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Manasa SM
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

GJ Suresha
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

KR Vasudeva
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

HC Krishna
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

J Jayappa
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

Jayashree Ugalat
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

KJ Dayamani
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

Correspondence
Manasa SM
University of Horticultural Sciences, Bagalkot. College of Horticulture, Bengaluru, UHS Campus, GKVK, Bengaluru, Karnataka, India

Influence of modified atmosphere package on quality of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) fruits

Manasa SM, GJ Suresha, KR Vasudeva, HC Krishna, J Jayappa, Jayashree Ugalat and KJ Dayamani

Abstract
Cherry tomato is a highly perishable crop due to its higher respiration rate which leads to higher postharvest losses. Postharvest losses in cherry tomatoes can be reduced by using different packages with modified gas composition. In this study, cherry tomatoes were stored in low density poly ethylene (LDPE) with different gas composition (2 levels of O_2 (3% and 5%) with 3 levels of CO_2 (0%, 3% and 5%) and control) at 8±1°C and 85±5% RH. Physiological loss in weight (PLW), respiration rate, titratable acidity (TA), total soluble solids (TSS) and shelf life were evaluated. Fruits stored under 3% O_2+ 5% CO_2+ 92% N_2 has shown lower Physiological loss in weight, delayed change in respiration rate, titratable acidity and total soluble solids with shelf life of 33 days whereas, 15 days in control. Results shown that MAP could be effectively used in retention of maximum quality and shelf life of cherry tomato.

Keywords: cherry tomato, LDPE, modified atmosphere packaging, shelf life

1. Introduction

Tomato is an important and largely grown vegetable for the fresh and processing markets. Cherry tomatoes (*Solanum lycopersicum var. cerasiforme*) belong to the family *Solanaceae*, botanically known as berry. These are sweet, small tomatoes having intense colour and flavour along with several significant nutritional benefits. These are generally round in shape and weigh about 10-30 g. It is grown for its fruits which are utilized as vegetables to contribute to the essential nutrients in our diet. It helps in reducing lung cancer and also exhibit antioxidative, anticarcinogenic, antimicrobial, antiallergic, antimutagenic, and anti-inflammatory activities and reduces low density lipoprotein (LDL) oxidation and quench reactive oxygen radicals, thereby decreasing the risk of cardiovascular diseases (Lenucci *et al*., 2006) [23]. Being a climacteric and perishable vegetable, cherry tomatoes has very short life span of 5-6 days. Losses of fresh fruits and vegetable is mainly because of poor postharvest handling, such as a broken cold chain and unsuitable packaging materials results in high postharvest losses due to enhanced physiological activities and other metabolic processes that are associated with deterioration of produce. To overcome this problem modified atmosphere packaging can be effectively used.

Modified atmosphere packaging (MAP) technology retards the produce respiration rate and extends the shelf life of fresh produce (Caleb *et al*., 2012) [12]. Shelf-life of cherry tomato fruits can be extended by atmospheres with reduced O_2 and elevated CO_2 by means of MAP. The technique of MAP is used to prevent or retard postharvest fruit ripening and associated biochemical and physiological changes by favourably altering the O_2 and CO_2 levels around the products (Ali *et al*., 2004) [7]. Carbon dioxide is the most important gas in the MAP due to its bacteriostatic and fungistatic properties also decreases the rate of enzymatic activity thereby, increases the shelf life and maintains quality of produce (Sandya, 2010) [31]. Nitrogen is an inert tasteless gas and is used as fillar gas in MAP. Oxygen is introduced into the packaging atmosphere to prevent anaerobic respiration and it has set low to inhibit the growth of aerobic spoilage microorganism. Packaging protects the produce from mechanical injury and contamination during marketing. Modifying the gas composition around the fruits during packaging and subsequent cold storage could prolong the shelf life of cherry tomato fruits.

The MAP with a LDPE package may provide potential extension of postharvest life which is beneficial for transportation as well as storage.

2. Material and methods

2.1 Experimental material

Freshly harvested cherry tomatoes var. Mereliee was procured from Namdhari Fresh, Bidadi, and Bengaluru. The fruits were received in the laboratory within 24h after harvest in CFB boxes lined with polyethylene cover. After receiving fruits in the laboratory, they were sorted out to remove bruised, diseased and insect infested fruits. The sorted fruits were surface disinfected with 0.2% sodium hypochlorite solution and followed by washing with water. Further, fruits were air dried using electric fan.

