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EFFECT OF HARVESTING METHODS AND POST HARVEST TREATMENTS ON QUALITY OF TOMATO (*Lycopersicon esculentum*)

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Abstract
Tomato is highly perishable and cannot be stored for longer duration. Due to perishability, farmers are losing a bulk of produce every year as during storage its quality, especially in terms of water loss and physical disorders deteriorates. An experiment was conducted to study the effect of harvesting methods and chlorine treatment on post harvest physiology of tomato. Tomato fruits with stalk and without stalk were harvested at breaker stage and subjected for shelf life studies. The fruits with best harvesting method (fruits with stalk) were treated with chlorine by first dipping the fruits in distilled water and then chlorine solution (200ppm sodium hypochlorite) for 15 minutes. The fruits were then air dried and packed in gunny bags and perforated LDPE bags. The packed fruits were stored under ambient and refrigerated conditions. Results showed that tomatoes treated with chlorine and packed in perforated LDPE bags resulted in substantial reduction in losses caused by decay and weight loss under refrigerated conditions. This treatment combination also delayed compositional changes in TSS, titratable acidity and ascorbic acid. The shelf life of tomato under this condition extended upto 22 days as compared to non- treated ones. Hence, it could be concluded that post harvest treatment with chlorine has the potential to control decaying incidence, prolong shelf life and preserve valuable attributes of post harvest tomato fruits.

Keywords: Tomato, chlorine, harvesting method, shelf life, quality

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1. INTRODUCTION

Tomato is the highly used vegetable throughout the world. It is highly perishable and cannot be stored for longer duration. During storage its quality, especially in terms of water loss and physical disorders deteriorates. Owing to lack of information on appropriate post harvest treatments, packaging, temperature etc, the fruits not only lose their quality but also encounter a substantial post harvest loss to the farmers. The research efforts have helped to increase the production of tomato but the purpose of obtaining maximum profit will be served only if the increased production is supplemented with the similar efforts to minimize the post harvest losses and enhance the shelf life. The shelf life is also affected by stalk. Pathak and Srivastava (1969) reported that the stalks of the fruits showed less infection than without stalk fruit upon ripening.
In many countries of the world, fruits and vegetables are washed in chlorine before packaging. It is done in order to reduce microflora, especially bacteria from the produce (Amiruzzaman, 2000).
Modified atmosphere packaging is used in the storage of fresh fruits and vegetables. This results in the accumulation of carbon dioxide and depletion of oxygen around the crop, which may increase their shelf life. Therefore, this investigation was under taken to compare the storage behaviour of tomato harvested with and without stalks and to study the effect of chlorine, packaging and storage conditions on quality and shelf life of tomato.

2. MATERIAL AND METHODS

Tomato fruits (Himsona) with stalk and without stalk at breaker stage were got harvested from farmer's field and were subjected for shelf life studies, physiological loss in weight (%), TSS, acidity (%) and the best harvesting method was used for the second part of the study. For second part of experiment

the tomato fruits were dipped in 200 ppm chlorine solution for 5 minutes and spread on tray. It has two levels (chlorine treated and non-treated). The treated fruits were then packed in perforated LDPE bags, gunny bags, and control without packaging. These fruits were stored at ambient conditions and refrigerator. The experiment was laid out three replications. The treatment details are given below:

T_1 Non treated+ Ambient + without packaging.
T_2 Non treated+ Ambient + Gunny bags
T_3 Non treated+ Ambient + LDPE bags
T_4 Non treated+ Refrigerator + without packaging
T_5 Non treated+ Refrigerator + Gunny bags
T_6 Non treated+ Refrigerator + LDPE bags
T_7 Chlorine treated+ Ambient+ without packaging
T_8 Chlorine treated+ Ambient + Gunny bags
T_9 Chlorine treated+ Ambient + LDPE bags
T_{10} Chlorine treated+ Refrigerator+ without packaging
T_{11} Chlorine treated+ Refrigerator+ Gunny bags
T_{12} Chlorine treated+ Refrigerator+ LDPE bags

Data on physiological weight loss (%), decay (%), shelf life (days), acidity (%), total soluble solids (TSS) and vitamin- C(mg/100g) were recorded at three days storage interval.

Physiological weight loss (%): It was determined by periodical weighing of fruits and expressed as percentage of original weight.

Decay (%): The fruits were observed visually for rotting and microbial infection.

Shelf life (days): The shelf life was calculated by counting the days required to attain the last stage of ripening, but up to the stage when fruit remained still acceptable for marketing (Moneruzzaman et al, 2009).

Chemical analysis: TSS was determined by using refractometer, acidity by treating against sodium hydroxide solution, ascorbic acid by 2, 6- Dichlorophenol- Indophenol visual titration method. All these chemical analysis were conducted according to (Rangana, 1986).

