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EFFECT OF SOME EDIBLE COATING MATERIALS ON QUALITY AND STORABILITY OF CHERRY TOMATO FRUITS DURING COLD STORAGE AND SHELF LIFE PERIODS

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ABSTRACT: This research was conducted in the Post-Harvest Laboratory of the Horticulture Department, Faculty of Agriculture, Zagazig University, Egypt, during two seasons of 2019 and 2020 to study the effect of dipping cherry tomatoes fruits in solutions of edible materials on fruits quality and storability during storage at 7±2°C and 90 ± 3% relative humidity for 28 days. Where the fruits were dipped in chitosan nano particles (ChNPs) solution at 0.5 and 1 %, Arabic gum solution at 5 and 10%, bottle gourd seed oil at 0.2 and 0.4 % and distilled water (control). The results showed that, fresh weight losses, fruit decay, total soluble solids (TSS) content, fruit red color value a*and fruit red color value a*/b* increased progressive as the storage duration was extended from zero to 28 days. On the other hand, increasing the cold storage time reduced the fruit firmness, titratable acidity, vitamin C content and fruit red color value b*. Dipping in solution of bottle gourd seed oil at 0.4% gave the highest fruit firmness, vitamin C and the lowest values of weight loss percentage, Also, dipping in bottle gourd seed oil solution at 0.2 and 0.4 % did not show any decayed fruits and gave the highest values of a*/b*ratio, in addition, it is increased TSS in fruits at 28 days of storage. In general, ChNPs solution at 1 and Arabic gum solution at 10% % gave the highest values of titratable acidity.

Key words: Cherry tomato, coating materials, cold storage, fruits quality and shelf life.

INTRODUCTION

The cherry tomato (*Solanum lycopersicum* Mill. var. *cerasiforme*) is a type of small, round tomato believed to be a genetic cross between wild currant-type tomatoes and domesticated garden tomatoes (**Nesbitt and Tanksley, 2002**). Although they are usually red, there are other colors such as green yellow, purple and black. Cherry tomatoes are distinguished by their high nutritional value all over the world, and they are widely spread in European countries. (**Lin *et al.*, 2019)**.

Although tomatoes have many nutritional and antioxidant properties, they are having a respiratory peak during ripening due to ethylene production, which makes them perishable quickly (**Nabi *et al.*, 2017**). Accordingly, some methods have been used to extend the shelf life of tomatoes, maintain quality and improve the storage capacity of tomato fruits. Among these methods, dipping the fruits in some edible coating material such as, bottle gourd seed oil, Arabic gum, chitosan nano particles and other material.

Edible coating is a thin layer of material with which the surface of the fruits is covered, which is edible, and used for the purpose of maintaining the freshness and quality of the fruits and prolonging their shelf life, by reducing respiration, permitting gas exchange, and reducing microbial growth. (**Ali *et al.*,2010; Al-Juhaimi *et al.*,2013; Mahfoudhi *et al.*, 2014;** and **Mahajan *et al.*,2018)**. There are three different types of edible coating components: hydrocolloids, lipids and composites. Hydrocolloids include proteins and polysaccharides, while lipids include waxes; acylglycerols, and fatty acids, composites have included hydrocolloid and lipid components. (**Espino-Diaz *et al.*, 2010** and **Firdous 2021**). In coated tomatoes, the onset of traits associated with quality degradation, such as softness, color, and mass loss, was greatly delayed (**Fagundes *et al.*, 2013**).

Chitosan is a polycationic natural biopolymer that has a wide range of agricultural applications. (**Aday and Caner, 2010** and **Kong *et al.*, 2010**). Chitosan forms a semi-permeable film that modifies

the internal atmosphere, decreasing transpiration losses and preserves the fruits quality. (**Ribeiro *et al.*, 2007; Kibar and Sabir, 2018).**

All nanostructures have small particles, which explain the ease with which they can enter the stomata and cell walls. Because of nanoscale materials have large surface area to volume ratio, this unique characteristic gives them the potential to behave differently from the same material. Chitosan Nano-particles is considered as one of this engineered materials, which have excellent natural and harmless physicochemical properties.(**Agnihotri *et al.*, 2004**).For many horticulture crops, chitosan decreased degradation, maintained tissue firmness, and extended shelf life periods(**Liu *et al.*, 2014** and **Li *et al.*, 2015)**.In addition, **Sucharitha *et al.* (2018)** found that, smaller concentration of chitosan (0.25 %) were shown to be more effective than 0.5 % in retaining physico-chemical properties.

Gum Arabic is a natural gum obtained from the stems and branches of the acacia tree. It is a mixture of polysaccharides and glycoproteins that's widely used in industry for its emulsifying, film forming, and encapsulating abilities (**Al-Juhaimi *et al.*, 2013** and **Gurjar *et al.*, 2018**). The results showed that, the use of gum Arabic resulted in maintaining the quality of the fruits and increasing their shelf life **(Ali *et al.*, 2013** and **Ruelas-Chacon *et al.*, 2017**).

The fruits are extracted from the bottle gourd (*Lagenaria siceraria*) plant, which belongs to the cucurbitaceae family, and it has antioxidant and anti-microbial properties, which reduces fruit decay, as it is rich in Omega 6, 3 and 9, and contains a high percentage of unsaturated fatty acids and vitamin (A, E and C), and also contains biologically active ingredients (**Ibeto *et al.*, 2012; Warra *et al.*, 2016; Magu *et al.* 2017;** and **Oji and Chinedu, 2020**). **Raafat *et al.* (2016),** fruits treated with fenugreek, cinnamon, and thyme oils had the least weight loss at the end of storage period when compared to control treatments. Also, **(Tabaestani *et al.*, 2013; Chen *et al.*, 2014;** and **Yan *et al.*, 2014)** reported that, plant essential oils have antifungal properties. Moreover, **Xing *et al.* (2011)** found that, microencapsulated cinnamon oil could help preserve the flavour of cherry tomatoes by reducing deterioration.

The purpose of this research was to evaluate the effect of some edible coating materials on extending shelf life and quality of cherry tomatoes fruits.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2019 and 2020 in Post-Harvest Laboratory in Horticulture Department, Faculty of Agriculture, Zagazig University, Egypt, to study the effect of dipping cherry tomatoes fruits in solutions of edible materials on fruits quality and storability. Cherry tomatoes were obtained from a Private Farm in the Salhia Al Gadida District, Sharkia Governorate, Egypt. The experimental design was factorial (7 coating materials treatments × 5 storage periods) in a complete randomized design, in three replicates and the coating materials treatments were the following:

1. Fruits dipped in distilled water (control).
2. Fruits dipped in chitosan nano particles at 0.5 %
3. Fruits dipped in chitosan nano particles at 1%
4. Fruits dipped in Arabic gum solution at 5%.
5. Fruits dipped in Arabic gum solution at 10%.
6. Fruits dipped in bottle gourd seed oil at 0.2 %
7. Fruits dipped in bottle gourd seed oil at 0.4 %.

