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Effect of Hydrophobic Coating on the Quality of Bell Pepper during Storage

SONAL SHUKLA AND DASHRATH BHATI*

Department of Horticulture, School of Agriculture, ITM University, Gwalior, Gwalior-474 001 (Madhya Pradesh), India
**(e-mail: bhati.dashrath.1@gmail.com; Mobile: 97847 39334)*

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ABSTRACT

India is the second largest producer of bell pepper (*Capsicum annuum* L.). The post-harvest losses of bell peppers led to a reduction in the quality and appearance, thereby resulting in a reduction in marketability and economic losses. The present study was planned to assess the impact of hydrophobic coatings on the quality parameters of bell peppers. Unconventional oils viz., neem, mint and tulsi oils were utilized for coating along with chlorophyll content extracted from carrot leaves. All the selected oils were used in different concentrations i.e. 10, 25 and 50% along with 5% and without carrot leaf extract (CLE). All the treatments were assessed for physical, chemical and sensory attributes of bell peppers during a 16-day storage period. It was found that neem oil 50% (T_3N_{50}) had the highest firmness (2.87 kg/cm^2), less weight loss and the least per cent decay (31.04%) at the 16th day of storage. This treatment had the highest total soluble solids (3.45 B^o), ascorbic acid (101.00 mg/100 g), chlorophyll a (3.94 mg/g), chlorophyll b (1.03 mg/g) and total chlorophyll content (5.38 mg/g) as compared with control. Therefore, neem oil 50% can be used as a coating of bell pepper.

Key words: Oil-based coating, organoleptic parameters, capsicum, shelf-life

INTRODUCTION

Bell pepper (*Capsicum annuum* L.), a member of the Solanaceae family, is the second most consumed vegetable in the world, with notable agro-economic importance worldwide (Zhu *et al.*, 2018). These are part of an overall healthy diet because of their high nutritional and antioxidant values (Sousa *et al*., 2016). West Bengal, Karnataka, Haryana, Jharkhand, Himachal Pradesh and Madhya Pradesh are major bell pepper producing states in India (NHB, 2022).

Maturing and ripening is a highly complex physiological process and governed by various factors, which involve coordinated regulation of gene expression at the epigenetic, transcriptional, post-transcriptional and protein levels. Bell pepper produces non-climacteric fleshy fruit in which ripening and senescence are characterized by important visual and metabolic changes, with colour change caused by chlorophyll degradation and biosynthesis of new pigments (flavonoids and carotenoids) being the most obvious. The natural modifications of chlorophyll content and fruit pigments during bell pepper ripening are regulated by transcription factors. Over the past 10 years, biochemical data have also indicated that the bell pepper fruit ripening process is influenced by the metabolism of reactive oxygen species (ROS) and nitrogen oxygen species (NOS) which reflects the profound biochemical and molecular changes taking place during ripening (Corpas *et al.*, 2018). Among the many alterations that take place during the ripening of bell pepper fruit are physiological changes in colour, flavour, aroma and texture and these are under the regulation of both external and internal factors.

Bell peppers, known for their vibrant colours crisp texture and high levels of vitamins A and C, antioxidants and dietary fiber, are highly perishable and subject to rapid post-harvest deterioration due to moisture loss, microbial contamination and physiological decay, leading to significant losses and reduced marketability. Presently different studies have been conducted on the packaging and coating for horticultural produce to extend shelf-life and post-harvest quality (Kumar *et al.*, 2023; Omveer *et al.*, 2023; Verma *et al.*, 2023; Shreelakshmi *et al.*, 2023). Variety of

biopolymers and essential oils have been studied for their antibacterial activity against several phytopathogenic bacteria with the aim of replacing the use of chemicals like antibiotics or copper-based compounds (Azaiez *et al.*, 2018), which cause bacterial resistance and a negative impact on the environment and health (Popovic *et al.*, 2018). Hydrophobic coatings, derived from natural and synthetic materials such as waxes, lipids and biodegradable polymers, form a semi-permeable barrier on the surface of the produce, significantly reduce transpiration and respiration rates, which are major contributors to post-harvest quality degradation in bell peppers. By limiting moisture loss and oxygen ingress, these coatings help to maintain the firmness, colour and nutritional quality of the peppers for a longer period. However, very less studies have been conducted on the oil-based coating in bell pepper. Therefore, keeping all this in view, the present study was conducted to study the impact of oil based on the quality of bell pepper during storage.