Fruits were packed in low density polyethylene covers, each packs were filled with fruits and silica gel sachets. Later according to the treatment details covers were flushed with different concentrations of oxygen (99.85%), carbon dioxide (99.9%) and nitrogen (UHP) using the modified atmosphere packing machine gas mixer Make: Dan sensor, Model: MAP Mix Provectus 3 Gas. Gas packing Makeak Ramon Model 960 AB. Cherry tomatoes with different gas concentration along with control were stored in low temperature storage of 8±1 °C and relative humidity of 80±5 per cent. The packages were filled with different gas composition of package without gas composition (Control), Packages with 3% O_2 + 0% CO_2 + 97% N_2, 3% O_2 + 3% CO_2 + 94% N_2, 3% O_2 + 5% CO_2 + 92% N_2, 5% O_2 + 0% CO_2 + 95% N_2, 5% O_2 + 3% CO_2 + 92% N_2 and 5% O_2 + 5% CO_2 + 90% N_2. The samples were evaluated for physical, physiological and chemical parameters at the interval of five days up to 30 days.

2.2 Physiological loss in weight (%)

Fruits from each replication of the treatment was taken to record the physiological loss in weight (PLW). The weight of the fruits was recorded using precision electronic weighing balance (Make: Sartorius Weighing Technology GmbH, Goettingen, Germany, Model: GE812) before storage. Thereafter, the weights were recorded at 5 days interval during storage and the cumulative PLW was calculated with the following formula and expressed as per cent physiological loss in weight:

$$\text{Physiological loss in weight (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

2.3 Respiration rate (mg CO_2 $kg^{-1}h^{-1}$)

The respiration rate of the fruits packed with different gas composition was measured after taking them out of the LDPE package during their storage.

The fruits of known volume were enclosed in a hermetic container for specified time and head space gas concentration of CO_2 was measured by piercing the probe of an auto oxygen/carbon dioxide analyzer (Make: Quantek, Model: 902D Dual track) into the container through the septa fixed on the lid of container and direct reading was noted down from the instrument screen. The respiration rate was calculated in mg kg^{-1} h^{-1} by using formula:

$$\text{Respiration rate(mg kg}^{-1}\text{h}^{-1}) = \frac{2 \times \%\ CO_2 \times \text{Container volume(ml)} \times 60}{\text{Fruit weight (kg)} \times \text{Enclosing time (min)} \times 100}$$

2.4 Titratable acidity (%)

The total titratable acidity of cherry tomato was determined by visual titration method as explained by Cohen (1971) [15].

Preparation of sample: The known amount of sample was taken in a volumetric flask and diluted with known volume of distilled water and the aliquot was used for analysis.

Procedure**:** A known amount of aliquot was taken in a conical flask and titrated against 0.1N NaOH (sodium hydroxide) solution using 1-2 drops of phenolphthalein indicator. The appearance of pink colour was considered as the end point of titration. Then, the acidity was computed and expressed as per cent citric acid.

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value} \times \text{N of alkali} \times \text{Vol. made up} \times \text{Eq. wt. of citric acid} \times 100}{\text{Vol. of sample taken for estimation} \times \text{Wt. or vol. of sample (ml)} \times 1000}$$

2.5 Total soluble solids (°Brix)

Total soluble solids (TSS) of the fruits was determined with the help of digital hand refractometer and expressed as degree Brix (°B). Care was taken that the prism of the refractometer was washed with distilled water and wiped dry before every reading (Anon., 1984) [8].

2.4 Shelf life (Number of days)

The shelf life expressed in days was determined by looking into the physico-chemical parameters.

