The Bioscan 12(1): 209-214, 2017
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

STORAGE LIFE ENHANCEMENT OF CHERRY TOMATO USING MODIFIED ATMOSPHERE PACKAGING

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KEYWORDS
Cherry tomato modified atmosphere packaging, packaging storage life
Low temperature storage(LTS).

Received on :
20.12.2016

Accepted on :
24.02.2017

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ABSTRACT
Experiments were conducted to extend the storage life of freshly harvested cherry tomatousing different packaging material under LTS conditions. The fresh cherry tomato were packed in LDPE packages of various thicknesses viz. 25, 37.5 and 50 μm and 0, 4 and 8 perforations of 1.0 mm diameter each and a separate sample was taken for comparison. All the samples were stored under LTS condition (10 $\pm$ 0.5ºC and 90 $\pm$ 2% RH). Gas concentrations (O_2 and CO_2) and quality parameters such as PLW, colour, firmness, lycopene content, TSS, titrable acidity and sensory evaluation were determined at regular intervals during the entire storage period. Results obtained were analyzed statistically with the help of ANOVA and DMRT ($\acute{a}$ = 0.05). Higher O_2 concentration (15.80%), lower CO_2evolute (4.75%) was observed in 37.5μm packaging with 8 perforations. Lower PLW was observed to be 0.94% and 0.64% of initial weight in non-perforated 37.5μm and 50μm respectively. TCD was observed to lowest (8.79) and firmness better retained by 37.5μm with 8 perforation. Among all the treatments, 37.5 μm LDPE packages with 8 perforations was found to be the best package and cherry tomato could be stored for 3 weeks under low temperature storage conditions.

INTRODUCTION

Tomato has a place with the Solanaceae (the nightshade) family and it was a standout amongst the most widely consumed fresh vegetable in the mechanized world. Naturally, tomato was an organic product (berry), yet they are frequently alluded to as vegetable. Being a climacteric and perishable natural product, tomatoes have a short life expectancy, for the most part 11-14 days (Gharezi *et al.,* 2012). The little nibbling size tomatoes (cherry, grape sort) comprise high convergences of sugars and acids, main provider to tomato aroma, plus now incorporate around 24% of retail offers of tomato in the United States. (Anon 2008).Postharvest proposals demonstrate that tomatoes, containing cherry and grape tomatoes, ought to be put away at 10ºC or higher to abstain from chilling damage (Jimenez *et al.,* 1996, Roberts *et al.,* 2002) also Maul *et al.* (2010) stated that tomato's aroma quality might be hindered if it was stored at 10ºC.

Cherry tomatoes are vended at a leading in numerous of the large trade stocks in the nation. Here was a curiosity in finding methods to enhance the storage life. Harmless and less costly methods that can prolong the storage life whereas on the similar phase reserve the quality under ambient and low temperature storage conditions, needs to be assessed. Henceforward the current research was taken up to study the consequence of MAP as well as different storage conditions on storage life, retention of bioactive compounds and sensory characteristics. Thus taking into consideration problems related to post harvest storage of cherry tomato, and potential of MAP to overcome these, the present deal with the effect of packaging material on keeping quality of cherry tomato and to select the best packaging material for storage life enhancement under low temperature storage condition.

MATERIALS AND METHODS

Raw material and sample preparation

Freshly harvested Punjab red cherry tomato variety was obtained from Vegetable Farm, PAU, Ludhiana. The harvested crop was transported immediately and carefully loaded and carried in nylon bag so that there was no mechanical injury to the fruit during transportation from farm to Fruits and Vegetables Pilot plant, Department of PFE (Processing and Food Engineering), Punjab Agricultural University. The fruit was then physicallywashed and sorted out to remove any damaged and diseased fruit. For the experiment 200 g of cherry tomato weighed and packaged in LDPE bags of 25, 37.5 and 50 μm. (25μm, 37.5μm, 50μm) thickness with 0, 4, 8 perforations each having a diameter of 1mm. The packages were then heat sealed with the assistance of sealing machine and the control samples were kept loose.