MATERIALS AND METHODS

The fresh bell peppers were procured in a single lot from the local market, Gwalior, Madhya Pradesh. All the purchased bell peppers were brought at Post Harvest Management Laboratory, Department of Horticulture, School of Agriculture, ITM University, Gwalior. The procured bell peppers were sorted on the bases of size, shape and stage of maturity followed by washing in tap water. The defect free bell pepper fruits were dipped in 200 ppm of calcium chloride solution for 2 min. Bell pepper fruits were left for few min to remove water from the surface of the fruits. The experiment was conducted as the completely randomized design in replications.

Neem, mint and tulsi oil were selected on the basis of feasibility and availability for coating. These selected oils were used in different concentrations viz., 10, 25 and 50% in hexane. The chlorophyll extract was prepared from carrot leaves and utilized as colouring agent in the coating. This was extracted with the help of acetone in the ratio of 1:2 (w:v). The obtained 5% carrot leaves extract (CLE) was added in the coating. Overall, 19 treatments were prepared in different combinations. The codes for the different coating treatments were: T_0C (control), T_1CLE (100% CLE), $T_2N_{50}CLE$ (50% neem oil with 5% CLE), T_3N_{50} (50% neem oil), $T_4N_{25}CLE$ (25% neem oil with 5% CLE), T_5N_{25} (25% neem oil), $T_6N_{10}CLE$ (10% neem oil with 5% CLE), T_7N_{10} (10% neem oil), $T_8M_{50}CLE$ (50% mint oil with 5% CLE), T_9M_{50} (50% mint oil), $T_{10}M_{25}CLE$ (25% mint oil with 5% CLE), $T_{11}M_{25}$ (25% mint oil), $T_{12}M_{10}CLE$ (10% mint oil with 5% CLE), $T_{13}M_{10}$ (10% mint oil), $T_{14}T_{50}CLE$ (50% tulsi oil with 5% CLE), $T_{15}T_{50}$ (50% tulsi oil), $T_{16}T_{25}CLE$ (25% tulsi oil with 5% CLE), $T_{17}T_{25}$ (25% tulsi oil), $T_{18}T_{10}CLE$ (10% tulsi oil with 5% CLE) and $T_{19}T_{10}$ (10% tulsi oil).

Immersion method (2 min) was used for the application of coating. The treated bell peppers were kept at ambient conditions (25±2°C and 55±5% RH). All the coated treatments were analyzed for morphological attributes i.e. fruit weight (g), polar diameter (mm) and equator diameter (mm) by using weighing balance and vernier calliper. Physical parameters like weight loss (%), decay per cent and fruit firmness (kg/cm^2) were observed. The physiological loss in weight (PLW %) was calculated by the per cent weight reduction with respect to initial and final weight. The weight was measured by using a laboratory level weighing scale having 0.01 g accuracy (Sreelakshmi *et al.*, 2023). Total soluble solid ($Brix^o$), titratable acidity (%), ascorbic acid content (mg/100 g), chlorophyll a (mg/g), chlorophyll b content (mg/g) and total chlorophyll content (mg/g) were analyzed. All the parameters were analyzed at 0, 4, 8, 12 and 16^{th} day of storage.

RESULTS AND DISCUSSION

The fruit weight ranged between 69.14 to 88.39 g at 0 day of the study (Table 1). Declining trend was recorded in fruit weight and recorded 38.38 (T_0C) to 52.66 g (T_3N_{50}) at 16^{th} day of storage. The polar diameter and equator diameter ranged between 73.70 to 42.70 mm and 72.00 to 51.70 mm, respectively. Similar gradual declining trend was recorded in the polar diameter and equator diameter and this ranged between 55.30 to 30.30 mm and 57.70 to 30.70 mm during 16^{th} day of storage, respectively.

