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Effects of oxygen and ethylene scavengers on storage and sensory quality of tomato (*Lycopersicon esculentum* L.)

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Abstract
A study was carried out to evaluate the effect of oxygen and ethylene scavengers on quality of tomato during storage. Experiment was carried out with Low density polyethylene (LDPE, 55 micron) package having perforations 2 perforations (6.288×10^{-8}%), 4 perforations (1.257×10^{-7}%) and 6 perforations (1.886×10^{-7}%). Different scavengers were kept inside the package and stored at 10±1°C for a period up to 28 days. Samples were drawn at 0, 7, 14, 21 and 28 days and quality analysis were carried out. Normal sample in 4 perforation (1.257×10^{-7}%) resulted in maximum sensory value of 7.54 for taste, whereas packages having 4 perforation (1.257×10^{-7}%) with oxygen scavengers gave maximum value of colour, flavor, texture and overall acceptability with sensory score of 7.43, 7.23.7.51 and 7.86 respectively.

Keywords: Tomato, scavengers, quality, shelf life and perforations

1. Introduction

Tomato (*Lycopersicon esculentum* L.) is the third most important vegetable crop in India next to potato and onion, but it is the second most important vegetable crop in the world after potato (Luthria *et al.*, 2006) [4]. Tomato has high content of lycopene, carotenoids, phenols, vitamin C and E (Kucuk *et al.*, 2002) [6], which contribute to high antioxidant capacity. Most importantly, tomato consumption has been shown to decrease the risks of cardiovascular disease and certain kinds of cancer like cancers of prostate, lung and stomach (Canene-Adams *et al.*, 2005) [2].

Tomato fruit is a perishable and cannot be kept safely in normal condition for a long period. Tomato has a limited shelf life and presently about 30-40% of the tomato is estimated to be lost during post-harvest operations including handling and storage due to decay, over ripening, mechanical injury, weight losses etc. (Osei *et al.*, 2010) [5]. It is one of the most popular salad vegetables in raw taste and is made into soups, pickles, conserves, ketchups and other products. It is served as a sauce with raw, stewed, baked, fried and various other foods. It is considered a very important "protective food" due to its unique nutritional value and extensive production (Choudhary, 2003) [3].

2. Materials and Methods

Freshly harvested tomatoes were procured from wholesale market and brought to the laboratory. Bruised, diseased and cracked tomatoes were discarded from the whole materials. Tomatoes were washed using potable water and by using forced air, the surface moisture was removed. The tomatoes were then graded based on the size. The samples were kept in a walk-in type cold room (Ozone Biotech, New Delhi) at a temperature of 10°C. The cold room was having racks for storing packages in single layer. It was maintained temperature with a variation of ±1 °C.

Types of scavengers: Normal (N), Oxygen (O), Ethylene (E), Both (O+E)
No. & area of perforations in packages: 2 (6.288×10^{-8}%), 4 (1.257×10^{-7}%) & 6 (1.886×10^{-7}%)
Storage time: 0,7,14, 21 & 28 days.

Methods

Headspace analysis

Prior to opening the packages for physiochemical analysis, the headspace oxygen (O_2), carbon dioxide (CO_2) and nitrogen (N_2) concentrations within package headspace were measured by Checkmate II headspace analyzer (PBI Dansensor, Ringsted, Denmark) (Figure 1) as per Ayhan *et al*., (2008) [1]. The headspace gas samples were taken through a hypodermic needle inserted through an adhesive septum fixed on the pouch. Three measurements were taken from three replications and mean was taken as final value.