3. Results and Discussion

3.1 Physiological loss in weight (PLW) (%)

The changes in PLW of cherry tomato fruits var. Mereliee as influenced by modified atmosphere packaging is presented in Table 1. PLW was gradually increased and found higher in the packages without modification of gases (Control) (0.54%) during 15 days of storage and remained lower in the packages with active modification of gaseous atmosphere (Treatments). However, minimum PLW was recorded in gaseous atmosphere with 3% O_2 + 5% CO_2 + 92% N_2 (0.18%) during 30 days of storage. The weight loss in cherry tomatoes was observed during storage due to loss in moisture content and utilization of substrates during respiration. These results were conformity with findings of Taye *et al*. (2017) [34] who examined least weight loss in cherry tomato at 5 per cent CO_2 as compared to control and Antala *et al*. (2014) [9] they shown least weight loss in sapota fruit stored at low temperature (6°C) with higher CO_2 concentration (10%).The lower PLW in the reduced O_2 and elevated CO_2 is due to lower respiration rate of fruits in the package due to active modification of the atmosphere within the package. The transpiration rate of the fruits would also reduce due to moisture equilibrium between fruits and within the package. Further, decrease in PLW is also might be due to low temperature storage which reduced metabolic activities and evapo-transpirational losses (Rana *et al*., 2018) [28] of fruits that delayed physiological processes. The low weight loss in the low O_2 and high CO_2 related to water vapor accumulation within plastic film packages during the storage (Akbudak *et al*., 2012) [3]. The weight losses increased with ripening which occurred with the prolonging storage period of fruits. Panda *et al*. (2017) [27] reported that mass loss is due to respiration and transpiration in strawberries. Weight loss is mainly 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 in each cycle. The low weight loss at 8±1°C could also be attributed to the retardation of physiological processes such as respiration and transpiration that occur at low temperature. The least weight loss was observed in fruits with 5 per cent CO_2 at pink maturity stage. Similar trend was also observed by Caron *et al*. (2013) [13] who reported 1per cent and 0.24 per cent mass loss in cherry tomatoes during 20 days of storage when packed in Vegetable Pack and PEBD film respectively. Similar results were also obtained by Chitravathi *et al*. (2015) [14], Gharezi *et al*. (2012) [18], Akbudak and Akbudak (2007) [2] in cherry tomatoes, Manjunatha *et al*. (2014) [25] in cucumber, Nath *et al*. (2012) [26] in pears, Romero *et al*. (2003) in grapes, Ahmed and Thompson (2007) [1] in banana and Haile (2017) [19] in tomato.

3.2 Respiration rate (mg CO_2 kg^{-1} h^{-1})

Data regarding respiration rate (mg CO_2 kg^{-1} h^{-1}) of cherry tomato fruits influenced by MAP is presented in Table 2. Respiration rate of cherry tomato fruits var. Mereliee are registered an increasing trend from 16.64 mg CO_2 kg^{-1} h^{-1} at 5 DAS to 29.11 mg CO_2 kg^{-1} h^{-1} at 25 DAS and declined further to 27.89 mg CO_2 kg^{-1} h^{-1} at 30 DAS. The rate of respiration of a fruit is inversely proportional to shelf-life; a higher rate decreases shelf-life. Reducing the rate of respiration by limiting O_2 prolongs the shelf-life of fruits by delaying the oxidative breakdown of the complex substrates.

Table 1: Effect of MAP on physiological loss in weight of cherry tomato var. Mereliee during cold storage (8±1°C)

Treatments	Physiological loss in weight (%)					
	5DAS	**10DAS**	**15DAS**	**20DAS**	**25DAS**	**30DAS**
T_1-control	0.19±0.02^{a} (2.48±0.01)	0.25±0.01^{a} (2.85±0.06)	0.54±0.00^{a} (4.23±0.02)	--	--	--
T_2-3% O_2+0% CO_2	0.07±0.00^{c} (1.55±0.00)	0.10±0.00^{c} (1.77±0.02)	0.14±0.01^{b} (2.12±0.10)	0.15±0.01^{c} (2.21±0.07)	0.18±0.01^{c} (2.44±0.04)	0.22±0.01^{b} (2.68±0.04)
T_3-3% O_2+3% CO_2	0.09±0.01^{b} (1.69±0.1)	0.11±0.00^{b} (1.87±0.02)	0.12±0.00^{c} (1.96±0.02)	0.14±0.01^{c} (2.14±0.06)	0.22±0.00^{a} (2.71±0.03)	0.25±0.01^{a} (2.86±0.04)
T_4-3% O_2+5% CO_2	0.05±0.00^{e} (1.27±0.00)	0.08±0.00^{e} (1.61±0.02)	0.10±0.01^{e} (1.77±0.08)	0.11±0.00^{d} (1.88±0.02)	0.15±0.00^{e} (2.20±0.03)	0.18±0.01^{d} (2.41±0.09)
T_5-5% O_2+0% CO_2	0.05±0.01^{de} (1.33±0.1)	0.11±0.00^{b} (1.88±0.01)	0.14±0.00^{b} (2.13±0.00)	0.17±0.00^{a} (2.37±0.03)	0.23±0.01^{a} (2.76±0.05)	--
T_6-5% O_2 +3% CO_2	0.06±00^{d} (1.39±0.00)	0.10±0.01^{bc} (1.82±0.05)	0.13±0.00^{b} (2.05±0.00)	0.16±0.01^{b} (2.29±0.04)	0.21±0.00^{b} (2.60±0.00)	0.25±0.01^{a} (2.88±0.03)
T_7-5% O_2+5% CO_2	0.06±00^{d} (1.38±0.00)	0.09±0.00^{d} (1.69±0.01)	0.11±0.00^{d} (1.87±0.01)	0.12±0.00^{d} (1.96±0.01)	0.16±0.01^{d} (2.28±0.04)	0.20±0.01^{c} (2.55±0.05)
Mean	1.59	1.93	2.30	2.14	2.50	2.68
F-test	*	*	*	*	*	*
S.Em±	0.04	0.02	0.03	0.03	0.02	0.03
C.D. at 5%	0.11	0.06	0.08	0.08	0.06	0.10