The maximum weight loss percentage was observed in the control treatment (T_0C) at 58.06% by the 16th day after the experiment started, followed by treatment $T_{13}M_{10}$, $T_2N_{50}CLE$

Table 1. Morphological parameters of bell peppers during storage

Treatment	Fruit weight (g)					Polar diameter (mm)					Equator diameter (cm)				
	0 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day
T_0C	71.84	65.60	56.70	44.07	38.38	58.30	55.00	51.30	33.30	30.30	56.30	54.30	52.00	33.00	31.30
T_1CLE	79.89	62.00	52.10	47.65	45.32	42.70	40.00	38.70	36.30	32.70	51.70	49.30	47.00	44.70	41.30
$T_2N_{50}CLE$	87.55	77.50	64.48	52.65	45.01	62.30	60.00	59.00	56.30	51.70	60.00	58.70	57.00	54.30	50.00
T_3N_{50}	88.39	81.70	77.53	65.30	52.66	68.30	66.30	65.00	58.30	55.30	67.00	65.30	63.70	61.70	57.70
$T_4N_{25}CLE$	82.82	78.90	67.05	56.21	49.75	64.30	66.00	64.00	41.30	39.30	65.00	63.30	62.00	51.30	48.30
T_5N_{25}	74.19	62.40	56.94	52.58	43.10	60.70	58.00	57.00	38.30	36.30	60.70	59.00	57.30	36.30	34.30
$T_6N_{10}CLE$	79.31	57.40	54.94	47.56	42.43	55.30	54.00	54.00	34.30	32.70	67.00	65.00	63.70	42.30	41.00
T_7N_{10}	74.20	68.40	63.40	52.32	41.27	58.30	55.30	53.70	38.40	36.70	64.70	63.00	60.30	40.50	35.20
$T_8M_{50}CLE$	71.00	63.10	51.77	49.59	39.85	65.00	63.30	61.70	59.00	47.00	63.00	60.70	60.00	56.70	53.00
T_9M_{50}	76.37	63.90	58.61	43.64	43.39	57.70	54.70	52.30	39.70	32.60	63.70	62.00	60.30	42.30	34.30
$T_{10}M_{25}CLE$	79.29	66.20	65.26	56.60	45.37	47.00	43.70	41.30	37.90	31.50	60.70	59.70	57.70	35.70	34.00
$T_{11}M_{25}$	77.09	66.10	66.65	42.89	41.18	52.00	49.70	48.30	34.30	31.70	59.70	57.30	55.30	33.00	31.30
$T_{12}M_{10}CLE$	81.64	71.90	63.63	50.81	42.34	68.00	65.70	59.30	36.70	35.00	71.30	68.70	63.70	38.30	39.00
$T_{13}M_{10}$	79.46	66.50	55.79	43.00	39.48	66.30	64.00	61.70	51.70	46.70	57.30	55.70	54.00	51.70	49.00
$T_{14}T_{50}CLE$	86.35	74.70	61.08	49.02	42.26	54.30	52.70	51.00	39.30	36.70	69.70	68.00	66.30	41.70	40.30
$T_{15}T_{50}$	70.68	63.50	53.78	41.69	40.60	71.00	68.70	64.30	52.30	49.70	69.30	67.30	64.70	51.70	48.30
$T_{16}T_{25}CLE$	75.80	71.40	65.32	54.56	43.33	62.30	61.00	52.70	38.30	35.30	67.00	65.70	60.70	47.30	30.70
$T_{17}T_{25}$	83.00	73.40	61.04	52.73	44.00	73.70	72.00	64.70	51.70	42.20	72.00	70.70	61.00	43.30	39.70
$T_{18}T_{10}CLE$	69.14	58.50	45.73	43.15	41.43	59.30	56.70	52.30	49.70	45.30	63.30	60.30	55.70	53.00	46.70
$T_{19}T_{10}$	79.16	69.70	57.61	45.36	43.95	60.00	60.00	56.70	54.30	50.00	60.30	59.00	54.00	52.00	49.30
S. E. (m)±	9.73	9.18	8.98	7.88	8.39	0.38	0.48	0.36	0.52	0.47	0.34	0.38	0.41	0.31	0.42
C. D.	24.92	26.20	25.55	20.85	21.15	1.07	1.07	1.04	1.19	1.11	0.95	0.93	1.03	1.02	1.11