Experimental design

Punjab red cherry was a new variety of Punjab and was packed in LDPE packaging material in 3 different μm with 3 types of perforations provided viz: 0, 4 and 8 and stored under low temperature of 10 $\pm$ 0.5º C and RHwas maintained at 90 $\pm$ 2%. Observations recorded at 3 day interval were Gas composition, PLW (Physiological loss in weight), Colour, Firmness, Lycopene content, TSS (Total soluble solids),

Titratable acidity, and Sensory evaluation.

Low temperature storage condition

The cherry tomato (both packaged and control) were stored in the walk-in-cool chamber having a dimensions of 174cm x 173cm x 216 cm, at a temperature of 10ºC ± 0.5º C with a RH of 90 ± 2%. Both relative humidity and temperature inside the chamber was accurately kept up at craved levels. Cherry tomato was placed in plastic cases of 50cm x 32cm x 28 cm and cases were set on the racks inside the chamber.

Storage study of cherry tomato

In-package gas arrangementexamination (as far as O_2 and CO_2 focus), PLW (physiological loss in weight), colour, firmness, lycopene content, total soluble solids, titratable acidity and sensory assessment of the cherry tomato were observed. The observations were recorded at an interim of 3 days at low temperature storage conditions.

In pack gaseous composition

The gas composition in the head space of package was dissected with the assisstance of gas analyzer (Make: PBI Dansensor; Model; checkpoint II portable gas analyser).

Physiological loss in weight (PLW) (Moneruzzaman *et al.,* 2009)

The physiological loss in weight (PLW) was examined by measuringthe individual package at first and on day of perception using a laboratory level measuring scale. The PLW at each interim was calculated as

$$PLW(\%)] = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Colour (McGuire 1992)

The colour of samples was measured utilizing Miniscan XE plus Hunter lab colorimeter.. Three required functions total colour difference (ÄE), chroma and hue angle were calculated from the 'L', 'a' and 'b' readings as follows.

$\Delta E = \sqrt{[(L-L_o)^2 + (a-a_o)^2 + (b-b_o)^2]}$

Chroma = $\sqrt{(a^2 + b^2)}$

Hue angle = $\tan^{-1}(b/a)$

Where L_o, a_o and b_o represents the respective readings of fresh samples.

Firmness

The textural characteristics of cherry tomato were studied using texture analyser (Make: Stable Micro Systems, Model: TA.TXT. Plus).

Puncture test

This test characterized by a penetration of the punch into the fruit sufficient to cause irreversible changes using a 2mm stainless steel probe. The following test settings were used:

TEST - Return to start

Probe - P/2N Needle

Pre - test speed-5 mm/s

Test speed - 1 mm/s

Post speed - 10 mm/s

Distance - 10mm

The fruit sample was kept at the centre of the base of the texture analyser, which was exactly beneath the probe attached to the load cell. Puncture force was obtained from peak point of the force-distance curve in the test.

Lycopene content

Lycopene was a pigment responsible for the colour of the cherry tomato. A known weight of tomato was crushed in pestle and mortar and the pigment i.e. lycopene were extracted using 10ml of acetone. The extract was covered with aluminum thwart to counteract photo-bleaching. Consolidated blend was at last put on shaker at 140 rpm for 30 minutes and then centrifuged at 12000 rpm for 15 min. Final volume of supernatant was made to 100 ml by adding acetone. Lycopene content was estimated by taking absorbance at 503 nm (Sozzi *et al.,* 1998).

Lycopene content (mg/100g) = (31.206 x A503)/W

Where,

A = Absorbance at specific wavelengths

W = Fresh weight of tissue extracted

Total soluble solids (AOAC 1995)

The TSS content of the product was measured utilizingan advance refractometer (PR-100). Every specimen was cut into two pieces. Every piece was further isolated into 3 sections, so there were 6 sections (replications) for every estimation per fruit. The juice from every part was separted manually (> 2 drops) and after that put into the refractometer. The value of soluble solids content was communicated in Brix%.