Storage Periods

The fruits were chosen free from damage or defects, then washed in tap water and dried at room temperature. After that, treatments were carried out by dipping the fruits in solutions of Arabic gum, chitosan nanoparticles and bottle gourd seed oil, each separately with different concentrations. The fruits were then placed in white plastic containers of size (14 x 11 x 5 cm) each containing 10 fruits. Observations were sampled at intervals of every seven days up to 28 days (0, 7, 14, 21 and 28 days) to make some measurements on them. The fruits were stored at a temperature of 7 ± 2˚C and a relative humidity of 90 ± 3% in a cooler, and during the shelf life period (five days) the temperature was 20 ± 2˚C and the relative humidity was 60-70 ± 2˚ % (similarly as super market conditions).

The number of plastic containers required for this experiment were 2 plastic containers (cold storage and shelf life) x 3 replicate = 6 for each storing period x 5 storing periods = 30 x 7 treatments = 210 plastic containers.

To make the gum Arabic coating solutions, the powder was dissolved in 100 ml purified water, agitated for 60 minutes on a magnetic stirrer/hot plate (Model: HTS-1003), and then filtered to remove contaminants. When treating the fruits with bottle gourd seed oil, the fruits were dipped for five minutes, and then the fruits were cooled in the air.

Preparation of chitosan nano particles

This compound was prepared in Tanta University; Central Laboratory as follows: The powder for chitosan nanocrystals was made by grinding the powder for 40 hours at high power in a mill. The chitosan samples were then examined by X-ray diffraction using a Philips model diffractometer. The infrared spectra of the chitosan samples were then recorded using a PERKIN-ELMER-1430 in the range 200 to 4000 cm^{-1}.

Data Recorded

Weight loss percentage: The fruits were weighed before cold storage to obtain the initial weight and then weighed after each period of cold storage as well as after 5 days shelf life period. Weight loss (%) was calculated according to the following equation: Weight loss (%) = Initial fruit weight - fruit weight of sampling date ÷ Initial fruit weight × 100.

Fruit firmness: Fruit firmness of each individual cherry tomato fruits was measured at two points of the equatorial region by Push Pull dynamometer (Model FD101). The values were expressed as kg/cm^2.

Fruit decay percentage: It was determined as percentage of decayed fruits by using the following equation: Fruit decay (%) = number of decayed fruits ÷ Initial number of stored fruits × 100.

Total soluble solids (TSS): It was determined by measuring the refractive index of fruit juice by using a hand refractometer as Brix^o.

Juice total acidity: It was determined by titrating an aliquot of juice against 0.1N NaOH in presence of phenolphthalein dye as indicator, the results were calculated as grams of citric acid per 100 ml fruit juice (**AOAC, 2000**).

Ascorbic acid content (vitamin C): It was determined by titration in presence of 2,6 dichlorophenol-indophenol dye asindicator against 2% oxalic acid solution as substrate. Ascorbic acid was calculated as milligrams per 100 ml of juice (**Kabasakalis *et al*., 2000**).

Superficial color: color measurement (were, a: redness and b: yellowness.) with the help of (Tomato Meter) CloroflexEz, according to **Tabaestani *et al*. (2013).**

Statistical analysis

Statistical analysis was conducted for the collected data using the Statistic 9 (2008) according to (**Snedecor and Cochran, 1989**). Data subjected to the ANOVA and a factorial in a complete randomized design, was used (**Steel and Torrie, 1980**). Means were tested using LSD test ($P < 0.05$) to investigate the significant differences between coating materials treatments, weeks of storage and their interaction.

RESULTS AND DISCUSSION

Fresh weight loss percentage

During cold storage periods

Data in Table 1 show that fresh weight loss percentage of cherry tomato fruits significantly increased with prolonging storage periods up to 28 days of cold storage in both seasons. Concerning dipping treatments effect, dipping fruits in solution of chitosan nano particles (ChNPs) at 0.5 and 1% gave the highest values of weight loss percentage (0.31 and 0.30 % for ChNPs at 0.5 % and 0.31and 0.32 for ChNPs at 1%), whereas dipping in solution of bottle gourd seed oil at 0.4% gave the lowest values (0.15 and 0.16 %) in the 1st and 2nd seasons. As for the interaction effect, at 28 days of cold storage, dipping in 1%ChNPs solution recorded maximum weight loss percentage in both season (0.68 and 0.67%), whereas dipping in 0.4 % bottle gourd seed oil solution recorded minimum weight loss percentage (0.32 and 0.34%) in both seasons.

During shelf life periods

After 5 days of shelf life, fresh weight loss (%) increased with the advance cold storage periods up 28 days (6.18 and 6.42%) in both seasons (Table 1). Respecting the effect of dipping treatments, dipping in Arabic gum solution at 10% increased weight loss percentage, followed by Arabic gum at 5% and ChNPs at (0.5 and 1%), whereas dipping in 0.4 % bottle gourd seed oil solution decreased weight loss percentage (3.79 and 4.08 %) in both seasons after 5 days of shelf life. With respect to the interaction effect, dipping cherry tomatoes fruits in Arabic gum solution at 10% gave the highest values of weight loss percentage at 28 days of cold storage, whereas dipping in 0.4 % bottle gourd seed oil solution gave the lowest values of fresh weight loss at the same period. In general, the weight loss increases with the increase in the cold storage period and during the shelf life. The treatment of dipping the fruits with bottle gourd seed oil at 0.4% also gave the lowest values of weight loss, while the highest values in weight loss were recorded when the fruits were treated with (ChNPs) at 0.5 and 1% in the cold storage and gum Arabic solution at 10% in shelf life.

The weight loss during storage might be due to water loss by transpiration and some processes of oxidation, the substrate loss by respiration (**Ali *et al*., 2010; Juhaimi *et al*., 2012; Ngcobo *et al*., 2012; Wang *et al*., 2015;** and **Li *et al*., 2019**). In this respect, **Hassan *et al*. (2017), Kibar and Sabir (2018)** on tomato**, (Gharezi *et al*., 2012; Abdullah and Ibrahim, 2018; Mohammed *et al*., 2021;** and **Razali *et al*., 2021**) on cherry tomato, reported that, increasing storage period significantly increase weight loss percentage of fruits.

Also, based on previous results, immersion of the fruits in a solution of pumpkin seed oil led to a decrease in weight loss percentage, possibly due to the properties of bottle gourd seed oil, which contains antioxidants and antimicrobials, which reduce decay and thus reduce weight loss (**Ibeto *et al*., 2012; Warra *et al*., 2016; Magu *et al*., 2017;** and **Oji and Chinedu,2020**).In this respect, **Raafat *et al*.(2016)** found that, fruits treated with fenugreek, cinnamon, and thyme oils lost the least weight at the end of storage period when compared to control treatments.