Table 2. Physical attributes of coated bell peppers during storage

Treatment	Weight loss (%)				Decay (%)				Fruit firmness (kg/cm^2)				
	4 Day	8 Day	12 Day	16 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day
T_0C	13.49	29.30	43.23	58.06	9.19	19.39	40.93	49.23	3.89	2.20	1.89	1.62	1.22
T_1CLE	22.42	34.80	40.36	43.27	8.17	17.48	27.84	36.76	4.23	3.10	2.20	1.97	1.43
$T_2N_{50}CLE$	11.50	26.40	39.86	48.59	6.25	15.56	25.92	34.84	4.15	3.30	3.10	2.51	1.89
T_3N_{50}	4.70	19.00	32.13	39.93	2.45	11.76	22.12	31.04	4.05	3.20	3.05	2.91	2.87
$T_4N_{25}CLE$	4.58	19.10	33.53	40.13	4.45	13.76	24.12	33.04	3.97	3.12	2.95	2.56	2.44
T_5N_{25}	15.86	23.30	29.13	41.91	6.61	15.92	26.28	35.20	4.12	3.27	2.95	2.20	2.10
$T_6N_{10}CLE$	27.68	30.70	40.03	46.50	7.43	16.74	27.10	36.02	4.40	3.55	3.02	2.10	1.40
T_7N_{10}	7.88	14.60	29.49	44.38	5.63	14.94	25.30	34.22	4.20	3.35	2.82	2.31	1.70
$T_8M_{50}CLE$	11.14	27.10	30.15	43.87	8.89	18.20	28.56	37.48	3.68	2.83	2.61	2.07	1.88
T_9M_{50}	16.28	23.30	42.86	43.18	7.03	16.34	26.70	35.62	3.85	3.00	2.47	2.10	1.76
$T_{10}M_{25}CLE$	16.46	17.70	28.62	42.78	6.21	15.52	25.88	34.80	4.12	3.27	2.74	2.20	1.78
$T_{11}M_{25}$	14.32	13.50	44.36	46.58	5.07	14.38	24.74	33.66	3.89	3.04	2.51	2.40	1.87
$T_{12}M_{10}CLE$	11.94	22.10	37.76	48.14	9.69	19.00	29.36	38.28	3.20	2.35	1.82	1.50	1.20
$T_{13}M_{10}$	16.35	29.80	45.88	50.31	7.10	16.41	26.77	35.69	4.11	3.26	2.73	1.80	1.34
$T_{14}T_{50}CLE$	8.86	21.10	38.60	46.58	6.61	15.92	26.28	35.20	4.65	3.80	3.27	2.61	1.95
$T_{15}T_{50}$	10.16	23.90	41.02	42.56	7.91	17.22	27.58	36.50	3.85	3.00	2.47	1.95	1.47
$T_{16}T_{25}CLE$	5.78	13.80	28.02	42.84	4.53	13.84	24.20	33.12	3.99	3.14	2.61	2.11	1.50
$T_{17}T_{25}$	11.57	26.50	36.47	46.99	9.32	18.63	28.99	37.91	4.50	3.65	3.12	2.18	1.58
$T_{18}T_{10}CLE$	15.45	33.90	37.59	40.95	6.20	15.51	25.87	34.79	4.10	3.25	2.72	1.80	1.43
$T_{19}T_{10}$	11.94	27.20	42.70	44.48	9.69	19.00	29.36	38.28	3.89	3.04	2.51	2.04	1.72
S. E. (m)±	0.88	0.23	0.28	0.85	0.42	0.67	0.65	0.71	0.42	0.53	0.46	0.39	0.42
C. D.	NS	1.37	1.64	1.58	1.42	1.58	1.43	1.60	NS	0.75	0.81	0.92	0.85

NS–Not Significant.