* Significant at 5%

DAS= Days after storage NS = Non-significant -- = Treatments terminated.

Values with different letter in the same column indicate significant differences at $p = 0.05$

Probability level according to Duncan's multiple range test Values in the parenthesis are arc sin transformed.

In climacteric fruit, respiration rate shows a decreasing trend to the lowest value termed as pre climacteric minimum followed by a sharp rise in respiration rate to the climacteric peak. This sudden rise is called as respiratory climacteric followed by a decrease in respiration rate in the senescence period (Sen *et al*., 2012) [3]. In the present study, respiration rate has shown climacteric pattern which has gradually increased up to 25 days and decreased during further storage. The fruits packaged with 3% O_2 + 5% CO_2 + 92% N_2 has the lowest respiration (27.66mg CO_2 kg^{-1} h^{-1}) during storage. Whereas, fruits in control reported 29.93 mg CO_2 kg^{-1} $h^{-1}$and 28.08 mg CO_2 kg^{-1} h^{-1} during 10 days and 15 days of storage respectively. It might be due to low O_2 and higher CO_2 concentrations suppress the respiration rate and also the ethylene production in tomatoes as O_2 is involved in the conversion of 1-amino-cycloprane-1-carboxylic acid to ethylene (Alejandra *et al*., 2009; Viskelis *et al*., 2011; Vunnam *et al*., 2014) [6, 36, 37]. These findings were similar with Singh *et al*. (2014) in bell pepper. Taye *et al*. (2017) [34] who reported that respiration rate was lower at 5 per cent CO_2 as compared to 3 per cent CO_2 and the control throughout the storage period, regardless of fruit maturity in cherry tomato. In addition, results also agreed with Islam *et al*. (2012) [20] who found the increase in respiration rates in climacteric fruit increases ethylene production which leads to early ripening and senescence in cherry tomato. Jat *et al*. (2013) [21] reported that ethylene production rate increased from green mature to fully ripe stage and then declined again in overripe fruit in ber. Daquino *et al*. (2016) [16] found a decrease in respiration rate of cherry tomato associated with increased level of CO_2 and decreased in level of CO_2.

Table 2: Effect of MAP on respiration rate (mg CO_2 kg^{-1} h^{-1}) of cherry tomato var. Mereliee during cold storage (8±1°C)

Treatment	Respiration rate (mg CO_2 kg^{-1} h^{-1})					
	5 DAS	**10 DAS**	**15 DAS**	**20 DAS**	**25 DAS**	**30 DAS**
T_1-control	16.90±0.19	29.93±0.63^{a}	28.08±0.35^{a}	--	--	--
T_2-3% O_2+0% CO_2	16.67±0.00	19.96±0.40^{c}	21.54±0.38^{c}	25.59±0.23^{cd}	28.68±1.43	28.27±0.75
T_3-3% O_2+3% CO_2	16.53±0.04	21.14±0.23^{b}	25.96±0.69^{b}	27.90±0.95^{b}	30.31±0.61	27.83±1.50
T_4-3% O_2+5% CO_2	16.54±0.27	19.52±0.33^{cd}	20.96±0.23^{c}	23.38±0.61^{e}	27.88±1.61	27.66±0.37
T_5-5% O_2+0% CO_2	16.61±0.05	19.33±0.19^{d}	25.57±0.44^{b}	29.33±0.37^{a}	30.62±1.56	--
T_6-5% O_2 +3% CO_2	16.59±0.31	19.54±0.08^{cd}	20.95±0.26^{c}	26.59±0.34^{c}	28.53±0.63	27.67±0.81
T_7-5% O_2+5% CO_2	16.62±0.04	19.29±0.33^{d}	21.18±0.30^{c}	24.74±0.72^{d}	28.62±0.96	27.99±0.70
Mean	16.64	21.25	23.46	26.25	29.11	27.89