Fig 1: Head space analyzer

Fig 2: Tools used for making perforations in packaging material

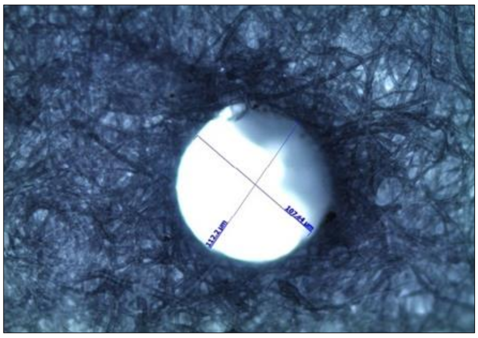

Fig 3: Perforations made in Paper sheet using Tool

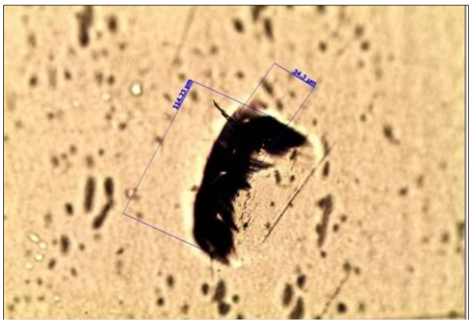

Fig 4: Perforation made in LDPE sheet using Tool

Making of perforations

Uniformity in perforated size is important for the study. Therefore, small tools were made with the help of surgical needles with a diameter of 0.45 mm (Figure 2). Figure 3 and 4 shows the types of perforations obtained in the paper sheet as well as LDPE sheet.

Sensory characteristics

Sensory analysis of the tomatoes was performed on a 9-point hedonic scale with the 9-member consumer test panel. Sensory characteristics include the overall acceptability of the minimum processed tomato stored in packages containing flavor, color or appearance, flavor, texture and with different numbers of perforations. The committee expressed their score as per the hedonic scale given below.

9-point hedonic scale classified as below:

9 = Like extremely
8 = Like very much
7 = Like moderately
6 = Like slightly
5 = Neither like nor dislike
4 = Dislike slightly
3 = Dislike moderately
2 = Dislike very much
1 = Dislike extremely

Statistical analysis

The experiments were installed with SAS 9.3 software using a factorial completely randomized design (CRD) with three replicas. The data obtained were submitted to analysis of varince.

3. Results and Discussion

A systematic study was conducted to know the effect of oxygen and ethylene scavengers on the shelf life and quality of tomato. This chapter deals with the results of the experiments carried out related to the study. The studies were continued up to 28 days when it was found that most of the samples were discarded in terms of sensory analysis.

3.1 Headspace gas composition

3.1.1 Oxygen

The variations in oxygen concentration within the packages having 250±10 g of tomato at stored at 10±1°C with respect to change in number (area) of perforations are given in Fig. 5.1- 5.3. There was rapid decrease of oxygen level up to 14th day of storage (14.35% & 25.35% reduction from initial value for 7th and 14th day of storage respectively) and the rate of decrease of oxygen concentration was slower at 21st and 28th (31.10 & 37.48% respectively) for package having 2 perforation. However, packages having scavengers shown rapid decrease of oxygen concentration up to 7th day of storage (maximum value of 27.75% for package having both scavengers) and rate of decrease in oxygen concentration inside the packages was slower thereafter. Packages having both scavengers showed lowest amount of oxygen followed by oxygen scavenger, ethylene scavenger and package having no scavenger (normal) respectively. It was observed that both number (area) of perforations as well as scavengers decided the gas composition inside the packages.

Lower the area of perforations more was the depletion of oxygen, which was due to the higher barrier properties of the overall package. Fig 5.1- 5.3 shows that the oxygen concentration in all packages constantly decreased during the experiment. The residual oxygen levels in packages were higher for packages with more area of perforations.