3. RESULTS AND DISCUSSION

A) Physiological weight loss of the fruits with respect to harvesting methods is presented in Table 1. with the increase in the storage period the PLW (%) increased and was found to be more in fruits stored without stalk (15.16%) after 15 days of storage. The season behind the higher loss associated with the fruits harvested without stalk 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 pathogens. Pathak and Srivastava (1969) noticed higher decay loss & pore shelf life in mango fruits harvested without stalk.

Total Soluble Solids (TSS) content of fruits was slightly higher in the fruits harvested with stalk (4.15^{o}Brix) as compared to that in without stalk (3.97^{o}Brix). Titratable acidity (%) content and shelf life of fruits with respect to harvesting methods is presented in Table 2. The fruits with stalk have lower acidity and higher shelf life (17.00) as compared to fruits with stalk. The longer shelf life and better market ability were also observed in tomato fruits harvested with a small stalk by Singh et al. (1993).

Table 1: Effect of harvesting methods on Physiological weight loss (%) in tomato fruits at different storage intervals

Harvesting method	3 days	6 days	9 days	12 days	15 days
Without stalk	3.06	6.20	8.35	11.09	15.16
With stalk	2.89	5.97	8.04	10.34	14.63

Table 2: Chemical parameters and shelf life of tomato as affected by harvesting methods

Harvesting method	TSS (degree Brix)	Titratable acidity (%)	Shelf life (days)
Without stalk	3.97	0.46	12.00
With stalk	4.09	0.40	17.00

B) Table 3 shows the combined effect of chlorine, storage condition and packaging on post harvest life of tomato. As the storage period prolonged the physiological weight loss (%) also increased. At 15th day of storage LDPE bags and kept in refrigerator showed minimum weight loss (9.87) followed by (11.02%) Chlorine treated, packed in LDPE bags and stored at ambient conditions. The percentage of decay was recorded at different storage intervals Table 4. Initially for a period

of 6 days no rotting was observed in all the treatments. However, it increased with the increase in storage period later and was observed to the highest in non treated fruits packed in gunny bags (18.77%). Significant differences were observed between all the treatments and storage period with respect to decay percentage. Singh et al. (1992) also observed that decay percentage of tomatoes increased with the increase in storage period.

Increase as well decrease in TSS was recorded in all the treatments for different storage intervals (Table 5). Significant differences in TSS values were observed between all the interactions. Maximum TSS was observed in Chlorine treated fruits, packed in LDPE bags and stored at ambient conditions (4.99^{o}Brix). The rise in TSS may be due to degradation of polysaccharides to simple sugars, thereby causing increase in TSS. Naik *et al.*, (1993) also observed on increase in TSS upto 14 days storage and thereafter it decreased.

The titratable acidity content of the tomato fruit decreased with the advancement of storage period (Table-6). Fruits packed in perforated LDPE bags showed minimum acidity contents amongst all the treatments. Significant differences were observed in acidity between treatments as well as storage period. During storage itself might utilize the acids so the acids in the fruits decreased. 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. Decrease in total acidity and increase in TSS during storage was also observed by Ramana et al. (1979).

Initially tomato contained 12.5mg/100g vitamin C, but with the increase in storage period it reduced significantly. The maximum (10.04 mg/100g) ascorbic acid was observed in T_9 treatment (Chlorine treated + Ambient condition + LDPE bags) and minimum value (9.44mg/100g) were found in T_{11} treatment. Decrease in vitamin c content with storage was also reported by (Moneruzzaman et al., 2009).

Table 3: Effect of packaging and post harvest treatments on PLW (%) of tomato fruit during storage

Treatments	Storage period (days)					
	3	**6**	**9**	**12**	**15**	**Mean**
T_1	9.84	13.21	17.24	18.73	21.15	**16.03**
T_2	10.70	13.65	16.55	18.13	21.87	**16.18**
T_3	5.30	7.40	8.37	10.31	12.34	**8.74**
T_4	9.68	12.66	15.50	17.00	19.06	**14.78**
T_5	7.46	9.94	11.57	12.42	14.68	**11.21**
T_6	5.25	7.52	8.45	9.15	11.29	**8.33**
T_7	10.27	13.31	15.92	17.40	19.72	**15.32**
T_8	9.65	12.90	15.70	16.61	18.26	**14.62**
T_9	4.29	6.53	9.23	10.20	11.02	**8.25**
T_{10}	8.45	12.64	14.06	14.89	16.39	**13.29**
T_{11}	5.28	11.41	12.07	12.46	15.09	**11.26**
T_{12}	4.05	5.45	7.00	8.06	9.87	**6.89**
Mean	**7.52**	**10.55**	**12.64**	**13.78**	**15.89**	