Fruit decay percentage

During cold storage periods

Data in Table 2 illustrate that decay percentage increased with the advance of cold storage periods. All treatments did not show any decayed fruits until 14 days of cold storage in both seasons. Dipping cherry tomato fruits in ChNPs solution at 1% recorded the highest decayed fruits, whereas dipping in bottle gourd seed oil solution at 0.2 and 0.4 % did not show any decayed fruits in both seasons. Respecting the interaction treatments, dipping fruits in Arabic gum solution at 10% gave the highest decayed fruits followed by dipping in ChNPs solution at 1% at 28 days of cold storage periods.

During shelf life periods

All treatments did not show any decayed fruits until 14 days of cold storage and decay percentage increased at 21 and 28 days of storage. Dipping fruits in bottle gourd seed oil solution at 0.2 and 0.4% did not show any decayed fruits during period's cold storage periods after 5 days of shelf life. Respecting the interaction effect, dipping fruits in Arabic gum solution at 10% gave the highest decayed fruits followed by ChNPs solution at 1% at 28 days of cold storage in first season with no significant differences between them in the second season. In general, decay percentage increases with the increase in the cold storage period. Dipping in bottle gourd seed oil solution at o.2 and 0.4 % did not show any decayed fruits, while the highest values in decay were recorded when the fruits were treated with Arabic gum solution at 10% followed ChNPs solution at 1% in the cold storage and shelf life.

Perhaps the low rate of fruit infection by treatment with bottle gourd seed oil is due to its antioxidant and anti-fungal properties. In addition, the decay began slowly and progressed till the storage period came to an end. This could be owing to the fruits' continual chemical and biological changes throughout storage, this caused an increase of moisture condensation on the fruits' external surfaces and decreases in fruit firmness, as well as the transformation of complex materials into simpler materials, and thus it is infected with fungi quickly (**Trail *et al.*, 1992; Abdullah and Ibrahim**, **2018**).Also, **Hassan *et al.* (2017)** reported that, the percentage of fruit decay increased dramatically as the cold storage duration lengthened, the maximum percentage of fruit decay was found at 35 days.

Fruit firmness

During cold storage periods

Data in Table 3 indicate that firmness values of cherry tomato fruits decreased with advancing cold storage periods up to 28 days in both seasons. Respecting treatments, dipping fruits in bottle gourd seed oil solution at 0.4% gave the highest fruit firmness followed by Arabic gum solution at 10%in both seasons, whereas ChNPs solution at 1% gave the lowest values. As for the interaction effect, data show that dipping in bottle gourd seed oil solution at 0.4% recorded the maximum values of fruit firmness at 28 days of storage period in both seasons.

During shelf life periods

After 5 days of shelf life, fruit firmness decreased with increasing cold storage periods from zero time to 28 days of storage and the minimum values were observed at the end of storage in both seasons. Respecting the effect of treatments, the highest fruit firmness was noticed by dipping in bottle gourd seed oil solution at 0.4% after 5 days of shelf life. With respect to the interaction effect, at 28 days of cold storage, dipping in bottle gourd seed oil solution at 0.4% recorded maximum values of fruit firmness in both seasons. Generally, the results clarify that dipping fruits in bottle gourd seed oil solution at 0.4% gave the highest fruit firmness. While, firmness values were decreased with the advance in the cold storage and shelf life.

The firmness of the fruits reduces as the cold storage period lengthens due to tissue changes that cause the fruit to soften. These changes occur as a result of enzyme activity that alters the structure and composition of cell walls, causing protopectin to decompose into soluble pectin and hemicenllulose to decompose into pentose and cenllulose, resulting in partial or complete solubilization and depolymerization of cell-wall (**Mirdehghan *et al.*, 2007; Al-Juhaimi*et al.*, 2013;** and **Viet and Trang, 2015**). In this respect, (**Agbemafle *et al.*, 2014; Hassan *et al.*, 2017; Kondle *et al.*, 2019;** and **Mohammed *et al.*, 2021**) reported that, the firmness of fruits decreased as the duration of storage period increased.

On the other side, coated tomato respiration rates may be lowered, which may cause ripening to be delayed, and this aids in maintaining the storage stability of fruit firmness (**Al-Juhaimi *et al.*, 2013**). Also, **Ali *et al.* (2010)** found that, At the end of storage, there was a clear softening in control fruit compared to gum Arabic coated fruits. On the other hand, regarding the effectiveness of oils in maintaining the firmness of fruits, **Serrano *et al.* (2005)** found that, treating sweet cherry fruits with essential oils resulted in improved fruit firmness compare with control treatment. Moreover, essential oils coating fruits have been shown to greatly delay the softening of whole tomatoes during storage, according to some studies (**Tabaestani *et al.*, 2013)**. Also, **Raafat *et al.* (2016)** found that**,** the firmness of the fruits was preserved when treated with basil, cinnamon, fenugreek, mint, thyme and black seed.

Table 1. Effect of some edible coating materials on weight losses percentage of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	Weight losses (%)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	0.00	0.00	0.18	0.42	0.42	0.20	0.00	0.00	0.26	0.40	0.40	0.21
ChNPs at 0.5 %	0.00	0.08	0.47	0.46	0.55	0.31	0.00	0.02	0.57	0.44	0.48	0.30
ChNPs at 1%	0.00	0.06	0.46	0.37	0.68	0.31	0.00	0.02	0.50	0.43	0.67	0.32
Arabic gum at 5%.	0.00	0.06	0.30	0.40	0.48	0.25	0.00	0.10	0.38	0.33	0.58	0.28
Arabic gum at 10%.	0.00	0.00	0.31	0.42	0.43	0.23	0.00	0.00	0.30	0.31	0.63	0.25
Bottle gourd seed oil at 0.2 %	0.00	0.00	0.38	0.44	0.39	0.24	0.00	0.00	0.47	0.35	0.35	0.22
Bottle gourd seed oil at 0.4 %	0.00	0.00	0.18	0.27	0.32	0.15	0.00	0.00	0.18	0.29	0.34	0.16
S.P.(average)	0.00	0.03	0.33	0.40	0.46	-	0.00	0.02	0.36	0.38	0.49	-
LSD at 0.05 level		C.M. = 0.04		S.P. =0.03	C.M×S.P.= 0.09			C.M.= 0.02		S.P.=0.02	C.M×S.P.=0.06	
	5 days shelf life											
	2019 season						2020 season					
Control	1.94	4.25	4.38	5.77	5.78	4.42	2.23	4.48	4.53	5.96	5.70	4.58
ChNPs at 0.5 %	2.09	5.07	5.99	4.50	6.63	4.85	2.32	5.37	6.29	4.80	6.93	5.14
ChNPs at 1%	2.35	4.89	5.51	6.49	5.63	4.97	2.58	5.20	5.74	6.76	5.93	5.24
Arabic gum at 5%.	2.33	5.88	5.01	5.28	6.15	4.93	2.60	6.19	5.31	5.59	6.45	5.22
Arabic gum at 10%.	2.20	5.25	3.51	6.41	9.03	5.28	2.50	5.58	3.82	6.71	9.32	5.58
Bottle gourd seed oil at 0.2 %	1.74	4.30	4.69	4.72	6.18	4.33	2.03	4.60	4.99	4.98	6.47	4.61
Bottle gourd seed oil at 0.4 %	1.12	3.24	5.15	5.60	3.84	3.79	1.40	3.54	5.44	5.88	4.13	4.08
S.P.(average)	1.96	4.70	4.89	5.54	6.18	-	2.24	4.99	5.16	5.81	6.42	-
LSD at 0.05 level		C.M.= 0.40		S.P.= 0.34	C.M×S.P.=0.91			C.M.= 0.40		S.P.= 0.33	C.M×S.P.= 0.89	