F-test	NS	*	*	*	NS	NS
S.Em±	0.10	0.20	0.23	0.34	0.69	0.52
C.D. at 5%	NS	0.62	0.71	1.05	NS	NS

* Significant at 5%   Initial respiration rate (mg CO_2 kg^{-1}h^{-1}) is 16.32

Table 3: Effect of MAP on titratable acidity (%) of cherry tomato var. Mereliee during cold storage (8±1°C)

Treatment	**Titratable acidity (%)**					
	5DAS	**10DAS**	**15DAS**	**20DAS**	**25DAS**	**30DAS**
T_1-control	0.67±0.03^{c} (4.70±0.11)	0.53±0.01^{d} (4.18±0.05)	0.57±0.02^{c} (4.34±0.06)	--	--	--
T_2-3% O_2+0% CO_2	0.71±0.01^{ab} (4.82±0.04)	0.69±0.01^{a} (4.77±0.04)	0.64±0.01^{a} (4.59±0.03)	0.58±0.02 (4.38±0.06)	0.61±0.00^{ab} (4.46±0.02)	0.61±0.01^{a} (4.47±0.05)
T_3-3% O_2+3% CO_2	0.70±0.02^{ab} (4.8±0.07)	0.66±0.02^{bc} (4.67±0.06)	0.58±0.02^{bc} (4.38±0.09)	0.57±0.02 (4.32±0.06)	0.59±0.01^{bcd} (4.40±0.05)	0.61±0.00^{a} (4.48±0.02)
T_4-3% O_2+5% CO_2	0.68±0.01^{bc} (4.74±0.04)	0.68±0.01^{ab} (4.72±004)	0.61±0.02^{ab} (4.49±0.07)	0.60±0.02 (4.42±0.06)	0.58±0.01^{d} (4.35±0.03)	0.59±0.00^{b} (4.39±0.02)
T_5-5% O_2+0% CO_2	0.72±0.02^{a} (4.88±0.06)	0.64±0.02^{c} (4.57±0.07)	0.59±0.02^{bc} (4.41±0.09)	0.57±0.02 (4.34±0.06)	0.60±0.02^{abc} (4.44±0.06)	--
T_6-5% O_2 +3% CO_2	0.71±0.01^{ab} (4.84±0.03)	0.64±0.01^{c} (4.60±0.04)	0.62±0.01^{a} (4.53±0.03)	0.61±0.02 (4.48±0.06)	0.62±0.01^{a} (4.51±0.03)	0.62±0.00^{a} (4.52±0.02)
T_7-5% O_2+5% CO_2	0.72±0.01^{a} (4.87±0.03)	0.66±0.02^{bc} (4.65±0.08)	0.63±0.01^{a} (4.54±0.04)	0.59±0.01 (4.40±0.05)	0.58±0.01^{cd} (4.37±0.05)	0.59±0.01^{b} (4.40±0.03)
Mean	4.81	4.59	4.45	4.39	4.43	4.46
F-test	*	*	*	NS	*	*
S.Em±	0.04	0.03	0.03	0.03	0.02	0.02
C.D. at 5%	0.12	0.10	0.11	NS	0.07	0.05

* Significant at 5%   Initial mean titratable acidity is 0.82%.
DAS= Days after storage   NS= Non-significant   -- = Treatments terminated
Values with different letter in the same column indicate significant differences at $p = 0.05$.
Probability level according to Duncan's multiple range test.
Values in the parenthesis are arc sin transformed.

3.3 Titratable acidity (%)

The data on changes in titratable acidity as influenced by modified atmosphere packaging of cherry tomato fruits var. Mereliee is presented in Table 3. The titratable acidity recorded decreasing trend during 20 DAS from initial mean value 0.82% to 0.57% (20 DAS, treatment T_3) except T_4 (0.58%, 25 DAS) and T_7 (0.58%, 25 DAS). However, decreasing trend in titratable acidity was observed during 25 DAS. Further, titratable acidity was found increasing during storage irrespective of treatments. 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. In the present study, Titratable acidity (%) shown the significant difference among the treatments and decreased gradually during the 20 days of storage. Further, it has shown increasing trend except treatment with 3% O_2 + 5% CO_2 + 92% N_2 and 5% O_2 + 5% CO_2 + 90% N_2 which, showed delay in increasing TA. Whereas, fruits in control has shown more decrease in acidity during 10 days of storage.

