments, packaging, temperature etc, the fruit not only lose their quality but also encounter a substantial post-harvest loss. In tropical countries 20-50% of loss occurs (Kader, 1992) between harvesting, transportation and consumption of fresh tomato. Physiological and biochemical processes such as transpiration, respiration and ripening continue after harvesting of fruit and vegetables. The extension of shelf life of tomato with minimum loss during storage would enable efficient transport and storage of tomato. As a climacteric fruit, ripening can happen even after harvest, causes the increase in production of ethylene (Sammi & Masud, 2007). To delay ripening and extend the quality of post-harvest tomato, the action of ethylene should be taken care (Martinez-Romero et al., 2008). Ethylene is considered as harmful because it is responsible for fruit pathogen susceptibility, physiological disorders and senescence that ultimately decreases the shelf life. Its level should not be higher than 0.1µL as increase in its level is directly related to quality loss (Wills & Warton, 2000). Also, several disorders in tomato depend upon ethylene concentration and its duration of exposure, atmospheric composition, and temperature (Saltveit, 2001).

In Nepal, some efforts have been made in this direction by employing certain chemicals/plant growth hormones to hasten or delay ripening, to reduce losses and to improve and maintain the color and quality by slowing down the metabolic activities of the fruit (Sudha et al., 2007). These chemicals are reported to arrest the growth and spread of micro-organisms by reducing the shriveling, which ultimately leads to an increased shelf life and maintain the marketability of the fruit for a longer period (Sudha, et al., 2007). Recently, the chemicals Gibberellic acid (GA_3) and calcium chloride ($CaCl_2$) have been widely used in other countries as a shelf life enhancer of perishable commodities like tomato. These compounds are well known for their qualities to conserve the physicochemical and biochemical characteristics as well. However, there is scarce information regarding the post harvest usage of these chemicals in Nepal. Therefore, the main objective of this study was to investigate the effect of GA_3 and $CaCl_2$ on shelf life of tomato (*Solanum lycopersicum*) during storage.

MATERIAL AND METHODS

Sample collection

Tomato *(Solanum lycopersicum*) fruit of Dr-3 variety was collected from a commercial farm located at Sunkhani rural municipality, Nuwakot, Nepal.The collected fruit were fresh, pink, round to oval in shape, and free from pest and diseases. The GPS location of the sampling site in Nuwakot is $85^0$8'41''NE latitude and $27^0$55'7'' N longitude, which is about 530 m from the sea level.The experiment, was conducted from March 18 to April 8, 2019. The average temperature of the experimental site during this period was 27^oC.

Treatments and experimental Design

Tomato fruit of uniform size were selected and sorted out. The experiment was laid out in Completely Randomized Design (CRD) with 7 treatments and each treatment was replicated 3 times. Treatments were T_1: Gibberellic acid (GA_3) at 0.1%, T_2: Gibberellic acid (GA_3) at 0.3%, T_3: Gibberellic acid (GA_3) at 0.5%, T_4: Calcium Chloride ($CaCl_2$) at 0.5%, T_5: Calcium Chloride ($CaCl_2$) at 1%, T_6: Calcium Chloride ($CaCl_2$) at 1.5%, T_7: Control (distilled water). The fruit were dipped in the treatment solution for 20 min.

Physiological loss in weight (PLW)

Weight loss was determined in three days interval. A digital sensitive balance was used to determine fruit weight. The PLW of tomato fruit samples was calculated by calculating the differences between initial weight and final weight that was divided by their initial weight.

Spoilage loss (%)

Spoiled fruit were determined by visual observation i.e. fruit showing the rotting symptoms. The decay percentage was calculated as the number of decayed fruit divided by initial number of all fruit times 100.

Total Soluble Solid (^{o}Brix)

The total soluble solids content was measured in ^{o}Brix with the help of hand held refractometer. Tomato sample was prepared by blending tomato flesh. A few drops of the blend was taken on prism of refractometer and direct reading was taken.

Titratable acidity (TA)

The titratable acidity (expressed as citric acid %) was determined by titrating 5-ml of juice with 0.1 N sodium hydroxide, using phenolphthalein as an indicator.

pH of the juice

The pH of the juice was measured with the help of digital pH meter.