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Table 2. Effect of some edible coating materials on fruit decay (%) of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	Fruit decay (%)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	0.00	0.00	0.00	0.00	3.33	0.66	0.00	0.00	0.00	0.00	3.33	0.66
ChNPs at 0.5 %	0.00	0.00	0.00	3.33	3.33	1.33	0.00	0.00	0.00	1.66	5.00	1.33
ChNPs at 1%	0.00	0.00	0.00	6.66	6.66	2.66	0.00	0.00	0.00	5.00	6.66	2.33
Arabic gum at 5%.	0.00	0.00	0.00	3.33	0.00	0.66	0.00	0.00	0.00	1.66	3.33	1.00
Arabic gum at 10%.	0.00	0.00	0.00	1.66	8.33	2.00	0.00	0.00	0.00	5.00	8.33	2.66
Bottle gourd seed oil at 0.2 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottle gourd seed oil at 0.4 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.P.(average)	0.00	0.00	0.00	2.14	3.09		0.00	0.00	0.00	1.90	3.80	
LSD at 0.05 level		C.M.= 1.01		S.P.= 0.85	C.M×S.P.= 2.26			C.M.= 0.85		S.P.=0.72	C.M×S.P.= 1.91	
	5 days shelf life											
	2019 season						2020 season					
Control	0.00	0.00	0.00	3.33	6.66	2.00	0.00	0.00	0.00	3.33	3.33	1.33
ChNPs at 0.5 %	0.00	0.00	0.00	3.33	3.33	1.33	0.00	0.00	0.00	3.33	5.00	1.66
ChNPs at 1%	0.00	0.00	0.00	6.66	6.66	2.66	0.00	0.00	0.00	6.66	8.33	3.00
Arabic gum at 5%.	0.00	0.00	0.00	3.33	3.33	1.33	0.00	0.00	0.00	3.33	3.33	1.33
Arabic gum at 10%.	0.00	0.00	0.00	6.66	10.00	3.33	0.00	0.00	0.00	5.00	8.33	2.66
Bottle gourd seed oil at 0.2 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottle gourd seed oil at 0.4 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.P.(average)	0.00	0.00	0.00	3.33	4.28		0.00	0.00	0.00	3.09	4.04	
LSD at 0.05 level		C.M.= 1.07		S.P.= 0.90	C.M×S.P.= 2.39			C.M.= 1.00		S.P.= 0.84	C.M×S.P.= 2.24	

ChNPs = chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Table 3. Effect of some edible coating materials on fruit firmness (g/cm^2) of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	fruit firmness (g/cm^2)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	580.00	574.00	556.67	513.33	490.33	542.87	588.00	580.00	546.67	540.33	473.33	545.67
ChNPs at 0.5 %	596.67	550.00	543.33	556.67	455.33	540.40	586 67	530.00	516.67	480.33	446.67	512.07
ChNPs at 1%	596.67	593.33	500.67	493.33	443.33	525.47	530.00	520.67	503.33	486.67	341.00	476.33
Arabic gum at 5%.	686.67	566.67	520.00	470.00	463.33	541.33	670.00	553.33	503.33	483.33	453.33	532.67
Arabic gum at 10%.	653.33	706.67	576.67	526.67	453.33	583.33	683.33	640.33	563.33	513.33	393.33	558 73
Bottle gourd seed oil at 0.2 %	596.67	663.33	533.33	493.33	481.67	553.67	580.00	543.33	520.00	483.33	486.67	522.67
Bottle gourd seed oil at 0.4 %	673.33	590.00	596.67	580.00	553.33	598.67	640.00	583.33	576.67	570.00	563.33	586.67
S.P.(average)	626.19	606.29	546.76	519.05	477.24	-	611.14	564.43	532.86	508.19	451.10	-
LSD at 0.05 level		C.M.= 45.58	S.P.= 38.52		C.M×S.P.= 101.92			C.M.= 38.78	S.P.= 32.77		C.M×S.P.= 86.71	
	5 days shelf life											
	2019 season						2020 season					
Control	500.33	496.67	490.00	466.67	433.33	477.40	530.00	510.00	506.67	496.67	415.00	491.67
ChNPs at 0.5 %	523.33	503.33	500.33	450.00	383.33	472.07	506.67	493.33	456.67	420.67	398.33	455.13
ChNPs at 1%	550.33	520.33	410.33	387.67	355.33	444.80	493.33	480.33	433.33	416.67	310.33	426.80
Arabic gum at 5%.	583.33	530.33	480.00	436.67	410.00	488.07	610.67	506.67	453.33	420.33	416.67	481.53
Arabic gum at 10%.	550.00	546.67	476.67	416.67	376.67	473.33	541.67	520.33	486.67	413.33	320.33	456.47
Bottle gourd seed oil at 0.2 %	543.33	530.00	520.00	443.33	424.67	492.27	510.00	480.33	473.33	443.33	416.67	464.73
Bottle gourd seed oil at 0.4 %	606.67	550.00	540.00	506.67	490.00	538.67	553.33	520.00	510.00	783.33	475.00	508.33
S.P.(average)	551.05	525.33	488.19	443.95	410.48	-	535.10	501.57	474.29	442.05	393.19	-
LSD at 0.05 level		C.M.= 37.35	S.P.= 31.57		C.M×S.P.= 83.52			C.M.=31.04	S.P.= 26.23		C.M×S.P.= 69.41	

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Total Soluble Solids (TSS Brix^{o})

During cold storage periods

The obtained data in Table 4 indicate that TSS content in cherry tomato fruits significantly increased with prolonging cold storage period up to 28 days, with no significant differences among 14,21 and 28 days of cold storage in both seasons. As for dipping treatments, there was no significant difference between most of the treatments, but the bottle gourd seed oil treatment recorded high values of TSS in fruits. Respecting the interaction effect, at 28 days of storage, dipping fruits in bottle gourd seed oil solution at 0.2 and 0.4 % increased TSS in fruits in both seasons compared to the other treatments.

During shelf life periods

TSS in fruits increased with increasing cold storage period from zero time to 28 days in both seasons. As for dipping treatments and interaction effect, dipping in 0.4% bottle gourd seed oil solution recorded maximum values of TSS during shelf life period and after 5 days of shelf life in both seasons. The total soluble solids increased throughout ripening due to degradation of polysaccharides to simple sugars thereby causing their rise (**Gharezi *et al*., 2012; Das *et al*., 2013;** and **Charles *et al*., 2016).** Similar results were obtained by (**Viet and Trang,2015; Hassan *et al*., 2017; Ruelas-Chacon *et al*., 2017;** and **Mohammed *et al*., 2021)** where they found that, TSS during cold storage was gradually increased as the cold storage period progressed. On the other hand, **Al-Juhaimi *et al*. (2013)** reported that, fruit that had been coated with 20% gum Arabic recorded the lowest TSS at the end of the storage period.

