Effect of Harvesting Method and Calcium on Post Harvest Physiology of Tomato[1]

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ABSTRACT

An experiment was conducted in Institute of Agriculture and Animal Science, Rampur, Chitwan during 2003 to find out the effect of harvesting method and calcium chloride treatment on post-harvest physiology of tomato. Tomato (Hybrid Gootya) fruits 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% for fifteen minutes. Fruit were then air-dried and stored at ambient condition (24 ± 3^0 C and 70 ± 5 % RH). Among the tested treatments the least cumulative physiological weight loss (12.14%) was exhibited by 1% calcium chloride. The shelf life of tomato fruits was significantly affected by harvesting method and calcium treatment. Tomato fruit harvested with stalk had higher shelf-life (15 days) as compared to those harvested without stalk (12.93 days) irrespective to calcium chloride application. The maximum shelf life was noticed in 1% calcium chloride treated fruits (16.50 days) followed by 0.75% calcium chloride treated fruits (16.17 days).

Key words: Calcium chloride, physiological weight loss, shell life, tomato

INTRODUCTION

Tomato is highly perishable and cannot be stored for longer duration. Due to perishability, farmers are losing a bulk of produce each year. Bistha (2002) have reported upto 50% post-harvest loss of tomato in Nepal. Calcium is relatively divalent cation that readily enters the apoplast and is bound in exchangeable from to cell wall and exterior surface of plasma membrane. Nontoxic even at high concentrations it serves as a detoxifying agent. In the cell walls calcium serves as a binding agent in the form of calcium pectates. Calcium has received considerable attention in recent years due to its desirable effects; particularly it can delay ripening and senescence, reduce respiration, extend shelf life and reduce the physiological disorders (Sharma et al 1996).

The shelf life is also affected by stalk. Pathak and Shrivastava (1969) have reported the stalk of fruits showed less infection than without stalk fruit upon ripening. Similarly Singh et al (1993) have reported longer shelf life and better marketability of tomatoes having a small pedicel along with calyx. Therefore, this investigation was undertaken to identify the appropriate dose of calcium chloride and compare the storage behavior of tomato harvested with and without stalk.

MATERIALS AND METHODS

This experiment was conducted during 2003 in Institute of Agriculture and Animal Science, Rampur, Chitwan under Completely Randomized Design (CRD) with three replications. Tomato (Hybrid Gootya) fruits with stalk and without stalk at breaker stage were harvested from farmer field at

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Bhandara, Chitwan and brought to IAAS, Rampur. Fruits were dipped in distilled water and different concentrations of calcium chloride viz. 0.25%, 0.50%, 0.75% and 1% for fifteen minutes. The fruits were then air-dried and 1.5 kg of fruits was kept on open tray. Each tray was considered as one treatment and ten fruits were numbered (1 to 10) individually for determining physiological weight loss.

Physiological weight loss (%) was determined by following formula:

Weight loss (%) = [(Initial weight – Final weight) / Initial weight] × 100

Titrable acidity was determined by titration method at red ripe stage. It was calculated by following formula:

Titrable Acidity (%) = (N_B x V_B × milliequivalent wt. of citric acid × 100 × d. f.) / Volume of sample

Where,
N_B = Normality of base, V_B = Volume of the base, d. f. = Dilution factor.

The total soluble solid (^{0} Brix) was determined by hand refractometer (Model: Erma Japan) in red ripe stage of fruits and pH was measured by automatic pH meter.

RESULTS AND DISCUSSION

Physiological weight loss

Cumulative physiological weight loss of the fruits with respect to harvesting methods and calcium chloride treatments is presented in Table 1. Harvesting method did not influence the weight loss of tomato. Physiological weight loss after 10 days of storage ranged from 15.07 to 15.27%. On the other hand, calcium chloride treatment significantly influenced the physiological weight loss of the fruits right after second days of storage and subsequently afterwards. After 2 days of storage, controlled fruits exhibited 4.2% PWL which was significantly higher than calcium treated fruits.