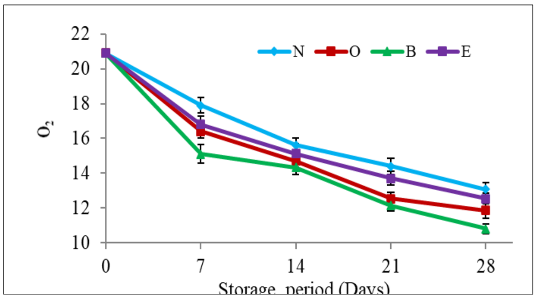

Fig 5.1: O_2 concentration (%) of tomato stored at 10°C for 2 perforation

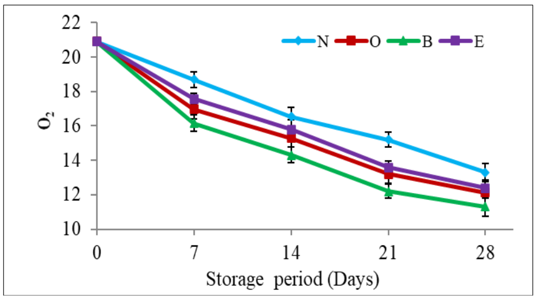

Fig 5.2: O_2 concentration (%) of tomato stored at 10°C for 4 perforation

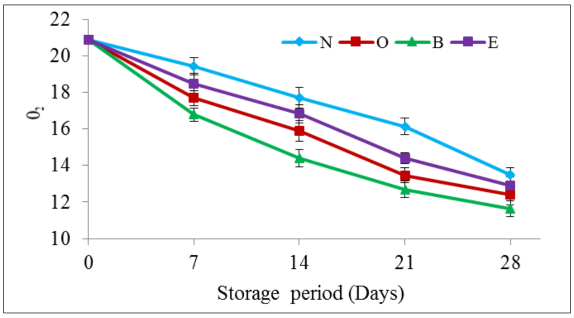

Fig 5.3: O_2 concentration (%) of tomato stored at 10°C for 6 perforation

Statistical analysis shows no significant difference of oxygen concentration inside the packages among normal package with 2 perforation & packages with ethylene scavengers having 6 perforations at 21 days of storage (Table 1). Similarly, no significant differences of oxygen level inside the packages were observed among Ethylene (2 & 4 perforations) & oxygen (6 perforations). Normal packages without any scavengers showed significant difference of oxygen concentration at 6 perforations and 4 perforations at 21 days of storage where no significant difference was observed at 28 days of storage (Table 2).

Table 1: O_2 concentration (%) of tomato after 21 days of storage

Treatment	Package Perforations	Oxygen (%)
N	6	16.133±0.4509
N	4	15.20±0.4358
N	2	14.40±0.4582^{a}
E	6	14.40±0.30^{a}
E	2	13.70±0.40^{b}
E	4	13.60±0.3464^{bc}
O	6	13.466±0.404^{bcd}
O	4	13.20±0.5567^{cd}
B	6	12.70±0.4582^{e}
O	2	12.533±0.3785^{ef}
B	4	12.20±0.40^{fg}
B	2	12.133±0.3214^{fg}

CD at 5% level scavengers = 0.403, perforations = 0.349

The summary of the statistical analyses of the observations presented in Table 1 indicate that the minimum oxygen concentration of 12.133±0.3214% was obtained for both (oxygen and ethylene scavengers) treated samples in 2 perforation package and maximum value of 16.133±0.4509% was for normal treated samples in 6 perforation packs. There was no significant difference between the oxygen concentrations in both (oxygen and ethylene scavengers) treated samples in 2 and 4 perforation packages. The observation on 28th day was almost in a similar trend as there on the 21st day.

Table 2: O_2 concentration (%) of tomato after 28 days of storage

Treatment	Package Perforations	Oxygen (%)
N	6	13.50±0.40^{a}
N	4	13.30±0.5291^{ab}
N	2	13.066±0.3785^{b}
E	6	12.90±0.50^{bc}
E	2	12.533±0.3055^{cd}
O	6	12.40±0.5567^{d}
E	4	12.40±0.4358^{d}
O	4	12.133±0.3511^{e}
O	2	11.866±0.4725^{ef}
B	6	11.633±0.4163^{fg}
B	4	11.30±0.5291^{ge}
B	2	10.80±0.30^{e}