Titratable acidity

During cold storage periods

It is clear from the results in Table 5 that there were a considerable and continues decrease intitratable acidity as they cold storage period was extended from 0 to 28 days. The minimum values of titratable acidity were occurred at the end of cold storage period and it recorded to 0.33 and 0.30 (mg/100 ml juice) in the 1st and 2nd seasons, respectively. Respecting dipping treatments, the data show that dipping cherry tomato fruits in ChNPs solution at 1% gave the highest values of titratable acidity. As for the effect of the interaction between edible coating materials and cold storage period, data in Table 5 show that the minimum values of titratable acidity at the end of cold storage period (28 days) were noticed by the fruits which dipped with bottle gourd seed oil solution at 0.2% (0.22 and 0.20mg/100 ml juice) in both seasons. Whereas dipping in Arabic gum solution at 10% gave the maximum values of titratable acidity in both seasons (0.42 and 0.44 mg/100 ml juice).

During shelf life periods

After 5 days of shelf life, data in Table 5 indicate that titratable acidity decreased with increasing cold storage period from zero to 28 days in both seasons. Respecting effect of edible materials, data show that dipping cherry tomato fruits in Arabic gum at 10% increased titratable acidity in fruits, whereas dipping in ChNPs solution at 1% decreased titratable acidity with no significant differences with control in first season, with no significant differences with control and bottle gourd seed oil solution at 0.4% in second season. Respecting the interaction effect, at the end of storage period dipping fruits in ChNPs at 1% gave the lowest values of titratable acidity. Increased activity of citric acid glyoxylase during ripening may contribute to the conversion of acids to sugars, resulting in a decrease in acidity during storage periods (**Rathore *et al*., 2007** and **Ali *et al*., 2013**). Also, the fruit itself may use the acid during storage, resulting in lower acid levels in the fruits throughout storage (**Bhatnagar *et al*., 2006**). In this respect, **Mohammed *et al*. (2021)** found that, the lowest levels of titratable acidity were recorded at the end of storage period. The same outcomes were reached by (**Gharezi *et al*., 2012; Abdullah and Ibrahim, 2018;** and **Kondle *et al*., 2019**).

On the other hand, **Al-Juhaimi *et al*. (2013)** found that, the increase in acidity of the titration was directly proportionate to the concentration of gum arabic because the gum coating provides a semi-permeable membrane enclosing the fruit. Also, **Kibar and Sabir (2018)** and **Razali *et al*. (2021)** reported that, chitosan-coated tomatoes had higher titratable acidity at the end of storage.

Ascorbic acid (vitamin C) content

During cold storage periods

The obtained results in Table 6 illustrate that there were a significant reduction in vitamin C content in cherry tomato fruits with the increase a cold storage period from zero time to 28 days and the minimum values of vitamin C content were occurred at the end of storage (28 days), and it reached to 18.12 and 17.82 mg/100 ml juice in the 1st and 2nd seasons, respectively. Respecting the effect of edible coating, data in Table 6 show that dipping in bottle gourd seed oil solution at 0.4% was the superior treatments in reducing the loss of vitamin C followed by bottle gourd seed oil solution at 0.2% and CHNPs solution at 0.5% in both seasons. Concerning the interaction effect, the same results showed, 28 days of cold storage, the maximum values of vitamin C were noticed by the fruits dipped in bottle gourd seed oil solution at 0.4% in both seasons (21.88 and 22.01mg/100 ml juice).

Table 4. Effect of some edible coating materials on total soluble solids of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	TSS (Brix°)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	6.62	6.70	7.00	7.33	7.70	7.07	6.50	6.39	6.62	7.33	7.40	6.85
ChNPs at 0.5 %	6.21	6.86	6.91	7.33	7.63	6.99	5.83	6.56	6.45	7.00	7.16	6.60
ChNPs at 1%	6.29	6.53	7.00	7.00	5.80	6.55	6.33	6.23	6.45	6.83	5.66	6.30
Arabic gum at 5%.	5.8	6.03	6.33	6.60	7.10	6.37	6.00	6.39	5.95	5.83	7.10	6.25
Arabic gum at 10%.	6.29	6.70	7.33	7.00	6.46	6.75	6.33	6.73	6.78	6.66	6.50	6.60
Bottle gourd seed oil at 0.2 %	5.64	7.03	7.33	7.33	7.80	7.02	6.00	6.99	7.40	7.33	7.52	7.04
Bottle gourd seed oil at 0.4 %	5.96	6.72	7.33	7.40	7.89	7.06	6.16	7.06	7.12	7.33	7.60	7.05
S.P.(average)	6.14	6.65	7.03	7.14	7.19	-	6.16	6.62	6.68	6.90	6.99	-
LSD at 0.05 level		C.M.= 0.38	S.P.= 0.32	C.M×S.P.= 0.86				C.M.= 0.35	S.P.= 0.29	C.M×S.P.= 0.78		
	5 days shelf life											
	2019 season						2020 season					
Control	6.66	7.00	7.33	7.16	7.33	7.10	7.00	6.83	7.16	7.50	7.66	7.23
ChNPs at 0.5 %	6.33	7.00	6.33	7.33	7.66	6.93	5.66	7.00	6.16	7.50	7.33	6.73
ChNPs at 1%	6.36	7.00	7.00	7.66	7.50	7.10	6.16	7.00	7.00	7.50	7.66	7.06
Arabic gum at 5%.	6.50	7.00	6.83	7.00	7.50	6.96	6.00	7.33	6.83	7.50	7.00	6.93
Arabic gum at 10%.	6.66	6.66	7.33	7.50	7.50	7.13	6.66	6.33	7.33	7.50	7.83	7.13
Bottle gourd seed oil at 0.2 %	6.00	5.66	6.66	7.66	7.83	6.76	6.50	6.33	6.66	7.66	8.00	7.03
Bottle gourd seed oil at 0.4 %	6.66	6.66	7.50	7.83	8.00	7.33	6.66	7.00	7.00	7.66	8.33	7.33
S.P.(average)	6.45	6.71	7.00	7.45	7.61	-	6.38	6.83	6.88	7.54	7.69	-
LSD at 0.05 level		C.M.= 0.29	S.P.= 0.25	C.M×S.P.= 0.67				C.M.= 0.30	S.P.= 0.260	C.M×S.P.= 0.687		