Table 3. Total soluble solids (B°), titratable acidity (%) and ascorbic acid content (mg/100 g) during storage in different treatments

Treatment	Total soluble solid (B°)					Titratable acidity (%)					Ascorbic acid content (mg/100 g)				
	0 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day
T_0C	5.20	4.62	4.05	3.11	2.42	1.80	1.95	0.79	0.32	0.11	125.21	110.36	103.11	92.36	89.64
T_1CLE	4.91	4.53	4.19	3.76	3.17	1.79	1.10	0.61	0.41	0.32	124.39	113.12	105.87	99.5	96.78
$T_2N_{50}CLE$	5.09	4.64	4.31	3.88	3.21	1.92	1.21	0.63	0.46	0.33	123.41	112.14	104.89	98.52	95.8
T_3N_{50}	5.21	4.83	4.52	4.09	3.45	1.31	1.11	0.64	0.42	0.24	128.61	117.34	110.09	103.72	101.00
$T_4N_{25}CLE$	5.15	4.75	4.44	3.90	3.34	1.39	1.20	0.74	0.61	0.36	127.32	116.05	108.8	102.43	99.71
T_5N_{25}	4.57	4.16	3.88	3.31	2.74	1.82	1.19	0.68	0.42	0.31	126.36	115.09	107.84	101.47	98.75
$T_6N_{10}CLE$	4.17	3.73	3.41	2.91	2.39	1.43	1.20	0.57	0.46	0.40	124.36	113.09	105.84	99.47	96.75
T_7N_{10}	4.84	4.41	4.13	3.64	3.07	1.65	1.19	0.79	0.44	0.25	125.21	113.94	106.69	100.32	97.6
$T_8M_{50}CLE$	4.51	4.19	3.80	3.38	2.71	1.78	1.45	0.65	0.51	0.19	120.36	109.09	101.84	95.47	92.75
T_9M_{50}	4.40	4.03	3.73	3.29	2.64	1.84	1.45	0.82	0.76	0.67	120.10	108.83	101.58	95.21	92.49
$T_{10}M_{25}CLE$	5.12	4.60	4.32	3.81	3.25	1.52	1.24	0.69	0.36	0.38	120.30	109.03	101.78	95.41	92.69
$T_{11}M_{25}$	4.61	4.24	3.90	3.45	2.84	1.76	1.41	0.67	0.41	0.52	119.20	107.93	100.68	94.31	91.59
$T_{12}M_{10}CLE$	4.16	3.76	3.43	2.94	2.34	1.91	1.29	0.71	0.38	0.35	118.95	107.68	100.43	94.06	91.34
$T_{13}M_{10}$	4.67	4.21	3.91	3.41	2.89	1.88	1.52	0.88	0.58	0.42	120.25	108.98	101.73	95.36	92.64
$T_{14}T_{50}CLE$	4.81	4.41	4.15	3.64	3.15	1.69	1.39	0.62	0.44	0.32	122.63	111.36	104.11	97.74	95.02
$T_{15}T_{50}$	4.48	4.09	3.70	3.26	2.61	1.87	1.64	0.69	0.53	0.32	122.36	111.09	103.84	97.47	94.75
$T_{16}T_{25}CLE$	4.44	4.04	3.72	3.27	2.65	1.84	1.35	0.65	0.52	0.41	122.31	111.04	103.79	97.42	94.70
$T_{17}T_{25}$	4.77	4.33	4.03	3.58	2.99	1.85	1.25	0.75	0.46	0.34	122.30	111.03	103.78	97.41	94.69
$T_{18}T_{10}CLE$	4.42	4.09	3.74	3.25	2.64	1.63	1.39	0.59	0.42	0.28	121.36	110.09	102.84	96.47	93.75
$T_{19}T_{10}$	4.67	4.22	3.92	3.41	2.81	1.52	1.20	0.78	0.52	0.35	121.26	109.99	102.74	96.37	93.65
S. E. (m)±	0.46	0.42	0.38	0.51	0.34	0.38	0.40	0.39	0.41	0.46	0.04	0.04	0.04	0.31	0.27
C. D.	NS	0.93	0.77	0.72	0.87	1.21	1.21	0.05	0.05	0.05	NS	0.42	0.25	0.36	0.45