Titratable acidity

A representative sample of 3 tomatoes was taken and juice extracted. About 2 ml of this juice was taken and titrated against N/10 NaOH solution with phenolphthalein as indicator and pink color as end point (Ranganna 1991). The volume of NaOH used was recorded and acidity was computed as follows

Acidity (gm/100ml of juice) = (0.64 X)/Y

Where,

X = ml of N/10 NaOH used

Y = ml of sample taken for titration

Sensory evaluation

A panel was made and individual members were briefed about the sensory attributes that should be judged. Sensory assessment rating scales were givenin light of which the rating was given to various specimen. The normal estimations of the appraisals given by every one of the individual were then calculated.

The specimen were inspected at pre-decided interim by a panel constituted with the end goal of sensory evaluation. The sensory evaluation scale for rating the sensory assessment of stored cherry tomato were created on the basis of three principle parameters i.e. visual appearance, odour and water accumulation and these quality attributes of the specimen were analyzed by utilizing the rating scales proposed by Deza (2003), Pernin and Gaye (1986) and Rai *et al*. (1999), respectively. The standard conditions such as excellent, good *etc*. were defined as presented in Table 3.1.

Visual appearance; 9 = Excellent, 7 = good: slight(1-5%)

browning, 5= Normal: moderate (5-10%) browning, 3= Limited Quality: Severe (10-50%) browning, 1= Not acceptable: Extreme(>50%) browning. Odour was scored as: 1=Normal (no off odour), 2= Slight off odour, 3= Moderate off odour, 4= Severe off odour, 5=Not acceptable. Water accumulation was scored as: 9= no water accumulation, 7= Fruit slightly wetty, 5= Fruit and film slightly wetty, 3= Fruit moderately wetty, 1=Fruit and film moderately wetty, 0= Fruit completely wetty and dripping of water.

Statistical analysis

The statistical analysis of data obtained was carried out to establish the difference among treatments. All the experiments were performed in triplicate. One way analysis of variance (ANOVA) and Duncan's multiple range tests (DMRT) ($\acute{a}$ = 0.05) were used to determine statistically significant differences between treatments, concerning the Gas concentrations (O_2 and CO_2) and quality parameters such as physiological loss in weight (PLW), colour, firmness, lycopene content, TSS, titrable acidity, and sensory attributes. Evaluations were based on a p = 0.05 significance level.

RESULTS AND DISCUSSION

Gaseous concentration

Oxygen

The O_2 concentration varied from 20.9% to 0.50% irrespective of the packaging material thickness and as well as perforation seen collectively as shown in Table 1. It was evident from the O_2concentration examined in every non-perforated package that O_2 concentration diminished with rise in the thickness of the package as a result of decrease in the permeability of every package This might be due to the fact that non-perforated packages facilitated very little gas exchange as compared to perforated packages and thus, the O_2 concentration fell drastically. Highest oxygen concentration 15.80% was observed in 37.5μm LDPE packaging with 8 perforation as it allows better gaseous exchange with the environment.

Carbondioxide

It was evident from the CO_2 concentration examined in every non-perforated package that CO_2 concentration increased with an increase in the thickness of the package because of the decrease in the permeability of each package, which posed restriction to the CO_2 for its dissipation from the package.The CO_2 concentration varied from 0.03% to 14.20% irrespective of the packaging material thickness and as well as perforation seen collectively as shown in Table 2. Low carbon-dioxide evolution was observed 4.60% and 4.75 % in 25 μm and 37.5μmLDPE packaging with 8 perforation as it better interact with gaseous environment

Physiological loss in weight (PLW)

The PLW in different LDPE packages having cherry tomato was examined at predefined interims of time throughout the low temperature storage condition and was conveyed in %age as shown in Table 3. It was perceived that with the increase in storage period, the physiological loss in weight (%) increased. The PLW was maximum (9.90% on the 24th day) in the control samples i.e. for unwrapped cherry tomato.PLW ranges from 0.05 % to 9.90 % on different packages seen collectively. Lower PLW was observed to be 0.64% and 0.94% in non-perforated in 50μm and 37.5μm respectively.The reason might