Vitamin C (Ascorbic acid) content

The vitamin C content of tomato was measured by volumetric method as per the reference from Sadasivam and Manickam (1991).Vitamin C (ascorbic acid) content was determined by using titrimetric method with the titration of filtrate against 2, 6- dichlorophenol indophenol and the results of vitamin C content were expressed as mg/100 g.

Temperature and Relative Humidity

Temperature and Relative Humidity (RH) were recorded each day during experimental period.

Storability/shelf life

The shelf life of tomato fruit was evaluated by counting the number of days required to attain the fully ripe stage up to the stage when fruit remained still accepted for marketing. It was based on the physical appearance and spoilage.

Data analysis

All collected data were entered in MS-Excel sheet and subjected to Analysis of Variance (ANOVA). Means of treatments which were significantly different were separated by Duncan's Multiple Range Test (DMRT). Analysis of Variance (ANOVA) and mean comparison by Duncan's Multiple Range Test (DMRT) were performed using Gen-STAT.

RESULTS AND DISCUSSION

Physiological loss in weight (PLW)

As shown in Table (1), there was a progressive and continuous increase in PLW of fruit with increase in storage period in all the treatments.

It was observed that PLW of tomatoes didn't differ significantly among the treatments. However, the increasing trend in the weight loss was found maximum in the fruit kept as control from 12 days onwards. Minimum percentage of PLW was observed in the fruit treated with 0.1% Gibberellic acids (GA_3) from 6 days after treatments (DAT) onwards during the storage.

It was advocated that the reason for primary mechanism of moisture loss from fresh fruit and vegetables was due to vapor–phase diffusion driven by a gradient of water vapor pressure at different locations (Yaman & Bayoindril, 2002). Moreover, water loss can be reduced effectively by placing additional physical barriers between the produce and the surrounding air and during ripening of fleshy fruit changes in tissue permeability and cellular compartmentation occur (Wills et al., 1998). In terms of weight loss, it was reported that the reduction in the fruit treated with GA might be due to its anti-senescent action (Sudha, et al., 2007). Therefore in the present study, the GA_3 treatment which caused the decrease in the tissue permeability and thereby reducing the rate of water loss might have led to delay in fruit ripening. On the other hand, it is understood that calcium is the important mineral of middle lamellae. Softening of fruit may be mainly due to weakening of middle lamellae during ripening.

Calcium helps to bind poly-galactonic acid each other and make the membrane strong and rigid (Sharma et al., 1996). Thus, calcium might have delayed senescence and rate of respiration and transpiration in tomato fruit (Bhattarai & Gautam, 2006).

Table 1. Effect of postharvest treatments on physiological loss in weight (PLW) of tomato fruit

Treatments	Physiological loss in weight (%)						
	3DAT	6DAT	9DAT	12DAT	15DAT	18DAT	21DAT
GA_3-0.1%	3.61	5.54	6.58	7.72	8.34	9.1	10.43
GA_3-0.3%	3.55	5.7	6.59	7.74	8.38	9.17	10.52
GA_3-0.5%	3.93	6.26	7.58	8.97	9.74	10.49	11.68
$CaCl_2$-0.5%	4.12	6.45	7.93	9.26	9.95	10.77	11.79
$CaCl_2$-1%	4.03	6.37	7.74	9.10	9.85	10.79	12.28
$CaCl_2$-1.5%	3.46	5.61	6.78	8.04	8.71	9.76	10.78
Control	4.03	6.13	7.66	9.35	10.06	11.41	12.88
SEm(±)	0.336	0.495	0.657	0.8	0.817	0.777	0.761
LSD (0.05)	Ns	Ns	Ns	Ns	Ns	Ns	Ns
CV%	15.3	14.3	15.7	16.1	15.2	13.2	11.5
Grand Mean	3.82	6.01	7.27	8.6	9.29	10.21	11.48

Note: DAT=Days after treatment

Decay loss (%)

The decay loss is shown in Table 2, which indicated that the loss increased significantly with the prolongation of storage period in all the treatments. The decaying loss was noticed from 9DAT of storage in control fruit and significant decay loss appeared from the 15DAT in other treatments. Therefore, the decay loss data from 15 DAT are described in table (2). Accordingly, the minimum decay loss was noticed in the tomato treated with 0.1% GA_3 from 15DAT to 21DAT whereas the maximum decay was observed in untreated fruit from 15 DAT to 21DAT.