Reduced in TA might be due to increased metabolism by utilization of acids in respiration and other physiological processes together with carbohydrates (Akbudak *et al*., 2007) [2] and also changes in the organic acids during ripening have been attributed to raise in citrate and fall in malate, indicating a change in metabolism of citrate and reduction in the level of citric acid (Gharezi *et al*., 2012) [18]. These results were in conformity with Sabir and Agar (2011), Majidi *et al*., 2014 [24] in tomatoes and Gharezi *et al*. (2012) [18] in cherry tomatoes.

3.4 Total soluble solids (°B)

The data regarding changes in total soluble solids (°B) as influenced by MAP of cherry tomato fruits var. Mereliee is presented in Table 4. The total soluble solids acts as a rough index of the amount of sugars present in fruits. It is the total amount of sugars and soluble minerals present in fruits and vegetable. Sugars constitute about 80-85 per cent of soluble solids. The total soluble solids increased during the ripening due to degradation of polysaccharides to simple sugars thereby causing an increase in TSS (Gharezi *et al*., 2012; Kudachikar *et al*., 2011) [18]. In the present study, TSS has shown the significant difference among the treatments and increased gradually during 20 days of storage. Further, it has shown decreasing trend except in treatment with 3% O_2 + 5% CO_2 + 92% N_2 and 5% O_2 + 5% CO_2 + 90% N_2 which showed the decreasing trend after 25 days of storage. TSS increased gradually with the advancement of storage period. This might be due to moisture loss during storage and decreased in TSS was associated with the oxidative breakdown of sugars as a result of respiration and over ripening (Antala *et al*., 2014) [9]. In control highest TSS (7.97°Brix) was recorded during 10 days of storage. Whereas, 7.97 °Brix and 7.90 °Brix was noticed in treatment with 3% O_2 + 5% CO_2 + 92% N_2 and 5% O_2 + 5% CO_2 + 90% N_2 during 25 days of storage respectively. It might be due to suppression of respiration rate in active modified atmosphere (higher CO_2 and lesser O_2) which slows down synthesis and use of metabolites resulting in slower change in carbohydrates to sugars (Akbudak *et al*., 2007) [2]. This results were in confirmity with Majidi *et al*. (2014) [24] in tomato, Venkatram *et al*. (2016) [35] in tomatoes, Workneh *et al*. (2012) [38] in tomato, Azene *et al*. (2014) [10] in papaya and Akbudak *et al*. (2006) [4] in cherry tomato and Islam *et al*. (2012) [20] in cherry tomatoes.

Table 4: Effect of MAP on total soluble solids (°B) of cherry tomato var. Mereliee during cold storage (8±1°C)

Treatment	Total soluble solids (°B)					
	5DAS	10DAS	15DAS	20DAS	25DAS	30DAS
T_1-control	6.10±0.20[a]	7.97±0.21[a]	7.77±0.15[a]	--	--	--
T_2-3% O_2+0% CO_2	5.50±0.36[b]	6.00±0.20[e]	6.40±0.26[c]	7.77±0.15	7.70±0.10[ab]	7.60±0.10[bc]
T_3-3% O_2+3% CO_2	5.57±0.15[b]	6.17±0.15[cde]	6.80±0.20[b]	7.93±0.15	7.83±0.06[a]	7.53±0.21[c]
T_4-3% O_2+5% CO_2	5.60±0.10[b]	6.03±0.15[de]	6.47±0.15[bc]	7.53±0.25	7.97±0.15[a]	7.93±0.15[a]
T_5-5% O_2+0% CO_2	5.17±0.49[b]	6.50±0.26[b]	6.77±0.25[bc]	7.87±0.31	7.73±0.21[ab]	--
T_6-5% O_2 +3% CO_2	5.47±0.21[b]	6.40±0.10[bc]	6.53±0.23[bc]	7.50±0.10	7.43±0.15[b]	7.37±0.06[c]
T_7-5% O_2+5% CO_2	5.40±0.17[b]	6.33±0.15[bcd]	6.43±0.21[bc]	7.57±0.15	7.90±0.30[a]	7.83±0.12[ab]
Mean	5.54	6.49	6.74	7.69	7.76	7.65
F-test	*	*	*	NS	*	*
S.Em±	0.16	0.11	0.12	0.11	0.10	0.08
C.D. at 5%	0.48	0.32	0.37	NS	0.32	0.25

* Significant at 5% Initial mean value of Total soluble solids (°B) is 5.14

DAS= Days after storage NS= No significant-- = Treatments terminated

Values with different letter in the same column indicate significant differences at $p = 0.05$.