Table 1: Oxygen concentration (%) in LDPE packages of various thicknesses under low temperature storage condition of cherry tomato

Storage period (days)	O_2 concentration (%) Treatments								
	25μm LDPE package			37.5μm LDPE package			50μm LDPE package		
	A	B	C	D	E	F	G	H	I
0	20.90	20.90	20.90	20.90	20.90	20.90	20.90	20.90	20.90
3	12.90	18.50	19.60	12.50	18.36	19.50	8.70	17.45	19.30
6	10.80	17.60	18.80	10.67	17.42	18.70	7.90	16.43	18.56
9	8.50	16.90	17.90	8.30	16.75	17.70	6.50	15.75	17.43
12	7.60	16.10	17.30	7.42	15.93	17.20	4.30	14.90	17.06
15	6.45	15.30	16.70	6.38	15.10	16.50	3.60	14.70	16.34
18	4.20	15.10	16.30	3.90	14.96	16.20	3.10	14.30	16.04
21	2.70	14.50	16.10	2.40	14.20	15.93	1.90	13.80	15.70
24	1.10	13.20	15.50	0.80	12.90	15.80	0.50	12.50	15.20

Table 2: Carbon-dioxide concentration (%) in LDPE packages of various thicknesses under low temperature storage condition of cherry tomato

Storage period (days)	Carbon-dioxideconcentration (%) Treatments								
	25μm LDPE package			37.5μm LDPE package			50μm LDPE package		
	A	B	C	D	E	F	G	H	I
0	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
3	4.50	1.97	1.71	4.56	2.10	1.92	6.72	2.42	2.14
6	4.97	2.40	2.19	5.01	2.54	2.38	7.56	2.84	2.47
9	5.81	2.98	2.74	5.83	3.13	2.91	8.75	3.92	3.03
12	6.92	3.70	3.27	7.05	3.82	3.35	8.92	4.33	3.44
15	7.40	4.90	3.53	7.53	5.23	3.67	10.10	5.76	3.79
18	7.90	5.70	3.96	8.05	5.97	4.10	11.40	7.20	4.16
21	8.60	6.20	4.19	8.90	6.35	4.42	12.90	9.40	4.57
24	10.10	7.10	4.60	10.50	7.50	4.75	14.20	11.20	4.90

Table 3: PLW (%) in LDPE packages of various thicknesses under low temperature storage condition for cherry tomato

Storage period (days)	Physiological loss in weight (PLW) Treatments 25μm LDPE package A	B	C	37.5μm LDPE package D	E	F	50μm LDPE package G	H	I	Control J
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.10	0.15	0.25	0.05	0.14	0.16	0.05	0.12	0.20	1.02
6	0.18	0.34	0.52	0.21	0.36	0.49	0.12	0.21	0.41	2.28
9	0.39	0.52	0.71	0.29	0.48	0.64	0.20	0.37	0.57	4.18
12	0.62	0.72	0.98	0.36	0.64	0.85	0.24	0.48	0.71	5.79
15	0.84	0.94	1.19	0.44	0.79	1.07	0.29	0.56	0.90	6.50
18	1.12	1.23	1.44	0.53	0.96	1.33	0.38	0.73	1.19	8.36
21	1.43	1.56	1.73	0.72	1.17	1.65	0.51	0.97	1.48	9.20
24	1.86	1.97	2.25	0.94	1.45	2.10	0.64	1.24	1.82	9.90

Table 4: Total colour difference (ΔE) values in LDPE packages of various thicknesses under low temperature storage condition for cherry tomato