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Table 5. Effect of some edible coating materials on acidity of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	Acidity (g citric acid /100 ml juice)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	0.51	0.45	0.41	0.40	0.38	0.43	0.50	0.44	0.39	0.39	0.35	0.41
ChNPs at 0.5 %	0.63	0.57	0.55	0.49	0.33	0.51	0.63	0.53	0.47	0.51	0.35	0.49
ChNPs at 1%	0.63	0.62	0.60	0.59	0.29	0.54	0.63	0.64	0.63	0.57	0.27	0.55
Arabic gum at 5%.	0.48	0.47	0.45	0.41	0.30	0.42	0.55	0.52	0.49	0.39	0.23	0.43
Arabic gum at 10%.	0.54	0.52	0.50	0.45	0.42	0.48	0.51	0.49	0.48	0.47	0.44	0.48
Bottle gourd seed oil at 0.2 %	0.58	0.56	0.52	0.46	0.22	0.47	0.56	0.44	0.52	0.47	0.20	0.44
Bottle gourd seed oil at 0.4 %	0.52	0.50	0.47	0.46	0.35	0.46	0.52	0.50	0.49	0.44	0.31	0.45
S.P.(average)	0.55	0.53	0.50	0.46	0.33	-	0.55	0.51	0.50	0.46	0.30	-
LSD at 0.05 level		C.M.= 0.02		S.P.= 0.02		C.M×S.P.= 0.05		C.M.= 0.02		S.P.= 0.02		C.M×S.P.= 0.05
	5 days shelf life											
	2019 season						2020 season					
Control	0.32	0.40	0.28	0.27	0.25	0.30	0.31	0.52	0.29	0.24	0.33	0.34
ChNPs at 0.5 %	0.53	0.47	0.50	0.35	0.35	0.42	0.53	0.45	0.50	0.35	0.27	0.42
ChNPs at 1%	0.32	0.33	0.26	0.54	0.21	0.33	0.32	0.29	0.27	0.51	0.23	0.32
Arabic gum at 5%.	0.55	0.38	0.52	0.43	0.25	0.42	0.55	0.35	0.54	0.38	0.28	0.42
Arabic gum at 10%.	0.55	0.52	0.53	0.38	0.41	0.48	0.58	0.54	0.52	0.35	0.44	0.48
Bottle gourd seed oil at 0.2 %	0.51	0.47	0.46	0.34	0.38	0.43	0.54	0.45	0.48	0.36	0.34	0.43
Bottle gourd seed oil at 0.4 %	0.42	0.52	0.42	0.31	0.28	0.39	0.31	0.50	0.29	0.30	0.27	0.33
S.P.(average)	0.46	0.44	0.42	0.37	0.29	-	0.45	0.44	0.41	0.36	0.31	-
LSD at 0.05 level		C.M.= 0.04		S.P.= 0.03		C.M×S.P.= 0.09		C.M.= 0.02		S.P.= 0.02		C.M×S.P.= 0.06

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Table 6. Effect of some edible coating materials on vitamin C content of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	Vitamin C content (mg/100 ml juice)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	20.07	19.10	19.46	14.69	20.87	18.84	19.92	18.26	19.87	21.13	13.65	18.57
ChNPs at 0.5 %	21.07	20.18	20.17	19.33	19.43	20.03	20.95	20.66	20.29	20.29	18.57	20.15
ChNPs at 1%	21.58	20.22	20.03	15.86	11.86	17.91	21.41	19.28	20.08	14.71	12.99	17.69
Arabic gum at 5%.	19.74	20.67	19.27	17.89	18.57	19.23	19.73	19.61	19.22	19.48	17.69	19.15
Arabic gum at 10%.	19.63	20.93	20.00	19.57	13.93	18.81	19.75	20.70	20.78	16.55	18.70	19.29
Bottle gourd seed oil at 0.2 %	20.82	20.33	20.58	20.32	20.29	20.47	20.60	20.15	19.22	20.93	21.12	20.40
Bottle gourd seed oil at 0.4 %	20.97	20.96	19.41	21.91	21.88	21.03	20.63	21.30	19.65	21.13	22.01	20.94
S.P.(average)	20.55	20.34	19.84	18.51	18.12	-	20.42	19.99	19.87	19.17	17.82	-
LSD at 0.05 level		C.M.= 0.53	S.P.= 0.45		C.M×S.P.=1.19			C.M.= 0.65	S.P.= 0.55		C.M×S.P.=1.46	
	5 days shelf life											
	2019 season						2020 season					
Control	19.89	18.36	14.05	14.51	13.72	16.10	22.37	20.13	15.76	14.66	13.90	17.36
ChNPs at 0.5 %	19.66	18.55	16.83	16.94	16.21	17.64	19.29	19.66	17.54	16.28	16.00	17.75
ChNPs at 1%	20.25	12.52	17.86	10.23	9.47	14.06	20.71	14.48	16.53	10.67	9.60	14.40
Arabic gum at 5%.	18.51	18.29	18.18	21.60	21.27	19.57	19.29	18.40	17.16	20.40	20.23	19.09
Arabic gum at 10%.	19.08	19.17	18.05	14.27	13.47	16.81	19.51	20.54	19.34	14.02	13.42	17.36
Bottle gourd seed oil at 0.2 %	18.50	17.83	18.24	20.00	19.70	18.85	18.62	15.88	19.35	20.18	19.89	18.78
Bottle gourd seed oil at 0.4 %	17.25	21.86	23.16	18.53	17.66	19.69	17.43	23.49	24.21	17.80	17.70	20.12
S.P.(average)	19.02	18.08	18.05	16.58	15.93	-	19.60	18.94	18.55	16.29	15.82	-
LSD at 0.05 level		C.M.= 0.86	S.P.= 0.73		C.M×S.P.=1.93			C.M.= 0.74	S.P.= 0.62		C.M×S.P.=1.65	

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

During shelf life periods

Data in Table 6 indicate that vitamin C content in cherry tomato fruits decreased with prolonging cold storage period from zero time to 28 days in both seasons and the minimum values was at the end of storage (15.93 and 15.82mg/100 ml juice) in both seasons. With respect to the effect of dipping treatments, dipping in bottle gourd seed oil solution at 0.4% and Arabic gum solution at 5% gave the highest values of vitamin C after 5 days of shelf life in both seasons. Concerning of the interaction, the same data show that, the end of storage (at 28 days), the maximum values of vitamin C were noticed by the fruits which dipped in Arabic gum solution at 5% in both seasons (21.27 and 20.23mg/100 ml juice). The faster rate of sugar loss through respiration than water loss through transpiration may have contributed to the decrease in ascorbic acid level during storage (**Paradis *et al.*, 1995**). These results agree with **(Hassan *et al.*, 2017; Abdullah and Ibrahim, 2018; Kibar and Sabir, 2018;** and **Mohammed *et al.*, 2021**) who found that, vitamin C values decrease with storage. On the other side, due to the antioxidant protection provided by essential oils, essential oils coating cherry tomato fruits may help to prevent vitamin C loss **(Xing *et al.*, 2011** and **Kumarrai *et al.*, 2012**) Also, **Raafat *et al.* (2016)** found that, treating the fruits with thyme oil increased their vitamin C content. In addition, the changes in ascorbic acid content of sweet cherry fruits (**Petriccione *et al.*, 2015**) and strawberries (**Gol *et al.*, 2013)** were delayed by chitosan coating at 0.5%.

