

Original Research Article

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Studies on Postharvest Changes in Physico-Biochemical Properties of Guava (*Psidium guajava* L.) cv. Sardar Influenced by Different Composite Coatings

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ABSTRACT

The main aim of present study was to evaluate the efficacy of different composite edible coatings comprising olive oil, *Aloe vera* and sodium alginate as base coatings with antioxidant (ascorbic acid 0.1%) and calcium gluconate (0.5%) as texture enhancer on the postharvest quality attributes of guava cv. ‘Sardar’ during winter seasons of 2017 and 2018. After treatment, fruits were kept at ambient temperature of 27-29°C till 15 days and analyzed for various physico-biochemical parameters while the uncoated fruits serve as control. In all treatments, olive oil composite coatings were effective in maintaining physiological loss in weight (7.82%), fruit firmness (1.14 kg/cm²), TSS (12.52 °Brix), titratable acidity (0.24%), ascorbic acid (267.56 mg/100 g) and chlorophyll content (3.65 mg/g). Hence, it was concluded that coating treatment of olive oil and *Aloe vera* composite coating can be used for enhancing the shelf life and maintaining postharvest quality of guava cv. Sardar.

Keywords

Guava, Composite coatings, Postharvest quality, Sardar

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Introduction

Guava (*Psidium guajava* L.) is an important subtropical climacteric fruit tree native to Southern Mexico and Central America and belongs to family Myrtaceae. It is termed as a common man’s fruit and “Apple of the Tropics” as well. Guava fruit is consumed at both green and ripe stage. Moreover, guava fruits are processed commercially into jelly,

jam, puree, juice, powder and nectar. Guava fruit is highly perishable and loss of vitamin C after harvest takes place very fast which reduces its nutritive value unless appropriate postharvest measures are taken (Pal *et al.*, 2004). Guava being a climacteric fruit ripens rapidly after the harvest therefore has short shelf life. Once it is fully ripe, the fruit becomes soggy and consumer preference and marketing quality deteriorate rapidly. Olive oil

coating extended the shelf life of guava cv. Allahabad Safeda with minimum physiological weight loss (Kamboj and Kaur, 2018). The sodium alginate edible coating on the pear fruits reduced increase in the TSS value during the storage when compared to that of control fruits by slowing down the polysaccharide degradation (Kessiane *et al.*, 2012). Othman *et al.*, 2017 found that sodium alginate based edible films enhanced the physico-chemical quality of coated guava fruits contained essential oil. Ergun and Satici, 2012 found that the green-coloured 'Granny Smith' and red-coloured 'Red Chief' apples treated with *Aloe vera* gel had minimum weight loss during the storage period. So many studies have been conducted by researchers to enhance the production but little work has been conducted to reduce postharvest losses of guava fruits. However, it is important to reduce the postharvest losses of guava fruits after harvesting. Therefore, the present study was undertaken to determine the effectiveness of postharvest application of composite coatings like *Aloe vera* gel, olive oil and sodium alginate with food additives (Texture enhancer and antioxidant) for maintaining the quality and enhancing the shelf life of guava fruits.

Materials and Methods

The experiment was conducted at Postharvest Laboratory, Department of Horticulture, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during two winter seasons of 2017 and 2018. The guava fruits of winter season crops were harvested at 80% maturity (colour break stage) and collected in plastic crates covered with a thick layer of guava leaves and brought to the laboratory. Fruits with uniform size and colour were selected whereas blemished and diseased fruit were discarded. Prior to the post-harvest treatment, the fruits were washed in potable water. The fruits were then allowed to dry in

shade. Composite coatings were prepared by taking the distilled water in a beaker and calculation of each chemical needed for one litre solvent was done except olive oil coatings and accordingly, coatings were prepared for dip treatment of guava. The composite coatings were prepared from base coatings of olive oil, *Aloe vera* gel and sodium alginate with composite coating materials viz., calcium gluconate as a texture enhancer (TE) and ascorbic acid as an antioxidant (AO) of the required concentrations for each treatment. Twenty fruits were dipped in each solution for 10 minutes and then air dried except olive oil. In case of olive oil coating, fruits were coated 3-4 times with the help of brush and left for air drying.