Storage period (days)	Total colour difference (ΔE) Treatments 25 μm LDPE package A	B	C	37.5 μm LDPE package D	E	F	50 μm LDPE package G	H	I	Control J
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	6.38	4.90	2.46	6.26	4.78	1.95	8.32	5.15	3.24	6.85
6	8.16	6.54	3.14	7.61	5.36	2.83	9.75	6.62	4.63	9.24
9	10.52	7.67	3.95	9.46	6.44	3.76	11.76	7.95	5.95	12.56
12	15.49	8.53	4.76	14.82	7.18	4.42	17.50	9.35	6.87	18.46
15	16.50	9.65	6.32	15.63	7.91	5.28	18.90	10.81	8.05	20.70
18	17.20	10.89	7.62	16.59	8.53	6.51	19.60	11.34	8.91	21.90
21	17.90	11.64	8.80	17.64	9.05	7.43	20.20	11.92	9.76	23.20
24	18.70	12.30	9.40	18.37	9.70	8.79	21.40	12.70	10.21	24.30

Table 5: Firmness (kg) for cherry tomato in LDPE packages of various thicknesses under low temperature storage condition

Storage period (days)	Firmness (Puncture test) Treatments 25μm LDPE package A	B	C	37.5μm LDPE package D	E	F	50μm LDPE package G	H	I	Control J
0	10.51	10.51	10.51	10.51	10.51	10.51	10.51	10.51	10.51	10.51
3	8.63	10.02	10.29	7.46	9.06	10.23	6.79	8.62	9.94	5.93
6	8.14	9.14	9.72	6.92	8.21	9.65	4.59	7.73	8.83	3.74
9	6.94	8.67	9.05	5.83	7.54	8.96	3.23	6.86	7.62	2.37
12	5.64	8.35	8.78	4.49	6.94	8.69	2.92	6.01	7.24	1.79
15	4.29	8.04	8.53	3.18	6.75	8.42	1.74	5.71	6.92	1.14
18	3.78	7.66	8.21	2.63	6.23	8.09	1.10	5.12	6.76	0.86
21	3.29	7.24	7.95	2.18	5.90	7.78	0.83	4.76	6.35	0.53
24	2.80	6.82	7.42	1.72	5.10	7.45	0.62	4.05	5.84	0.47

Table 6: Lycopene content for cherry tomato in LDPE packages of various thicknesses under low temperature storage condition

Storage period (days)	Lycopene content Treatments 25μm LDPE package A	B	C	37.5μm LDPE package D	E	F	50μm LDPE package G	H	I	Control J
0	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
3	5.2	5.6	6.1	5.4	5.7	5.8	5.2	5.3	5.5	7.1
6	5.9	6.2	6.7	6.2	6.3	6.6	6.0	6.0	6.3	9.2
9	6.3	7.0	7.5	6.5	7.2	7.4	6.4	6.4	7.1	9.9
12	7.0	7.4	8.2	7.0	7.6	8	6.9	6.9	7.8	10.5
15	7.2	7.9	8.5	7.6	8.1	8.3	7.1	7.2	8.1	10.8
18	6.8	8.1	8.6	7.7	8.4	8.6	6.8	7.3	8.1	9.9
21	6.5	7.5	8.9	7.3	8.5	8.8	6.5	6.9	8.2	9.5
24	5.9	7.2	8.4	6.9	8.2	9.4	6.4	6.5	7.9	8.8

Table 7: Total soluble solids (ºBrix) in LDPE packages of various thicknesses under low temperature storage condition for cherry tomato

Storage period (days)	Total soluble solids (TSS) Treatments 25μm LDPE package A	B	C	37.5μm LDPE package D	E	F	50μm LDPE package G	H	I	Control J
0	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
3	6.5	6.5	5.6	6.4	6	6.7	5.2	5.8	5.0	6.1
6	5.5	6.4	5.2	5.3	5.6	6.5	5.0	5.1	4.4	6.0
9	5.4	5.9	5.0	5.0	5.2	6.1	4.1	4.7	4.2	5.5
12	5.2	5.4	4.6	4.7	5.0	5.6	3.8	4.3	3.7	5.1
15	4.5	5.6	4.5	4.8	5.6	5.5	3.4	4.1	3.4	4.6
18	3.7	5.1	4.4	4.5	5.1	5.7	3.2	4.2	3.6	4.3
21	3.4	4.5	4.5	4.1	4.8	5.5	2.7	3.7	3.8	3.9
24	2.9	3.9	4.1	3.7	4.5	5.4	2.2	3.3	3.3	3.4