The decaying loss of control sample was higher than that of fruit treated with GA_3 and $CaCl_2$. Calcium chloride treatment resulted in a reduction of decaying loss. Conway et al., (1987) reported the change in firmness as an indication of a degradation of apple cell walls and consequent reduction in fruit quality. Conway et al., (1987) further stated that the loss of firmness due to cell wall carbohydrate metabolism during storage was associated with increased susceptibility to infection by fungal pathogens. The chemicals used here might have reduced the pathogen susceptibility and prevented from the decay loss.

Table 2. Effect of postharvest treatments on decay loss of tomato fruit

Treatments	Decay loss (%)		
	15 DAT	18 DAT	21 DAT
GA_3-0.1%	0.408[c] (6.67)	0.408[f] (6.67)	0.408[d] (6.67)
GA_3-0.3%	0.629[ab] (20)	0.648[bc] (26.67)	0.648[c](26.67)
GA_3-0.5%	0.648[a] (26.67)	0.648[bcd] (26.67)	0.785[b] (40)
$CaCl_2$-0.5%	0.631[ab] (26.67)	0.717[ab] (33.33)	0.785[b](40)
$CaCl_2$-1%	0.494[bc] (13.33)	0.543[ce] (20)	0.648[c] (26.67)
$CaCl_2$-1.5%	0.494[bc] (13.33)	0.494[ef] (13.33)	0.648[c] (26.67)
Control	0.717[c] (33.33)	0.785[a] (40)	0.923[a] (53.33)
SEm(±)	0.045	0.0341	0.0385
LSD(0.05)	0.1366	0.1033	0.1169
CV%	13.6	9.7	9.6
Grand Mean	0.574	0.606	0.692

Note: Figures in parenthesis represent original values which were subjected to Arc Sine transformation.
DAT= Days after treatment

Total soluble solids (TSS)

The TSS content of tomato fruit was significantly influenced by different treatments (Table 3). TSS content was influenced by the stage of maturity of the fruit. TSS kept on decreasing with the prolongation of storage life. The highest TSS content observed in control tomatoes was 5.57 ^oB and lowest TSS content 5 ^oB was observed in 1% $CaCal_2$ and 0.1% GA_3 at 21 DAT. Variation in TSS was observed in all treatments on 0DAT. Even though they looked to be in uniform ripening while selecting for destructive samples, it could be possible that there was a slight difference in ripening of fruit.

In the current study, TSS content showed an increment up to 3 DAT followed by decrement of value along with the prolongation of storage period. Similar observation was observed by (Bhatane & Pawar, 2013) in Jamun where TSS content increased linearly up to third day and started to decline during storage. Increase in TSS during storage might be associated with the transformation of pectic substances, starch, hemi cellulose or other polysaccharides in soluble sugar and also with the dehydration of fruit (Singh et al., 2003, 2005 and Singh et al., 2004). The decrement of TSS with the advancement of storage might be due to depleted stored metabolites such as sugar utilized during the respiration process. It is well known that simple sugars and acids are the respiration substrates. The rates of sugars and acid consumption are higher with increment in time for respiration of fruit (Atta-Aly & Bercht, 1994). This may explain the decrease in total soluble solid content in fruit due to prolong time of storage.

Table 3. Effect of postharvest treatments on total soluble solids (TSS) content of tomato

Treatments	Total soluble solids ^{o} Brix							
	0DAT	3DAT	6DAT	9DAT	12DAT	15DAT	18DAT	21DAT
GA_3-0.1%	5.467	6	5.667	5.4	5.33	5.13	5.133	5
GA_3-0.3%	5.567	6.27	5.8	5.8	5.7	5.2	5.133	5.1
GA_3-0.5%	5.833	5.73	5.733	5.81	5.5	5.27	5.133	5.07
$CaCl_2$-0.5%	6.067	6.30	6.333	6	5.6	5.2	5.267	5.27
$CaCl_2$-1%	6.067	6.27	5.867	5.6	5.633	5.37	5.267	5
$CaCl_2$-1.5%	5.833	6.2	6.133	5.8	5.8	5.6	5.267	5.
Control	6.167	6.33	6.4	6.07	6.033	5.93	5.767	5.57
SEm(±)	0.2354	0.29	0.2466	0.321	0.2189	0.2482	0.1695	0.288
LSD(0.05)	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
CV%	7	8.4	7.1	9.6	6.7	8	5.6	9.7
Grand Mean	5.857	6.16	5.99	5.78	5.657	5.386	5.281	5.14