The trial was carried out in three replicates. The detail of the treatments include, T₁: Olive oil (100%) + TE (0.5%); T₂: Olive oil (100%)+ TE (0.5%) +AO (0.1%), T₃: *Aloe vera* (1:1) + TE (0.5%), T₄: *Aloe vera* (1:1) + TE (0.5%) +AO (0.1%), T₅: Sodium alginate (2%) +TE (0.5%), T₆: Sodium alginate (2%) + TE (0.5%) +AO (0.1%), and T₇ : the untreated *i.e.*, control. The treated fruits were kept at ambient temperature. The observations on physical and quality parameters were recorded at an interval of 3 days. Physiological loss in weight was recorded by weighing the sample on electronic balance and expressed in grams (g) from which the physiological loss in weight (PLW) was calculated. Fruit firmness was measured using penetrometer and expressed as kg/cm². The quality parameter, TSS of the fruit juice was recorded at room temperature using hand refractometer whereas, the parameters like titratable acidity and ascorbic acid were estimated according to the standard method described by Ranganna (1986) while chlorophyll estimation as per method described by Nayek *et al.*, (2014). The data was statistically analyzed in factorial completely randomized design (FCRD) for analysis of variance.

Results and Discussion

The data on effect of various treatments and storage periods on physiological loss in weight of guava under ambient condition are presented in Table 1. It clearly showed that all the treatments exerted a significant influence on physiological loss in weight. Minimum physiological loss in weight (9.35 and 6.29%) was recorded in T₁ followed by T₂ (9.48 and 6.31%) while maximum physiological loss in weight observed in control T₇ (19.44% and 17.30%) during both winter seasons of 2017 and 2018 respectively. In pooled data analysis, minimum physiological loss in weight (7.82%) was recorded in (T₁) followed by 7.89% in T₂ and maximum weight loss (18.37%) was recorded in control (T₇). Storage days affected physiological loss in weight significantly which increased gradually irrespective of the treatment as the storage period progressed. Similar observations have been reported in guava by Gad and Zagzog, 2017, Kumar *et al.*, (2017) in guava, who observed that coated fruits had minimum physiological loss in weight during storage period. Loss of weight in fresh fruits is mainly due to the loss of water caused by transpiration and respiration processes (Zhu *et al.*, 2008).

The data regarding influence of composite coatings during storage period on fruit firmness of guava cv. Sardar are mentioned in Table 1. Data presented in Table 1 showed that maximum fruit firmness (0.77 kg/cm² and 1.52 kg/cm²) was found in T₁ (olive oil 100% + TE 0.5%) in year 2017 and 2018 respectively while minimum fruit firmness was noticed in i.e., control T₇ (0.57 kg/cm² and 0.95 kg/cm²) during winter seasons of 2017 and 2018, respectively.

Among different coating treatments, pooled analysis data showed maximum fruit firmness (1.14 kg/cm²) was recorded in T₁ followed by

T₂ (1.09 kg/cm²) and minimum (0.76 kg/cm²) was recorded in control (T₇). Similar findings were reported by Gad and Zagzog (2017) in guava and Moradinezhad *et al.*, (2018) in ber who also found that fruits coated with edible coatings retained higher firmness as compared to uncoated fruits during storage period.

It was observed that the firmness of fruits reduced as ripening progressed. Similar observations have been reported in pear fruits as loss in firmness during storage occur due to break down of enzymes, loss of water and degradation of pectic substances present in the fruit (Nath *et al.*, 2012). The data on effect of composite coatings and storage periods and their interactions on fruit total soluble solids (TSS) of guava fruits under ambient condition are presented in Table 2. Maximum TSS was recorded (12.57 °Brix) in T₂ and minimum (6.35 °Brix) was recorded in control (T₇) on 15th day of storage during winter season of 2017.

Table 2 showed that maximum fruit TSS (13.62 °Brix) was recorded in (T₂) and minimum (6.28 °Brix) was recorded in control (T₇) on 15th day of storage period during winter season of 2018. In pooled analysis (Table 2) maximum fruit TSS (13.10 °Brix) was found in T₂ (Olive oil 100% + TE 0.5% +AO 0.1%) and minimum (6.32 °Brix) was recorded in control (T₇) on 15th day of storage period. The above results might be attributed to the reason that coating of olive oil retarded the ripening and senescence processes and simultaneously reduced the conversion of starch into sugars. Kamboj and Kaur (2018) reported that olive oil coated fruits retained significantly higher TSS in guava fruits.

The data pertaining to effect of composite coatings and storage periods on fruit titratable acidity of guava under ambient condition are presented in Table 2.