Initial value -
CD 0.05
Treatment (T) 0.02
Storage period (S) 0.01
TxS 0.05

Table 4: Effect of packaging and post harvest treatments on Decay (%) of tomato fruit during storage

Treatment	Storage period (days)					
	3	**6**	**9**	**12**	**15**	**Mean**
T_1	-	-	26.31	31.34	36.18	**31.28**
T_2	-	-	21.42	28.32	30.27	**26.67**
T_3	-	-	8.16	14.81	21.16	**14.71**
T_4	-	-	9.54	20.27	25.87	**18.56**
T_5	-	-	11.12	16.63	26.43	**18.06**
T_6	-	-	25.18	25.43	29.93	**26.85**
T_7	-	-	15.18	19.73	23.34	**19.42**
T_8	-	-	18.46	24.54	32.71	**25.24**
T_9	-	-	6.84	16.69	19.07	**14.20**
T_{10}	-	-	21.38	25.84	27.08	**24.77**
T_{11}	-	-	16.24	28.31	34.80	**26.45**
T_{12}	-	-	-	13.36	15.76	**14.56**
Mean	-	-	**16.35**	**22.11**	**26.88**	

Initial value -
CD 0.05
Treatment (T) 0.02
Storage period (S) 0.01
TxS 0.04

Table 5: Effect of packaging and post harvest treatments on TSS (%) of tomato fruit during storage

Treatment	Storage period (days)				
	3	6	9	12	Mean
T_1	4.36	4.53	4.42	4.29	4.40
T_2	4.72	4.86	4.78	4.63	4.75
T_3	4.90	5.11	4.99	4.81	4.95
T_4	4.29	4.58	4.46	4.27	4.40
T_5	4.66	4.96	4.82	4.58	4.75
T_6	4.53	4.70	4.95	4.83	4.75
T_7	4.42	4.63	4.89	4.57	4.63
T_8	4.39	4.51	4.43	4.32	4.41
T_9	4.94	5.01	5.12	4.91	4.99
T_{10}	4.21	4.49	4.36	4.17	4.31
T_{11}	4.30	4.52	4.40	4.24	4.36
T_{12}	4.41	4.60	4.32	4.27	4.40
Mean	4.51	4.71	4.66	4.49	

storage	
*Initial value	4.10
CD 0.05	
Treatment (T)	0.07
Storage period (S)	0.04
TxS	0.14

Table 6: Effect of packaging and post harvest treatments on titratable acidity (%) of tomato fruit during storage

Treatments	Storage period (days)				
	3	6	9	12	Mean
T_1	0.59	0.65	0.34	0.28	0.46
T_2	0.56	0.61	0.36	0.31	0.46
T_3	0.52	0.58	0.39	0.27	0.44
T_4	0.51	0.56	0.33	0.27	0.42
T_5	0.61	0.71	0.51	0.42	0.56
T_6	0.49	0.52	0.29	0.25	0.39
T_7	0.58	0.67	0.38	0.35	0.49
T_8	0.53	0.59	0.35	0.32	0.45
T_9	0.54	0.57	0.41	0.34	0.46
T_{10}	0.57	0.69	0.47	0.38	0.53
T_{11}	0.50	0.57	0.37	0.33	0.44
T_{12}	0.48	0.55	0.31	0.23	0.39
Mean	0.54	0.61	0.38	0.23	

*Initial value	0.45
CD (0.05)	
Treatment (T)	0.03
Storage period (S)	0.01
TxS	0.05

The results also showed that the shelf life of the tomato fruits increased upto 22 days (Fig. 1) by treating the fruits with chlorine and packed in perforated LDPE bags.

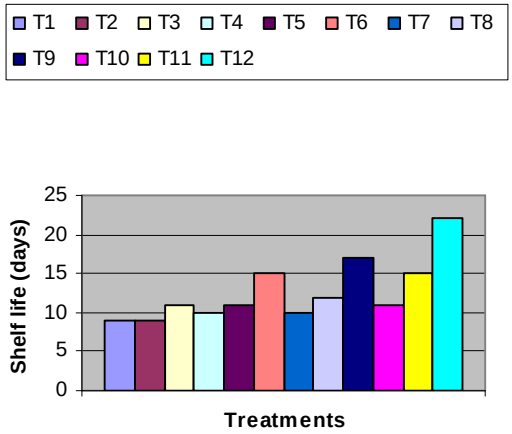

Fig 1 : Effect of packaging and post harvest treatments on shelf life of tomato fruits during storage

4. CONCLUSION

It can be concluded that shelf life of tomato could be extended upto 22 days without excessive deterioration in quality by treating the fruits with chlorine and packed in perforated LDPE bags and storing at refrigerated conditions as compared to the control for 9 days only.

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