CD at 5% level scavengers = 0.427, perforations = 0.370

3.1.2 Carbon-dioxide

The variations in carbon dioxide concentration within the packages having 250±10 g of tomato at 10±1°C with respect to the change in number (area) of perforations are given in Fig. 6.1- 6.3. It was found that, with respect to the perforation size is increasing then the carbon-dioxide concentration in the packages is decreased. The reaction with respect to the accumulation of carbon dioxide in the packages is in the opposite pattern as is the consumption of oxygen. Excessive oxygen depletion is associated with the accumulation of carbon dioxide. It was observed that the maximum CO_2 concentration was about 8.42% considering all the packages and treatments after 28 days of storage. The maximum acceptable limit for CO_2 in MAP is 10%, and our samples were below that limit. There was no significant difference between the carbon dioxide concentrations in normal treated samples in 4 and 6 perforation packs in 21days.

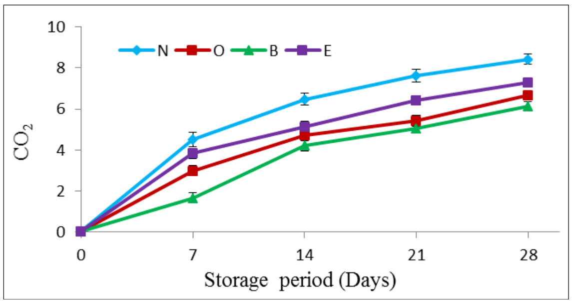

Fig 6.1: CO_2 concentration (%) of tomato stored at 10ºC for 2 perforation

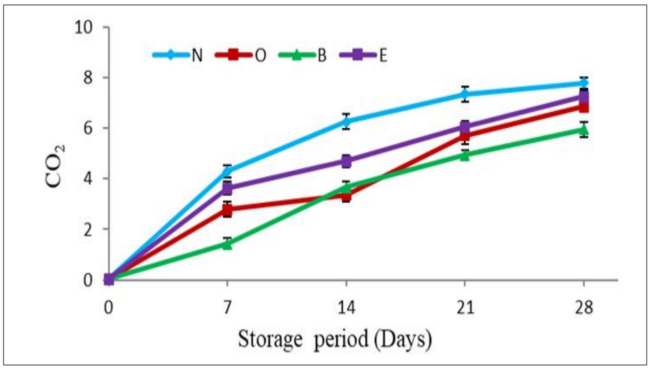

Fig 6.2: CO_2 concentration (%) of tomato stored at 10ºC for 4 perforation

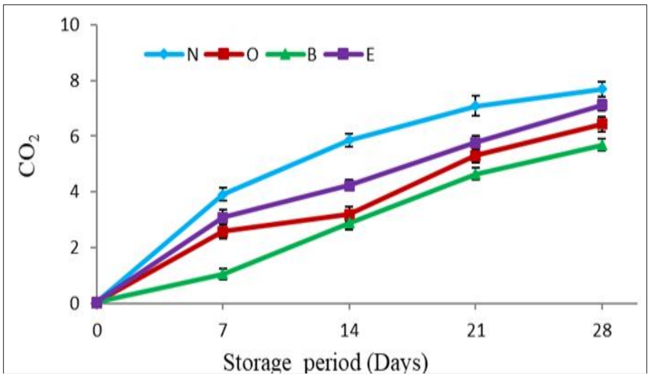

Fig 6.3: CO_2 concentration (%) of tomato stored at 10ºC for 6 perforation

Table 3: CO_2 concentration (%) of tomato after 21 days of storage

Treatment	Package Perforations	CO_2 (%)
N	2	7.62±0.3132
N	4	7.33±0.3113^{a}
N	6	7.08±0.3590^{a}
E	2	6.42±0.2165
E	4	6.05±0.2259
E	6	5.76±0.2581^{b}
O	4	5.71±0.3617^{b}
O	2	5.41±0.2761^{c}
O	6	5.31±0.2809^{c}
B	2	5.03±0.2154^{d}
B	4	4.93±0.1823^{d}
B	6	4.65±0.220