Table.1 Effect of different composite coatings on physiological loss in weight and fruit firmness (%) of guava cv. Sardar

Year	Physiological loss in weight (%)							Mean	Physiological loss in weight (%)							Mean	Physiological loss in weight (%)							Pooled Mean
	2017								2018								Pooled data							
	Storage intervals (days)								Storage intervals (days)								Storage intervals (days)							
Treatments	0	3	6	9	12	15		0	3	6	9	12	15		0	3	6	9	12	15				
T ₁	0.00	3.37	7.63	12.32	14.45	18.30	9.35	0.00	1.31	4.25	5.27	10.64	16.28	6.29	0.00	2.34	5.94	8.79	12.55	17.29	7.82			
T ₂	0.00	2.16	7.34	11.94	15.66	19.80	9.48	0.00	0.82	2.79	4.33	12.91	16.98	6.31	0.00	1.49	5.06	8.14	14.28	18.39	7.89			
T ₃	0.00	4.09	11.64	14.94	20.99	31.65	13.88	0.00	2.22	5.44	7.63	16.01	18.81	8.35	0.00	3.15	8.54	11.29	18.50	25.23	11.12			
T ₄	0.00	4.73	11.07	15.17	19.78	28.61	13.23	0.00	0.25	4.71	8.11	17.34	18.19	8.10	0.00	2.49	7.89	11.64	18.56	23.40	10.66			
T ₅	0.00	4.51	10.34	13.67	17.88	26.04	12.07	0.00	3.31	4.78	10.44	16.48	17.92	8.82	0.00	3.91	7.56	12.05	17.18	21.98	10.45			
T ₆	0.00	3.68	7.77	13.86	13.08	22.75	10.19	0.00	3.12	6.43	8.29	15.71	16.45	8.33	0.00	3.40	7.10	11.07	14.39	19.60	9.26			
T ₇	0.00	6.00	13.82	22.31	33.53	40.96	19.44	0.00	1.79	9.94	19.11	32.81	40.13	17.30	0.00	3.89	11.88	20.71	33.17	40.54	18.37			
Mean	0.00	4.07	9.94	14.88	19.33	26.87		0.00	1.83	5.47	9.02	17.41	20.8		0.00	2.95	7.71	11.96	18.38	23.78				
Factors																								
Storage Intervals (S)		CD at 5%			SE(m)			Factors		CD at 5%			SE(m)			Factors		CD at 5%			SE(m)			
Storage Intervals (S)		0.184			0.066			Storage Intervals (S)		0.122			0.044			Storage Intervals (S)		0.095			0.034			
Treatments (T)		0.301			0.108			Treatments (T)		0.199			0.071			Treatments (T)		0.155			0.056			
Interaction (S×T)		0.738			0.264			Interaction (S×T)		0.486			0.174			Interaction (S×T)		0.38			0.136			
Year	Fruit firmness (kg/cm ²)							Mean	Fruit firmness (kg/cm ²)							Mean	Fruit firmness (kg/cm ²)							Pooled Mean
	2017								2018								Pooled data							
	Storage intervals (days)								Storage intervals (days)								Storage intervals (days)							
Treatments	0	3	6	9	12	15		0	3	6	9	12	15		0	3	6	9	12	15				
T ₁	1.10	1.10	1.00	0.80	0.40	0.20	0.77	2.23	2.21	1.97	1.11	0.90	0.70	1.52	1.66	1.66	1.48	0.96	0.65	0.45	1.14			
T ₂	1.10	1.10	1.00	0.70	0.30	0.20	0.73	2.23	2.21	1.97	1.11	0.80	0.30	1.44	1.66	1.65	1.49	0.91	0.55	0.25	1.09			
T ₃	1.10	0.99	0.80	0.60	0.20	0.20	0.65	2.23	1.78	1.00	0.98	0.70	0.44	1.19	1.67	1.38	0.90	0.79	0.45	0.32	0.92			
T ₄	1.10	0.99	0.80	0.70	0.30	0.10	0.67	2.23	1.98	0.99	0.89	0.71	0.48	1.21	1.67	1.49	0.90	0.79	0.50	0.29	0.94			
T ₅	1.10	1.10	1.00	0.80	0.20	0.12	0.72	2.23	1.67	1.10	1.11	0.88	0.61	1.27	1.66	1.38	1.05	0.95	0.54	0.37	0.99			
T ₆	1.10	0.99	1.00	0.60	0.20	0.10	0.67	2.23	1.77	0.99	1.12	0.67	0.61	1.23	1.67	1.38	0.99	0.86	0.43	0.35	0.95			
T ₇	1.10	0.99	0.60	0.40	0.20	0.10	0.57	2.23	1.19	0.99	0.57	0.38	0.32	0.95	1.66	1.09	0.80	0.49	0.29	0.21	0.76			
Mean	1.10	1.04	0.89	0.66	0.26	0.15		2.23	1.83	1.29	0.98	0.72	0.49		1.66	1.43	1.09	0.82	0.49	0.32				
Factors																								
Storage Intervals (S)		CD at 5%			SE(m)			Factors		CD at 5%			SE(m)			Factors		CD at 5%			SE(m)			
Storage Intervals (S)		0.009			0.003			Storage Intervals (S)		0.014			0.005			Storage Intervals (S)		0.009			0.003			
Treatments (T)		0.014			0.005			Treatments (T)		0.024			0.008			Treatments (T)		0.014			0.005			
Interaction (S×T)		0.034			0.012			Interaction (S×T)		0.058			0.021			Interaction (S×T)		0.034			0.012			