Table 8: Odour values in LDPE packages of various thicknesses undμer low temperature condition

Odour Storage period (days)	Treatments 25μm LDPE package A	B	C	37.5μm LDPE package D	E	F	50μm LDPE package G	H	I	Control J
0	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	2	2	2
9	2	2	1	1	1	1	1	2	2	2
12	2	2	1	1	1	1	2	2	2	2
15	2	2	1	1	1	1	2	3	3	3
18	3	2	2	2	2	2	3	3	3	3
21	3	3	2	2	2	2	3	4	3	4
24	4	3	3	3	3	2	4	4	4	4

be that polyethylene packages restricted the moisture removal by creating a barrier to transpiration but unpacked cherry tomato lose their moisture to the surroundings rapidly.

Total colour difference (“E)

The TCD (“E) values in different LDPE packages having cherry tomato was examined at predefinedinterims of time during the low temperature storage condition as shown in Table 4. The rise in “E values indicated color variation. It was perceived that as the storage period increase the “E value too increase. The “E Value was maximum among (36.25) in the control samples *i.e.* for unpacked cherry tomato. Lower “E (8.79) was observed in 37.5μm LDPE packaging with 8 perforations

Total colour differenceshowed variation from 3.42 to 36.25 seen collectively. It was obvious from the “E values measured for cherry tomato in each package that the non-perforated LDPE packages showed maximum variation after control package. Minimum variation being seen in 37.5μm LDPE package with 8 perforation followed by 25μm LDPE package with 8 perforation

Firmness

The firmness in distinct LDPE packages having tomato was examined at predefined interims of time duringlow temperature storage condition as shown in Table 5. The firmness was observed to be decreasing with increase in the storage periodthe firmness value decreased rapidly under low temperature storage condition and was observed to be lowest in the control sample *i.e.* for unwrapped cherry tomato (0.47 kg on the 24th day). Better firmness 7.45 and 7.42 was retained by 37.5μm and 25μm LDPE packaging with 8 perforation.

In all the packages of various thicknesses, the cherry tomato in non-perforated packages had the lowest firmness as compared to cherry tomato in packages having perforation. The reason might be that the anaerobic condition prevailing in packages damaged the tissue and hence a significant loss in firmness took place.

Lycopene content

The lycopene content (mg/100g fw) in distinct LDPE packages having cherry tomato was examined at predefined interims of time during the low temperature storage condition as shown in Table 6. The lycopene content was observed to be increase with increase in storage period. The lycopene content was maximum in open sample i.e. for unpacked cherry tomato.

Lycopene content was better retained (9.4 mg/100g fw) in 37.5μmLDPE packaging with 8 perforationsIt was observed from the lycopene content measure for cherry tomato in each non-perforated package that lycopene content increase with an increase in thickness of package. It was also observed that lycopene content was less in non-perforated than in perforated packages. It might be due to desirable O_2 and CO_2 concentration which led to ripening of the cherry tomato.

Total soluble solids

It was observed that the value of TSS goes on decreasing as the storage period increases. The TSS of fresh cherry tomato was 7.2 ºBrix and it goes to 2.2 during storage period in LDPE packages seen collectively as shown in Table 7. It was also observed that there no particular trend in which it decreasing with reference to perforation and also with reference to

thickness of the LDPE packaging material.

Odour

The odour score of cherry tomato in different LDPE packages was noted down at predefined interims of time throughout the low temperature storage condition as shown in Table 4.145. These LDPE packages were of different thicknesses *viz*.25, 37.5 and 50μm having 0, 4 and 8 perforation. The odour score of cherry tomato was observed to be increase with the increase in storage period. Odour best retained by 37.5μm LDPE packaging with 8 perforation as it had only slight off odour the end of storage period.

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