Titratable Acidity (TA)

Data presented in Table 4, revealed that the result pertaining to the effect of different levels of GA_3 and $CaCl_2$ treatments to the titratable acidity (TA) was significant at 18 DAT. The TA significantly decreased with the advancement of storage periods. Variation in TA was found in 0 DAT in our data which might be due to slight difference in ripening stage although they appear to be of same stage during visual observation. During the initial day of storage, maximum TA was recorded in 1% $CaCl_2$ which was statistically at par with 0.1% GA_3 whereas minimum TA was recorded in control which was statistically at par with GA_3 0.5%, $CaCl_2$ 1.5%, $CaCl_2$ 0.5% and GA_3 0.3%. Similarly, during 18 DAT maximum TA was recorded in 0.5% GA_3 and minimum TA was recorded in untreated tomato.

Changes in TA take place due to changes in citric, malic and ascorbic acids. Concentrations of these acids are known to diminish during ripening (Medicott et al., 1986).The decreasing trend of acidity during storage period was probably due to utilization of acid in tricarboxylic acid cycle in respiration process. The change in total titratable acids during storage was mainly due to the metabolic activities of living tissues during which depletion of organic acids take place (Ramana et al., 1979).

Table 4. Effect of postharvest treatments on titratable acidity (TA) of tomato

Treatments	Titratable Acidity (%)							
	0DAT	3DAT	6DAT	9DAT	12DAT	15DAT	18DAT	21DAT
GA_3-0.1%	0.2847^{a}	0.1811	0.1762^{a}	0.1573	0.1422	0.1394^{a}	0.1359^{a}	0.1274
GA_3-0.3%	0.2102^{b}	0.1822	0.1745^{a}	0.1541	0.1436	0.1341^{a}	0.1344^{a}	0.1245
GA_3-0.5%	0.1729^{b}	0.1796	0.1779^{a}	0.1632	0.156	0.1405^{a}	0.1371^{a}	0.1235
$CaCl_2$-0.5%	0.1895^{b}	0.1886	0.1747^{a}	0.1657	0.1524	0.1437^{a}	0.1308^{a}	0.1153
$CaCl_2$-1%	0.2849^{a}	0.1953	0.1745^{a}	0.1621	0.1519	0.1407^{a}	0.1239^{ab}	0.1205
$CaCl_2$-1.5%	0.1879^{b}	0.1806	0.178^{a}	0.1589	0.137	0.137^{a}	0.123^{ab}	0.1235
Control	0.1605^{b}	0.1496	0.1339^{b}	0.1475	0.1208	0.1078^{b}	0.1021^{b}	0.1032
SEm(±)	0.022	0.01245	0.00958	0.0057	0.0136	0.00649	0.00741	0.006
LSD(0.05)	0.0667	Ns	0.029	Ns	Ns	0.01968	0.02248	Ns
CV%	17.9	12	9.8	6.2	16.4	8.3	10.1	8.7
Grand Mean	0.213	0.1796	0.17	0.1584	0.1434	0.1347	0.1267	0.1197

Note: DAT= Days after treatment

Vitamin C content (Ascorbic Acid)

As shown in data presented in Table 5, vitamin C decreased with the advancement of storage period in all the treatments from 3 DAT onwards. Slight variation in ascorbic acid content in 0 DAT might be due to slight difference in chemical change in ripening stage of destructive tomato though they appear to be of same ripening stage.

The maximum vitamin C was recorded in the fruit treated with 0.5% $CaCl_2$ (20.97 mg/100ml) at 3 DAT. Likewise, vitamin C was maximum in the fruit treated with 0.1% GA (14.25 mg/100ml) at 21 DAT. Minimum vitamin C was observed in control consistently from 0 DAT to 21 DAT after treatments as compared to other treatments. In comparison to untreated fruit, all the treatments tested under current study have shown higher impact on the ascorbic acid content. The results obtained from the present study indicated that the GA_3 and $CaCl_2$ treatments were beneficial in retarding degradation of ascorbic acid content of tomato fruit during their storage.