Where T₁: Olive oil (100%) + TE (0.5%), T₂: Olive oil (100%)+ TE (0.5%) +AO (0.1%), T₃: Aloe vera (1:1) + TE (0.5%), T₄: Aloe vera(1:1) + TE (0.5%) +AO (0.1), T₅: Sodium Alginate (2%) +TE (0.5%), T₆: Sodium Alginate (2%) + TE (0.5%) +AO (0.1%), T₇: Control (without coating), CMC - Carboxymethyl Cellulose, TE- Calcium gluconate and AO- Ascorbic acid

Table.2 Effect of different composite coatings on TSS (⁰Brix) and titratable acidity (%) of guava cv. Sardar

Year	TSS (⁰ Brix)						Mean	TSS (⁰ Brix)						Mean	TSS (⁰ Brix)						Pooled Mean
	2017							2018							Pooled data						
	Storage intervals (days)							Storage intervals (days)							Storage intervals (days)						
Treatments	0	3	6	9	12	15	0	3	6	9	12	15	0	3	6	9	12	15			
T ₁	10.05	11.56	12.01	12.34	12.54	12.55	11.84	12.60	12.71	13.12	13.52	13.56	13.58	13.18	11.33	12.13	12.57	12.93	13.05	13.06	12.51
T ₂	10.05	11.44	12.04	12.33	12.55	12.57	11.83	12.60	12.77	13.11	13.55	13.61	13.62	13.21	11.33	12.11	12.58	12.94	13.08	13.10	12.52
T ₃	10.05	12.11	12.42	12.64	12.66	11.23	11.85	12.60	12.78	13.45	13.57	13.58	11.01	12.83	11.32	12.44	12.94	13.11	13.12	11.12	12.34
T ₄	10.05	12.03	12.34	12.66	12.67	11.52	11.88	12.60	12.81	13.55	13.64	13.66	10.06	12.72	11.32	12.42	12.95	13.15	13.17	10.79	12.30
T ₅	10.05	12.04	12.33	12.54	12.58	11.85	11.90	12.60	12.78	13.34	13.57	13.59	11.05	12.82	11.32	12.41	12.84	13.05	13.08	11.45	12.36
T ₆	10.05	11.10	12.21	12.43	12.49	11.67	11.66	12.60	12.77	13.23	13.56	13.58	11.11	12.81	11.33	11.94	12.72	12.99	13.04	11.39	12.23
T ₇	10.05	12.43	12.71	12.98	8.11	6.35	10.44	12.60	13.01	13.89	14.01	9.04	6.28	11.47	11.32	12.72	13.30	13.49	8.57	6.32	10.96
Mean	10.05	11.82	12.29	12.56	11.94	11.11		12.60	12.80	13.38	13.63	12.95	10.96		11.32	12.31	12.84	13.09	12.44	11.03	
Factors		CD at 5%		SE(m)		Factors		CD at 5%		SE(m)		Factors		CD at 5%		SE(m)					
Storage Intervals (S)		0.137		0.049		Storage Intervals (S)		0.131		0.047		Storage Intervals (S)		0.093		0.033					
Treatments (T)		0.224		0.08		Treatments (T)		0.214		0.077		Treatments (T)		0.152		0.055					
Interaction (S×T)		0.549		0.197		Interaction (S×T)		0.524		0.188		Interaction (S×T)		0.373		0.134					
Year	Titratable acidity (%)						Mean	Titratable acidity (%)						Mean	Titratable acidity (%)						Pooled Mean
	2017							2018							Pooled data						
	Storage intervals (days)							Storage intervals (days)							Storage intervals (days)						
Treatments	0	3	6	9	12	15	0	3	6	9	12	15	0	3	6	9	12	15			
T ₁	0.25	0.25	0.21	0.19	0.17	0.16	0.21	0.32	0.31	0.29	0.26	0.23	0.18	0.27	0.29	0.28	0.25	0.22	0.20	0.17	0.24
T ₂	0.26	0.25	0.22	0.18	0.16	0.15	0.20	0.32	0.30	0.26	0.24	0.22	0.17	0.25	0.29	0.28	0.24	0.21	0.19	0.16	0.23
T ₃	0.26	0.24	0.20	0.16	0.14	0.13	0.19	0.32	0.31	0.23	0.21	0.16	0.14	0.23	0.29	0.28	0.21	0.19	0.15	0.14	0.21
T ₄	0.26	0.24	0.19	0.15	0.13	0.12	0.18	0.32	0.29	0.24	0.19	0.15	0.13	0.22	0.29	0.27	0.22	0.17	0.14	0.13	0.20
T ₅	0.26	0.25	0.18	0.17	0.15	0.14	0.19	0.32	0.29	0.25	0.17	0.14	0.12	0.22	0.29	0.27	0.21	0.17	0.15	0.13	0.20
T ₆	0.26	0.25	0.19	0.16	0.14	0.13	0.19	0.32	0.29	0.26	0.19	0.16	0.14	0.23	0.29	0.27	0.22	0.17	0.15	0.14	0.21
T ₇	0.26	0.20	0.13	0.11	0.11	0.09	0.15	0.32	0.23	0.19	0.13	0.11	0.10	0.18	0.29	0.21	0.16	0.12	0.11	0.09	0.16
Mean	0.26	0.24	0.19	0.16	0.14	0.13		0.32	0.29	0.25	0.20	0.17	0.14		0.29	0.27	0.22	0.18	0.16	0.14	
Factors		CD at 5%		SE(m)		Factors		CD at 5%		SE(m)		Factors		CD at 5%		SE(m)					
Storage Intervals (S)		0.003		0.001		Storage Intervals (S)		0.003		0.001		Storage Intervals (S)		0.002		0.001					
Treatments (T)		0.004		0.002		Treatments (T)		0.004		0.001		Treatments (T)		0.004		0.001					
Interaction (S×T)		0.011		0.004		Interaction (S×T)		0.01		0.004		Interaction (S×T)		0.01		0.003					