Table 1. Cumulative physiological weight loss (%) of tomato fruits at various days after storage (DAS) as affected by harvesting methods and calcium chloride treatment at ambient condition (24 ± 3^0 C and 70 ± 5% RH)

Harvest method	2 DAS	4 DAS	6 DAS	8 DAS	10 DAS
Without stalk	3.01	6.10	8.36	11.00	15.27
With stalk	2.97	6.04	8.38	10.45	15.07
SEM	0.15	0.29	0.31	0.47	0.41
$CaCl_2$					
Water	4.02	8.71	11.68	14.27	19.03
0.25%	3.21	6.13	8.56	12.06	17.02
0.50%	2.89	5.33	7.85	10.72	14.86
0.75%	2.25	4.81	6.93	8.25	12.80
1.00%	2.57	5.36	6.85	8.31	12.14
LSD (5%)	0.68	1.33	1.44	2.18	1.93
SEM	0.23	0.45	0.49	0.74	0.66

After 10 days of storage, the cumulative weight loss in 1.00, 0.75, 0.50 and 0.25% calcium treated fruits was 12.14, 12.80, 144.86 and 17.02%, respectively as compared to 19.03% in controlled fruits. Interaction effect between method of harvesting and calcium chloride treatment was non-significant.

Calcium is the important mineral constituent and it is the constituent of middle lamellae. Softening of fruits is mainly due to weakening of middle lamellae during ripening. Calcium helps to bind

polygalactonic acid each other and make the membrane strong and rigid. Calcium treatments have been commercially applied in apple to increase the shelf life and reduce the post harvest disorders (Sharma et al 1996). Thus, calcium might have delayed senescence and rate of respiration and transpiration in tomato fruits.

Although statistically non-significant fruits harvested with stalk resulted into lower PWL as compared to those without stalk. A similar result was noted by Singh et al (1993). The reason behind the higher loss associated with the fruits harvested without stalk and stored under ambient condition might be due to more decay loss as exposed surface of stalk or scar left at the time of harvesting creates avenue for the entry of pathogen. Pathak and Shrivastava (1969) have supplied similar explanation. They have also noticed higher decay loss and poor shelf life in mango fruits harvested without stalk.

pH of fruit juice

pH of the fruit juice with respect to harvesting method and calcium treatment is presented in Table 2. pH of fruit juice harvested without retaining the stalk showed slightly higher pH (4.053) compared to those harvested with stalk (4.018). There was no apparent effect of calcium treatment albeit it was recorded maximum (4.067) in control fruit and that of minimum (4.017) to 0.75% calcium treated fruit. Njoroge and Kerbel (1993) have also reported the significant effect of calcium on pH of fruit juice and it was higher (4.49) in control than that of 0.75% calcium treated fruits (4.47). Since calcium chloride is acidic in nature it might have lowered the pH of the treated fruits.

Table 2. Biochemical parameters and shelf life of tomato as affected by harvesting methods and calcium chloride

Treatment	pH	TSS (^{0}brix)	Titrable acidity, %	Shelf life
Harvesting method				
Without stalk	4.05	3.22	0.485	12.93
With stalk	4.03	3.15	0.494	15.00
SEM	0.009	0.064	0.018	0.23
Calcium Chloride				
Water	4.067	3.21	0.479	11.00
0.25%	4.044	3.33	0.514	12.83
0.50%	4.028	3.12	0.526	13.33
0.75%	4.017	3.13	0.433	16.17
1.00%	4.022	3.13	0.496	16.50
SEM	0.018	0.101	0.029	0.39

Total soluble solids

Harvesting method did not affect the Total Soluble Solids (TSS) content of fruit juice although it was slightly higher in the fruits harvested without retaining the stalk (3.218%) as compared to that having it (3.149%). Similarly, it was also not affected by the calcium treatment (Table 2). As the storage period prolonged the TSS of the fruit increased. During the storage weight loss is mainly due to the water loss and that lead to higher concentration of sugars in fruits. The experiment conducted by Subedi and Bhattarai (1995) had also the similar type of results. Agar and Kaska (1995) also reported similar results. Singh et al (1993) conducted an experiment to study the qualitative changes in storage in mango due to harvesting methods and found that there was no significant difference in TSS in fruit harvested with or without stalks after 6 days of storage.