An increase in ascorbic acid content in fruit is thought to be an indication that the fruit is still in the ripening stage, while a decrease indicates a senescent fruit (Esteves et al., 1984). According to (Mapson, 1970), retention of ascorbic acid might be due to the lowering of respiration of fruit or oxidation of ascorbic acid content of the treated fruit with Calcium chloride which had reduced the loss of ascorbic acid content.

The decreasing trend in vitamin C was probably due to degradation of ascorbic acid during the storage. It was suggested that loss of vitamin C is caused by leaching in surrounding water and thermal breakdown (Lee & Kader, 2000). In the present study, treatments with GA_3 and $CaCl_2$ might have delayed senescence which resulted in maintenance of fruit health in storage.

Table 5. Effect of postharvest treatments on ascorbic acid of tomato

Treatments	Ascorbic Acid(mg/100ml)							
	0DAT	3DAT	6DAT	9DAT	12DAT	15DAT	18DAT	21DAT
GA_3-0.1%	12.32^{bc}	19.98^{a}	16.48	14.55	12.07	14.33	13.6	14.25^{a}
GA_3-0.3%	14.77^{abc}	16.77^{a}	14.88	13.51	11.02	15.41	17.92	11.52^{abc}
GA_3-0.5%	18.58^{a}	17.17^{a}	15.32	13.93	12.29	14.83	16.39	10.32^{abc}
$CaCl_2$-0.5%	16.73^{abc}	20.97^{a}	17.88	11.93	12.41	15.47	15.55	9.01^{bc}
$CaCl_2$-1%	17.42^{ab}	19.87^{a}	16.38	14.14	16.06	14.68	13.74	12.82^{ab}
$CaCl_2$-1.5%	17.16^{abc}	16.54^{a}	14.49	13.07	11.72	15	15.98	11.33^{abc}
Control	12.03^{c}	13.41^{b}	13.82	8.97	9.96	11.52	12.03	6.71^{c}
SEm(±)	1.566	1.453	1.812	1.777	1.163	1.886	1.299	1.51
LSD(0.05)	4.751	4.408	Ns	Ns	Ns	Ns	Ns	4.581
CV%	17.4	14.1	20.1	23.9	16.5	22.6	15	23.1
Grand Mean	15.57	17.81	15.61	12.87	12.22	14.46	15.03	10.85

Note: DAT= Days after treatment

pH

Observation recorded for the effect of GA_3 and $CaCl_2$ on pH of tomato fruit during the storage periods is presented in Table 6. It was found that the pH value increased during the entire storage period except during 18 DAT. The difference among treatments during 0 DAT might be due to difference in chemical changes in ripening stage; however they appear to be of same ripening stage. pH value of treated tomato fruit didn't differ significantly within the treatments i.e. GA_3 and $CaCl_2$ except during 6 DAT and 21 DAT. Data shows that at 6 DAT highest pH value (4.163) was observed in control which was statistically par at 0.5% GA_3. Similarly, At 21 DAT higher pH value (4.59) was observed in control and lowest pH value (4.14) was observed in 0.3% GA_3.

The lower pH of chemically treated fruit than that of control set might be due to the difference in the modified atmosphere created by different types of treatments (Pila et al., 2010). The fluctuation of pH might be due to variations in titratable acidity or temperature of storage. The decline of acidity occurred due to increased activity of citric acid glyoxylase during ripening. Reduction in acid content may be due to their conversion into sugars and further utilization in metabolic process during storage (Rathore et al., 2007). These reports well justifies our finding here.

Table 6. Effect of postharvest treatments on pH of tomato

Treatments	pH							
	0DAT	3DAT	6DAT	9DAT	12DAT	15DAT	18DAT	21DAT
GA_3-0.1%	2.67	3.330	3.733^{b}	4.273	4.457	4.370	4.19	4.297^{bc}
GA_3-0.3%	2.83	3.617	3.937^{ab}	4.270	4.467	4.250	4.227	4.14^{c}
GA_3-0.5%	3.67	3.383	4.15^{a}	4.363	4.620	4.523	4.247	4.297^{bc}
$CaCl_2$-0.5%	3.3	3.580	3.747^{b}	4.113	4.480	4.520	4.377	4.420^{ab}
$CaCl_2$-1%	3.15	3.593	3.637^{b}	4.343	4.243	4.387	4.223	4.25^{bc}
$CaCl_2$-1.5%	3	3.497	3.673^{b}	4.307	4.263	4.390	4.153	4.197^{bc}
Control	3.56	3.753	4.163^{a}	4.497	4.650	4.7	4.413	4.59^{a}
SEm(±)	0.248	0.1103	0.0922	0.1111	0.1190	0.0952	0.0854	0.0672
LSD(0.05)	Ns	Ns	0.2796	Ns	Ns	Ns	Ns	0.2037
CV%	13.5	5.4	4.1	4.5	4.6	3.7	3.5	2.7
Grand Mean	3.17	3.536	3.863	4.31	4.454	4.449	4.261	4.313