Fruit red color value a*

During cold storage periods

Data in Table 7 indicate that red color value a*increased with prolonging cold storage period from zero time to 28 days in both seasons. As for dipping treatments and the interaction effect, at the end of storage (28 days), dipping cherry tomato fruits in bottle gourd seed solution at 0.2 and 0.4% and ChNPs solution at 1% recorded the highest red color a*value.

During shelf life periods

After 5 days of shelf life, the lowest values of color a* were recorded at the beginning of cold storage, where the highest values were recorded at the end of cold storage (28 days) in both seasons. As for the effect of treatments and the interaction, at the end of storage (28 days), the highest values of the color a* were noticed by fruits which dipped in bottle gourd seed solution at 0.2 and 0.4% in both seasons. The ripening process causes tomatoes to change color during storage, as chlorophyll decomposes with water, the color ripens, and carotenoids pigments are created (**Liu *et al.*, 2009** and **Fagundes *et al.*, 2015**). Also, fruit's color changes are linked to the rate at which it respiration (**Viet and Trang, 2015**). In this respect, **Gharezi *et al.* (2012**) found that, during storage, the color values increase significantly. In addition, coating fruits with 20% gum resulted in a slower rate of color index increase (**Al-Juhaimi *et al.*, 2013**). Moreover, the essential oil treatments improved the fruits color values compared to untreated one (**Raafat *et al.*, 2016**).

Fruit yellow color value b*

During cold storage periods

The obtained results in Table 8 indicate that, yellow color b*value declined with the prolonging of cold storage period in both seasons, where the minimum values were occurred at the end of storage period (28 days). With respect to treatments, results show that cherry tomato fruits dipped in ChNPs solution at 1% gave the best yellow color b*value in both seasons, with no significant differences among treatments. Respecting the interaction effect, the minimum values of the color b*at the end of storage period (28 days) were noticed by the fruits which dipped in Arabic gum solution at 5% in both seasons, whereas the maximum values were noticed by the fruits which dipped in ChNPs solution at 1 %.

During shelf life periods

After 5 days of shelf life, yellow color b*value decreased with increasing cold storage period from zero time to 28 days and the minimum values were obtained at the end storage period (Table 8). Respecting the effect of dipping in some solution, the obtained results show that there were no significant among dipping treatments in some edible materials in both seasons after 5 days of shelf life period. Respecting the interaction treatments, for all treatments the color value b*decreased in fruits with prolonging cold storage period and the lowest values were observed when fruits were dipped in 5% gum Arabic solution in both seasons. Decomposition of chlorophyll and carotenoid pigments could cause a decrease in b*value (**Weemaes *et al.*, 1999**). In this respect, b*value was significantly lower in coated fruits in compared to control (**Al-Juhaimi *et al.*, 2013**). In addition, treating the fruits with tomato wax led to a decrease in b*value, and an increase in a*value (**Dilmaçünal *et al.*, 2011**).

Fruit red color value a*/b*

During cold storage periods

The obtained results in Table 9 indicate that, a*/b*ratio increased with prolonging cold storage period from zero time to 28 days and the maximum values were noticed at 28 days of storage in both seasons. Respecting treatments, data show that dipping cherry tomato fruits in bottle gourd seed oil solution at 0.2 and 0.4% gave the highest values of a*/b*ratio in both seasons. With respect to the interaction effect, data show that the maximum values of a*/b*ratio were obtained by fruits dipped in Arabic gum solution at 5% at 28 days of storage with no significant difference between it and the control in the second season.

Table 7. Effect of some edible coating materials on Color (a*) of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons.

Treatments	Color (a*)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	7.52	12.34	11.22	8.64	11.98	10.34	7.56	12.25	11.49	9.06	12.29	10.53
ChNPs at 0.5 %	10.29	10.21	12.03	9.90	11.61	10.81	10.56	10.44	12.16	10.19	12.01	11.07
ChNPs at 1%	11.82	11.36	10.42	11.80	13.36	11.75	11.51	11.36	10.49	11.96	13.42	11.75
Arabic gum at 5%.	9.56	9.81	11.04	11.53	11.49	10.68	9.52	9.93	11.24	11.80	11.78	10.85
Arabic gum at 10%.	10.16	9.19	10.89	12.73	12.74	11.14	10.31	9.54	11.00	12.93	13.14	11.38
Bottle gourd seed oil at 0.2 %	12.51	11.04	11.98	11.85	13.15	12.11	12.16	11.06	12.12	11.93	13.39	12.13
Bottle gourd seed oil at 0.4 %	11.78	12.11	12.06	12.35	13.10	12.28	11.94	12.10	12.31	12.03	13.32	12.34
S.P.(average)	10.52	10.86	11.38	11.26	12.49	-	10.51	10.95	11.41	11.54	12.76	-
LSD at 0.05 level		C.M.= 0.75	S.P.= 0.63	C.M×S.P.=1.67				C.M.= 0.72	S.P.= 0.61	C.M×S.P.=1.63		
	5 days shelf life											
	2019 season						2020 season					
Control	11.26	13.29	12.46	12.40	12.80	12.44	11.85	12.86	12.78	12.50	12.73	12.54
ChNPs at 0.5 %	10.16	10.70	12.56	11.90	12.03	11.47	10.95	10.45	12.16	13.11	12.39	11.81
ChNPs at 1%	11.64	11.63	11.10	12.43	13.52	12.06	10.68	11.54	10.81	12.31	13.63	11.79
Arabic gum at 5%.	11.47	10.66	11.45	12.37	12.51	11.69	11.23	10.68	11.47	12.29	12.03	11.54
Arabic gum at 10%.	10.76	10.42	11.52	13.40	13.20	11.86	10.23	11.36	11.74	13.23	13.18	11.95
Bottle gourd seed oil at 0.2 %	12.58	11.33	12.30	12.53	13.55	12.46	11.51	11.98	13.20	13.70	15.23	13.12
Bottle gourd seed oil at 0.4 %	12.20	12.56	12.66	12.37	13.82	12.72	12.08	12.68	13.42	12.21	16.09	13.29
S.P.(average)	11.44	11.51	12.01	12.48	13.06	-	11.22	11.65	12.23	12.76	13.61	-
LSD at 0.05 level		C.M.= 0.69	S.P.= 0.58	C.M×S.P.=1.54				C.M.= 0.75	S.P.= 0.64	C.M×S.P.= 1.69		