Titrable acidity

There was also non-significant effect of harvesting method and calcium treatment on Titrable acidity (TA) content of fruit juice. TA of the fruit juice with respect to harvesting method and calcium treatment is presented in Table 2. TA of fruit juice harvested with stalk showed slightly higher (0.494%) compared to those harvested without stalk (0.485%).

During the storage the fruit itself might utilize the acids so that the acid in the fruits during storage periods decrease. The change in total titrable acids during storage was mainly due to the metabolic activities of living tissues during which depletion of organic acids takes place. Decrease in total acidity and increase in total sugars and TSS during storage at room temperature was also observed by Ramana et al (1979).

Shelf life

The shelf life of tomato fruits was significantly affected by the harvesting method and calcium treatment. Irrespective of calcium chloride treatment, tomato fruits harvested with stalk had maximum shelf life (15 days) as compared to those harvested without stalk (12.93 days) (Table 2). The longer shelf life and better marketability were also observed in tomato fruits harvested with a small stalk by Singh et al (1993).

Figure 1. Interaction effect of calcium chloride and harvesting methods on shelf life of tomato.

The calcium treatments significantly influenced the shelf life of tomato fruits. As the concentration of calcium increased, the shelf life of fruits increased. The maximum shelf life (16.50 days) was noticed in 1% calcium chloride treated fruits compared to the control (11 days). These results were in conformity with that of Wills and Tirmazi (1982). Calcium treatment could extend storage life and reduce incidence of physiological disorders and storage rots (Sharma et al 1996).

The interaction between calcium treatment and harvesting methods were non-significant. However, there was a trend of increasing shelf life owing to each increment in the level of calcium in each of harvesting methods (Figure 1). Fruits, which were harvested with stalk and treated with 1% calcium chloride, have highest shelf life of about 17.5 days, where as the shelf life was only 9.5 days for control fruits harvested without stalk.

Tomato is rapidly gaining its importance as essential nutritional vegetable commodity and income generating crop in Nepal. Treating the tomato fruits with calcium chloride at the rate of 1% could extend the shelf life and minimize the physiological weight loss. Tomato fruits harvested with stalk could prolong the shelf life as compared to those harvested without stalk.

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REFERENCES

Agar T and N Kaska. 1995. Effect of different harvest dates and post harvest treatments on the storage quality of Mandarins. **In:** *Proceedings of the International Symposium on Post Harvest Physiology, Pathology and Technologies for Horticultural Commodities: Recent Advances*. 16-21 Jan 1994. Agadir, Morocco. Pp. 75-82.

Bistha DB. 2002. Agriculture marketing and environment issues. **In:** *Agriculture and environment*. Ministry of Agriculture and Co-operatives, HMG/N, Kathmandu, Pp. 91-98.

Njoroge CK and EL Kerbel. 1993. Effect of post harvest calcium treatment on soluble solids, pH, firmness and color of stored tomato fruits. *E. Afr. Agric. Far J.* 58(3):111-116.

Pathak VN and DN Shrivastava. 1969. Epidemiology and prevention of Diplodia stem end rot of mango fruits. *Phytopathology* 65:164-175.

Ramana KVR, GR Setty, NVN Murthy, S Saroja and AM Nanjundaswamy. 1979. Effect of ethephone, benomyl, thiobendazole and wax on color and shelf life of coorg mandarin (*Citrus reticulata* Blanco). *Trop. Sci*. 21:265-272.

Sharma RM, R Yamdagni, H Gaur and RK Shukla. 1996. Role of calcium in horticulture - A review. *Haryana J. Hort. Sci.* 25(4):205.

Singh BP, SK Palra and DK Tonden. 1993. Effect of method of harvesting on storage behaviour of mango. *Indian J. Hort.* 50(1):5-9.

Subedi PP and SP Bhattarai. 1995. The effects of low cost cellar structure upon the storage of mandarin fruits in the sub tropics. **In:** *Proceedings of the International Symposium on Post Harvest Physiology, Pathology and Technologies for Horticultural Commodities: Recent Advances*. 16-21 Jan 1994. Agadir, Morocco. Pp. 137-146.

Wills RBH and SIH Tirmazi. 1982. Use of calcium to delay ripening of tomatoes. *Hort. Science* 12(6):551-552.