Probability level according to Duncan's multiple range test.

3.5 Shelf life (Number of days)

The results on shelf life of cherry tomato fruits var. Mereliee influenced by modified atmosphere packaging has presented in fig 1. The shelf life of cherry tomato var. Mereliee was extended up to 33 days in modified atmosphere packages with gaseous composition of 3% O_2 + 5% CO_2 +92% N_2. Whereas, in control shelf life was extended up to 15 days. It might be due to spoilage and ripening proceeded more quickly in the control treatment whereas, reduced in case of treatment with low O_2 which retards oxidation reaction and reduced the transpiration and respiration rate and high CO_2 which retarded microbes during storage and also due to the retardation of various physico-chemical changes such a firmness delay in color change accompanying maintenance of quality over the storage period (Akbudak *et al*., 2006) [4]. During storage, the ethylene concentration decreased inside the packages, which could be attributed to the effect of high CO_2 and low O_2 concentrations on inhibiting the ethylene production rate and extended shelf life (Bailen *et al*., 2006) [11]. Similar results were reported by Dhalsamant *et al*. (2017) [17] in mango and tomato, Haile (2017) [19] in tomato, Kudachikar *et al*. (2011) [22] in robusta bananas and Chitravathi *et al*. (2015) [14] who examined the overall beneficial effects in terms of shelf life extension of chillies could be attributed to optimum modified atmosphere conditions generated in the packets causing decreased tissue respiration and restricted weight loss.

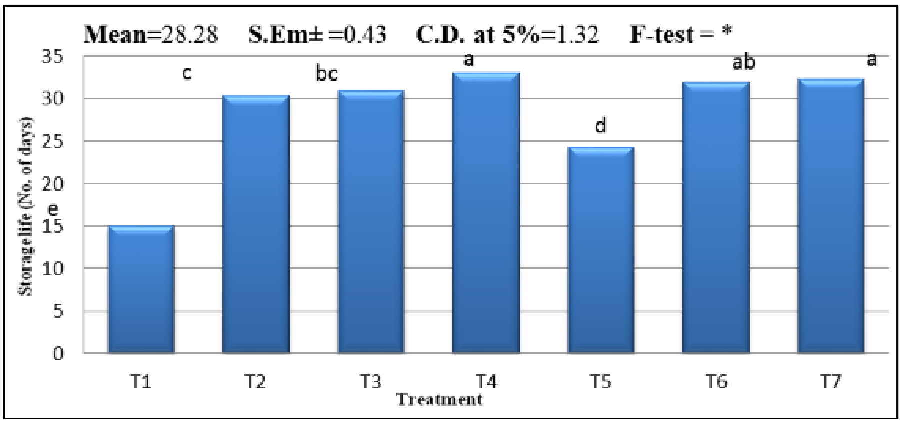

Fig 1: Effect of MAP on storage life of cherry tomato var. Mereliee during cold storage (8±1°C)

T1- Package without gas composition
T2- 3% O2 + 0% CO2 + 97% N2
T3- 3% O2 + 3% CO2 + 94% N2
T4- 3% O2 + 5% CO2 + 92% N2
T5- 5% O2+ 0% CO2 + 95% N2
T6- 5% O2+ 3% CO2 + 92% N2
T7- 5% O2+ 5% CO2 + 90% N2

3. Conclusion

Cherry tomato fruits packed in low density polyethylene with different gas composition prolonged storage life at 8±2°C and RH 80±5%. The treatment with 3% O_2+ 5% CO_2+ 92% N_2 significantly delayed the physico-chemical changes and registered maximum shelf life of 33 days (60%) followed by 5 per cent O_2+ 5 per cent CO_2+ 90 per cent N_2 which recorded shelf life of 32.33 days. The results on present research revealed that the shelf life of cherry tomato fruit can be extended by active MAP which delays the changes in physical, physiological and chemical properties and prolongs the storage life of fruit.

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