NS–Not Significant.

Table 4. Chlorophyll a, chlorophyll b and total chlorophyll content (mg/g) during storage in different treatments

Treatment	Chlorophyll a					Chlorophyll b					Total chlorophyll				
	0 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day	0 Day	4 Day	8 Day	12 Day	16 Day
T_0C	4.68	3.79	3.45	3.17	2.79	1.48	0.95	0.57	0.44	0.23	6.16	4.74	4.02	3.61	3.02
T_1CLE	4.67	4.30	3.96	3.77	3.56	1.47	1.16	0.95	0.86	0.66	6.14	5.46	4.91	4.62	4.21
$T_2N_{50}CLE$	4.11	4.06	3.72	3.53	3.32	1.34	1.09	0.82	0.73	0.53	5.45	5.15	4.54	4.26	3.85
T_3N_{50}	4.67	4.68	4.55	4.15	3.94	1.65	1.53	1.32	1.23	1.03	6.32	6.09	5.87	5.38	4.97
$T_4N_{25}CLE$	4.91	4.53	4.31	3.89	3.68	1.59	1.28	1.07	0.98	0.88	6.50	5.96	5.38	4.87	4.56
T_5N_{25}	4.45	4.22	3.88	3.69	3.48	1.25	1.12	0.73	0.64	0.44	5.70	5.34	4.61	4.33	3.92
$T_6N_{10}CLE$	4.54	4.31	3.97	3.78	3.57	1.34	1.03	0.82	0.72	0.52	5.87	5.33	4.78	4.50	4.09
T_7N_{10}	4.41	4.18	3.84	3.65	3.44	1.21	1.45	0.69	0.60	0.40	5.63	5.63	4.54	4.25	3.84
$T_8M_{50}CLE$	4.32	4.54	4.04	3.95	3.74	1.12	1.08	0.6	0.51	0.31	5.45	5.62	4.64	4.46	4.05
T_9M_{50}	4.77	4.54	4.06	3.83	3.62	1.57	1.26	1.05	0.95	0.75	6.33	5.79	5.11	4.79	4.38
$T_{10}M_{25}CLE$	4.79	4.55	4.21	4.02	3.81	1.59	1.28	1.07	0.98	0.78	6.38	5.83	5.28	5.00	4.59
$T_{11}M_{25}$	4.67	4.44	4.12	3.91	3.70	1.47	1.16	0.95	0.85	0.65	6.13	5.59	5.06	4.76	4.35
$T_{12}M_{10}CLE$	4.56	4.33	3.99	3.8	3.59	1.36	1.05	0.84	0.74	0.54	5.91	5.37	4.82	4.54	4.13
$T_{13}M_{10}$	4.84	4.61	4.17	3.98	3.77	1.64	1.33	1.12	1.03	0.83	6.49	5.95	5.29	5.01	4.60
$T_{14}T_{50}CLE$	4.61	4.38	4.04	3.85	3.64	1.41	1.10	0.89	0.80	0.60	6.02	5.48	4.93	4.65	4.24
$T_{15}T_{50}$	4.22	4.44	4.10	3.91	3.70	1.34	1.03	0.82	0.73	0.53	5.56	5.47	4.92	4.64	4.23
$T_{16}T_{25}CLE$	4.51	4.28	3.94	3.75	3.54	1.31	1.00	0.79	0.70	0.50	5.82	5.28	4.73	4.45	4.04
$T_{17}T_{25}$	4.64	4.41	4.07	3.88	3.67	1.44	1.13	0.92	0.82	0.62	6.07	5.53	4.98	4.70	4.29
$T_{18}T_{10}CLE$	4.59	4.36	4.02	3.83	3.62	1.39	1.08	0.87	0.78	0.58	5.99	5.45	4.90	4.61	4.20
$T_{19}T_{10}$	4.51	4.28	3.94	3.75	3.54	1.31	1.10	0.79	0.70	0.50	5.83	5.38	4.74	4.45	4.04
S. E. (m)±	0.21	0.25	0.23	0.23	0.35	0.22	0.29	0.34	0.27	0.25	0.44	0.55	0.57	0.50	0.60
C. D.	NS	0.72	0.71	0.66	0.64	NS	0.63	0.57	0.64	0.42	NS	0.77	0.95	0.74	0.65