Note: DAT= Days after treatment

Shelf-life

The maximum shelf life of tomato fruit as shown in Fig. 1 was noticed in fruit treated with 0.1% GA_3 (18.67 days) followed by 1.5% $CaCl_2$ (16 days) whereas the minimum shelf life was observed with control (9.33

days).

In justification to our result, Cheour et al. (1991) reported that the application of calcium prolonged the storage life of strawberries due to decline in accumulation of sugars, decrease in organic acids, increase of color saturation index and mold development. It was also advocated that post- harvest dipping of fruit in GA_3 delayed the conversion of starch to sugars, reduced peroxidase activity and ethylene production (Chundawat & Rao, 1988).

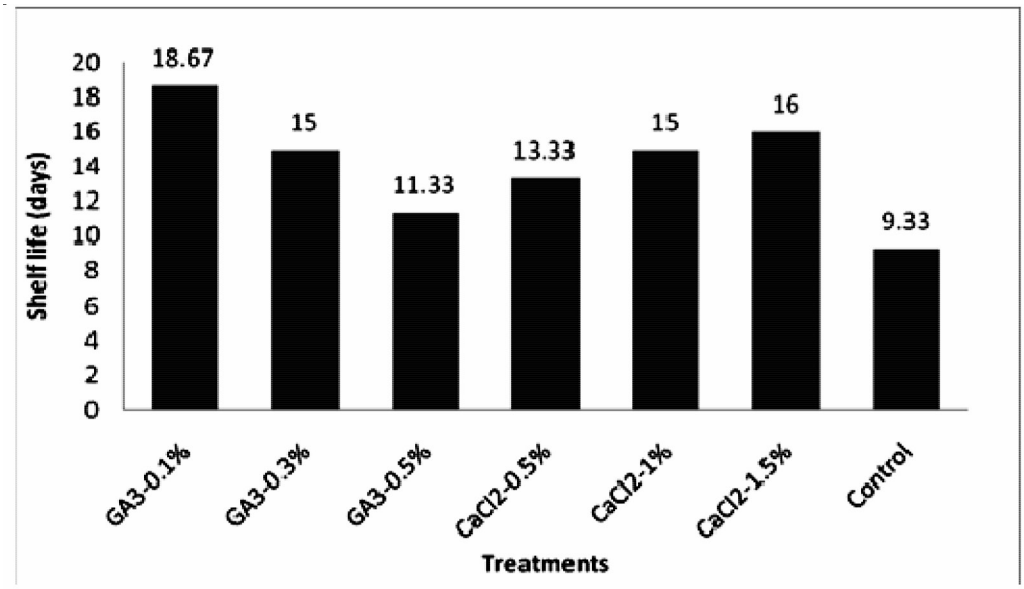

Figure 1. Effect of postharvest treatment on shelf life of tomato

CONCLUSION

The results clearly indicated that GA_3 and $CaCl_2$ play a very effective role in controlling the weight loss, decay, and other compositional changes such as pH, TA, TSS and vitamin C of tomato fruit. These chemicals can delay the ripening process with minimum quality loss, while there were greater compositional changes with maximum quality loss in case of control during storage at ambient temperature. The shelf life of tomato could be extended up to 18 days and 16 days without excessive deterioration in quality by treating the fruit with 0.1% GA_3 and, or 1.5% $CaCl_2$. Among all the tested treatments, GA_3 @ 0.1% extended the better storage life and maintained quality parameters. Moreover, it was clearly revealed that GA_3 and $CaCl_2$ has the potential to control decay, prolong the storage life, and preserve valuable attributes of tomato fruit while retaining its nutritional quality.

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