CD at 5% level scavengers = 0.267, perforations = 0.231

Table 4: CO_2 concentration (%) of tomato after 28 days of storage

Treatment	Package Perforations	CO_2 (%)
N	2	8.42±0.2548
N	4	7.78±0.2206^{a}
N	6	7.68±0.2605^{a}
E	2	7.29±0.2250^{b}
E	4	7.24±0.2364^{b}
E	6	7.11±0.20^{b}
O	4	6.85±0.2066^{c}
O	2	6.67±0.2443^{cd}
O	6	6.44±0.270^{d}
B	2	6.13±0.2154^{e}
B	4	5.95±0.2939^{e}
B	6	5.69±0.2163

CD at 5% level scavengers = 0.232, perforations = 0.201

4. Sensory analysis

Sensory analysis of texture, color, flavor, texture and overall acceptability after 28 days of storage is presented at Fig 7. Lowest sensory score was observed in case of samples stored with ethylene scavengers with 2 MAP having perforations (3.8) and maximum value was observed in case of samples stored with oxygen scavengers (7.8) for 4 perforations and 7.6 for 2 perforations.

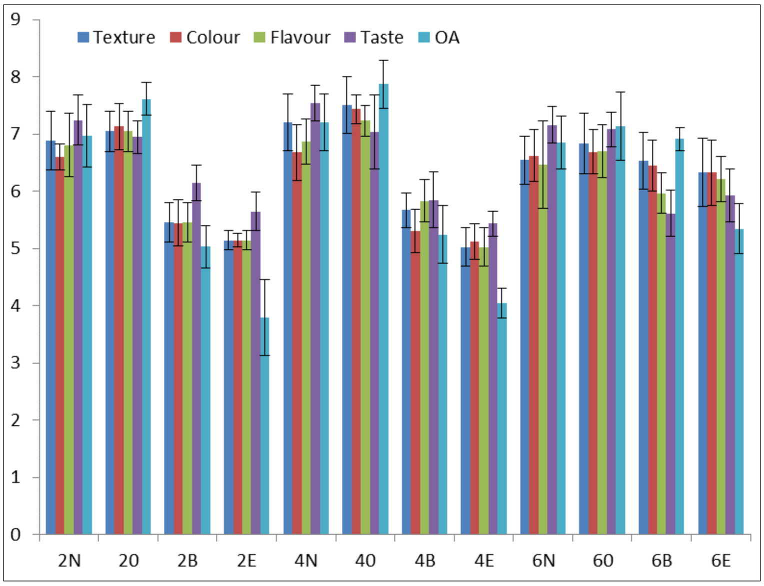

Fig 7: Sensory analysis of tomato stored at 10°C

Statistical analysis presented at table 5 indicates that maximum value for taste was observed for samples stored at MAP with 4 perforations and without any scavenging materials. Samples stored in MAP having 4 perforations with oxygen scavenger gave best result for colour (7.43), flavor (7.23), texture (7.51) and overall acceptability (7.86) with acceptable taste (7.54) followed by samples stored with oxygen scavengers with 2 perforations and samples stored with 4 perforations (without any scavenging material).