NS–Not Significant.

and recorded 50.31 and 48.59% weight loss, respectively (Table 2). The treatment T_3N_{50} had least weight loss 39.93% on the 16th day. Whereas, highest weight loss was recorded in control (T_0C) followed by $T_{13}M_{10}$ (10% mint oil), T_2N_{50}CLE (50% neem oil with 5% CLE) and $T_{12}M_{10}$CLE (10% mint oil with 5% CLE). However overall, it was noted that coating helped in reducing the weight loss. Maximum decay per cent was recorded in control, whereas least decay per cent was recorded in T_3N_{50} at the 16th day of storage. Textural changes among the treated bell pepper were also recorded highest in the treatment T_3N_{50} (3.20 kg/cm²) which was statistically at par with T_4N_{25}CLE (25% neem oil with 5% CLE) and T_5N_{25} (25% neem oil) at the 16th day of storage.

Declining trend was recorded for TSS, titratable acidity, titratable acidity and ascorbic acid content (Table 3). The T_3N_{50} treatment had highest levels of ascorbic acid on the 4th day (117.34 mg/100 g), 8th day (110.09 mg/100 g), 12th day (103.72 mg/100 g) and 16th day (101.00 mg/100 g).

Significant variations were recorded in the chlorophyll a, chlorophyll b and total chlorophyll content during 16 days storage (Table 4). However, similar trend was recorded for the treatment T_3N_{50} and exhibited the highest chlorophyll a level on subsequent days 4th day (5.68 mg/g), 8th day (4.55 mg/g), 12th day (4.15 mg/g) and 16th day (3.94 mg/g).

Bell pepper is a non-climacteric fleshy fruit post-harvest ripening and senescence. Unlike climacteric fruit, where a decline in auxin content and signalling and the onset of ethylene synthesis are known to be triggers for initiation of ripening, the actual initiator of non-climacteric ripening has still not been established. Many factors, however, such as various plant hormones, biotic and abiotic stresses are known to influence bell pepper fruit ripening (Cheng *et al.*, 2016). Numerous studies have shown that different coating influences the physical and biochemical properties of fruit from species. Bell pepper fruit colour is mainly determined by chlorophyll and carotenoids and their concentrations change during ripening. Carotenoids are responsible for the colour of mature bell pepper fruit. Fruit texture change is a typical process that occurs during the ripening and senescence of fleshy fruit (Tucker *et al.*, 2017; Gao *et al.*, 2020). Several enzymes like *pectinacetylesterase, polygalacturonas, pectinesterase, pectin methylesterase, pectate lyase, beta-galactosidase, cellulase* are involved in cell wall synthesis and degradation processes (Araque *et al.*, 2019).

CONCLUSION

The aim of the present study was studying the impact of hydrophobic coating on bell pepper shelf-life. The coatings demonstrated a remarkable improvement on the basis of their physico-mechanical properties and helped in enhancing the shelf-life of the bell pepper. Among the unconventional oil, neem oil 50% helped in enhancing the shelf-life of bell-pepper.

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