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Table 8. Effect of some edible coating materials on Color (b*) of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	Color (b*)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	11.87	7.95	9.02	7.80	7.75	8.88	9.47	8.65	9.32	8.21	7.41	8.61
ChNPs at 0.5 %	11.38	9.28	8.13	8.52	8.37	9.13	10.35	8.53	8.30	8.53	8.25	8.79
ChNPs at 1%	9.99	9.85	9.17	9.38	9.24	9.52	9.65	9.19	9.36	9.08	9.05	9.26
Arabic gum at 5%.	10.44	8.61	8.17	8.70	6.64	8.51	10.53	9.62	8.42	8.09	7.10	8.75
Arabic gum at 10%.	9.39	10.15	8.62	9.30	8.39	9.17	9.41	9.64	8.24	8.10	8.35	8.75
Bottle gourd seed oil at 0.2 %	9.70	8.35	9.46	7.91	8.69	8.82	9.72	8.48	8.85	8.07	8.30	8.68
Bottle gourd seed oil at 0.4 %	9.48	9.28	8.76	8.22	8.13	8.77	9.29	8.80	8.23	8.21	8.43	8.59
S.P.(average)	10.32	9.06	8.76	8.55	8.17	-	9.77	8.98	8.67	8.33	8.12	-
LSD at 0.05 level		C.M.= 0.66		S.P.= 0.55	C.M×S.P.=1.47			C.M.= 0.29		S.P.= 0.25	C.M×S.P.= 0.66	
	5 days shelf life											
	2019 season						2020 season					
Control	10.33	8.08	7.64	7.55	7.36	8.20	9.37	8.21	8.71	7.95	7.17	8.28
ChNPs at 0.5 %	10.90	8.52	8.64	7.75	7.34	8.63	9.40	8.38	8.12	7.95	8.03	8.37
ChNPs at 1%	9.26	8.29	8.01	7.74	7.36	8.13	8.70	8.28	8.72	7.76	7.54	8.20
Arabic gum at 5%.	9.00	8.21	7.97	7.43	6.66	7.85	9.29	9.12	8.17	8.03	6.79	8.28
Arabic gum at 10%.	8.90	8.00	8.37	7.83	7.46	8.11	9.01	9.10	8.14	7.50	7.69	8.29
Bottle gourd seed oil at 0.2 %	9.30	8.97	8.11	7.47	7.61	8.29	9.30	8.15	8.32	7.75	7.49	8.20
Bottle gourd seed oil at 0.4 %	9.14	8.19	8.28	7.39	7.38	8.07	8.79	8.17	8.08	7.70	7.09	7.96
S.P.(average)	9.55	8.32	8.14	7.59	7.31	-	9.12	8.49	8.32	7.80	7.40	-
LSD at 0.05 level		C.M.= 0.46		S.P.= 0.39	C.M×S.P.=1.03			C.M.= 0.32		S.P.= 0.27	C.M×S.P.= 0.72	

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

Table 9. Effect of some edible coating materials on Color value (a*/b*) of cherry tomato fruits during cold storage and shelf life periods in 2019 and 2020 seasons

Treatments	Color value (a*/b*)											
	Cold storage periods (days)					C.M. (average)	Cold storage periods (days)					C.M. (average)
	0	7	14	21	28		0	7	14	21	28	
	2019 season						2020 season					
Control	0.65	1.56	1.24	1.10	1.54	1.22	0.80	1.41	1.23	1.10	1.66	1.24
ChNPs at 0.5 %	0.93	1.10	1.48	1.17	1.38	1.21	1.02	1.22	1.46	1.20	1.45	1.27
ChNPs at 1%	1.18	1.15	1.13	1.25	1.44	1.23	1.19	1.23	1.12	1.31	1.48	1.26
Arabic gum at 5%.	0.91	1.14	1.37	1.33	1.78	1.31	0.90	1.03	1.33	1.45	1.66	1.27
Arabic gum at 10%.	1.08	0.95	1.25	1.37	1.52	1.24	1.09	0.99	1.33	1.62	1.57	1.32
Bottle gourd seed oil at 0.2 %	1.29	1.32	1.26	1.49	1.51	1.37	1.25	1.30	1.38	1.47	1.61	1.40
Bottle gourd seed oil at 0.4 %	1.24	1.31	1.39	1.50	1.61	1.41	1.28	1.37	1.49	1.46	1.59	1.44
S.P.(average)	1.04	1.22	1.30	1.32	1.54	-	1.07	1.22	1.33	1.37	1.57	-
LSD at 0.05 level		C.M.= 0.12	S.P.= 0.10	C.M×S.P.= 0.28				C.M.= 0.10	S.P.= 0.08	C.M×S.P.= 0.22		
	5 days shelf life											
	2019 season						2020 season					
Control	1.09	1.64	1.64	1.64	1.73	1.55	1.27	1.56	1.46	1.57	1.77	1.53
ChNPs at 0.5 %	0.96	1.25	1.46	1.55	1.63	1.37	1.16	1.24	1.50	1.64	1.54	1.42
ChNPs at 1%	1.26	1.40	1.38	1.64	1.83	1.50	1.22	1.39	1.24	1.59	1.80	1.45
Arabic gum at 5%.	1.27	1.30	1.43	1.66	1.88	1.51	1.20	1.17	1.40	1.53	1.78	1.41
Arabic gum at 10%.	1.20	1.30	1.37	1.71	1.78	1.47	1.13	1.24	1.44	1.79	1.71	1.46
Bottle gourd seed oil at 0.2 %	1.36	1.26	1.51	1.68	1.77	1.52	1.23	1.46	1.59	1.77	2.04	1.62
Bottle gourd seed oil at 0.4 %	1.33	1.54	1.53	1.67	1.87	1.59	1.37	1.55	1.66	1.58	2.27	1.69
S.P.(average)	1.21	1.38	1.47	1.65	1.79	-	1.23	1.37	1.47	1.64	1.84	-
LSD at 0.05 level		C.M.= 0.11	S.P.= 0.09	C.M×S.P.= 0.26				C.M.= 0.11	S.P.= 0.09	C.M×S.P.= 0.25		

ChNPs= chitosan nano particles, C.M. = Coating materials, S.P. = Storage periods (days).

During shelf life periods

The data in Table 9 show that, after 5 days of shelf life, a^*/b^*ratio increased with increasing cold storage period up to 28 days and the maximum values were noticed at the end of storage in both seasons. For all treatments, there was no significant difference among dipping treatments in some edible coating after 5 days of shelf life. Also, for all interaction treatments, a^*/b^*ratio increased with prolonging cold storage period after 5 days of shelf life in both seasons. **Saad, *et al.* (2016)** reported that, the a^*/b^*ratio is used as an indicator of color development in tomatoes, also it was found that, the color a^*/b^* increased by a higher percentage than the red color. Also, **Hassan *et al.* (2017)** found that, a^*/b^* color value was increased with advancing cold storage period.

Conclusion: From the foregoing results, it could be concluded that dipping cherry tomatoes fruits in solution of bottle gourd seed oil at 0.4% and storage at 7±2°C and 90 ± 3% relative humidity for 28 days gave the highest fruit firmness, vitamin C and the lowest values of weight loss percentage, Also, dipping in bottle gourd seed oil solution at 0.2 and 0.4 % did not show any decayed fruits and gave the highest values of a^*/b^*ratio, in addition, it is increased TSS in fruits at 28 days of storage.

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RESEARCH ARTICLE

Effect of Some Edible Coating Materials On Quality and Storability of Cherry Tomato Fruits During Cold Storage and Shelf Life Periods

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