Table 5: Sensory analysis of tomato after 28 days of storage

Treatment	Package Perforations	Taste	Color	Flavor	Texture	OA
N	4P	7.54±0.3086	6.67±0.4867^{ab}	6.86±0.40^{ab}	7.20±0.4949	7.20±0.494^{ab}
N	2P	7.24±0.433^{a}	6.60±0.22^{abcd}	6.80±0.554^{bc}	6.87±0.511^{ab}	6.96±0.55^{abc}
N	6P	7.15±0.3166^{ab}	6.62±0.446^{abc}	6.46±0.759	6.54±0.4216^{c}	6.84±0.463^{cd}
O	6P	7.07±0.3073^{abc}	6.68±0.3919^{a}	6.7±0.4555^{c}	6.83±0.524^{b}	7.13±0.597^{ab}
O	4P	7.03±0.6480bcd	7.43±0.250	7.23±0.2692	7.51±0.493	7.86±0.415
O	2P	6.94±0.2877^{cd}	7.13±0.4031	7.04±0.3539^{a}	7.04±0.353^{a}	7.61±0.289
B	2P	6.14±0.3086	5.44±0.4065	5.45±0.35^{de}	5.45±0.3503	5.03±0.37^{f}
E	6P	5.92±0.4630^{e}	6.32±0.567^{e}	6.21±0.3887	6.32±0.595^{cd}	5.34±0.43^{e}
B	4P	5.84±0.4876^{ef}	5.31±0.3789^{f}	5.83±0.374^{d}	5.66±0.295^{e}	5.24±0.51^{ef}
E	2P	5.64±0.335^{f}	5.14±0.1236^{fg}	5.14±0.166^{e}	5.14±0.166^{f}	3.80±0.66^{g}
B	6P	5.61±0.4013^{e}	6.44±0.44^{cdef}	5.96±0.357^{d}	6.53±0.49^{cd}	6.91±0.20^{bcd}
E	4P	5.43±0.2236^{e}	5.12±0.31^{fg}	5.02±0.338^{e}	5.02±0.338^{f}	4.04±0.265^{g}

CD at 5% level Texture: scavengers = 0.235, perforations = 0.204
Taste: scavengers = 0.211, perforations = 0.184
Color: scavengers = 0.210, perforations = 0.182
Flavor: scavengers = 0.228, perforations = 0.197
OA: scavengers = 0.247, perforations = 0.214

5. Conclusion

It can be concluded from above discussion that the 4 perforation packages created better environment conditions and resulted in better sensory quality attributes for the tomato as compared to 2 and 6 perforation packages. The amount of load and area of perforation of course need to be decided depending on the film permeability characteristics and behavior of commodity. Lowest sensory score was observed in case of samples stored with ethylene scavengers with 2 perforations (3.8) and maximum value was observed in case of samples stored with oxygen scavengers (7.8) for 4 perforations and 7.6 for 2 perforations. Samples stored in packages having 4 perforations with oxygen scavenger gave best result for colour (7.43), flavour (7.23), texture (7.51) and overall acceptability (7.86) with acceptable taste (7.54) followed by samples stored with oxygen scavengers with 2 perforations and samples stored with 4 perforations (without any scavenging material).

6. References

1. Ayan Z, Esturk O, Tas E. Effect of modified atmosphere packaging on the quality and shelf life of minimally processed carrots. Turkish Journal of Agriculture and Forestry 2008;32:57-64.
2. Canene-Adams, Kirstie Campbell, Jessica Zaripheh, Susan Jeffery, Elizabeth Erdman Jr, John. The Tomato as a functional food. The Journal of Nutrition 2005, 1226-30.

3. Choudhary B. Vegetable (10th Ed.) National Book Trust, India 2003, 40.
4. Luthria, Dave Mukhopadhyay, Sudarsan Krizek, Donald. Content of total phenolics and phenolic acids in tomato (*Lycopersicon esculentum* Mill.) fruits as influenced by cultivar and solar UV radiation. Journal of Food Composition and Analysis 2006, 771-777.
5. Osei MK, Akromah R, Shilh SL, Green SK. Evaluation of some tomato germplasm for resistance to tomato yellow leaf curl virus disease (TYLCV) in Ghana. Aspects of Applied Biology 2010, 315-32.
6. Kucuk Omer, Sarkar Fazlul, Djuric Zora, Sakr Wael, Pollak Michael, Khachik Fred *et al*. Effects of lycopene supplementation in patients with localized prostate cancer. Experimental biology and medicine (Maywood, N.J.) 2002, 881-5.