Where T₁: Olive oil (100%) + TE (0.5%), T₂: Olive oil (100%)+ TE (0.5%) +AO (0.1%), T₃: Aloe vera (1:1) + TE (0.5%), T₄: Aloe vera(1:1) + TE (0.5%) +AO (0.1), T₅: Sodium Alginate (2%) +TE (0.5%), T₆: Sodium Alginate (2%) + TE (0.5%) +AO (0.1%), T₇: Control (without coating), CMC - Carboxymethyl Cellulose, TE- Calcium gluconate and AO- Ascorbic acid

Table.3 Effect of different composite coatings on ascorbic acid (mg/100 g) and chlorophyll content (mg/g) of guava cv. Sardar

Year	Ascorbic acid (mg/100 g)							Mean	Ascorbic acid (mg/100 g)							Mean	Ascorbic acid (mg/100 g)							Pooled Mean
	2017								2018								Pooled data							
	Storage intervals (days)								Storage intervals (days)								Storage intervals (days)							
Treatments	0	3	6	9	12	15		0	3	6	9	12	15		0	3	6	9	12	15				
T ₁	290.44	290.12	281.67	275.63	265.46	254.23	276.26	264.58	264.10	261.22	259.99	257.56	245.67	258.85	277.52	277.11	271.44	267.81	261.51	249.95	267.56			
T ₂	290.44	288.16	279.68	274.16	264.63	251.36	274.74	264.50	264.10	260.13	259.09	255.67	244.56	258.02	277.52	276.14	269.90	266.63	260.15	247.96	266.38			
T ₃	290.44	235.17	235.78	229.86	221.34	197.56	235.02	264.58	262.11	254.66	247.65	223.45	194.77	241.20	277.52	248.64	245.22	238.76	222.39	196.17	238.12			
T ₄	290.44	236.14	231.56	229.86	220.26	175.69	230.66	264.59	262.31	255.31	247.22	220.26	176.88	237.76	277.52	249.23	243.44	238.54	220.26	176.28	234.21			
T ₅	290.44	259.67	251.64	246.87	238.79	237.26	254.11	264.59	263.11	258.66	249.80	238.79	189.77	244.12	277.52	261.39	255.15	248.34	238.79	213.51	249.12			
T ₆	290.44	262.23	257.46	249.67	236.45	229.78	254.34	264.59	262.32	254.66	248.65	236.45	218.98	247.61	277.52	262.28	256.06	249.17	236.45	224.38	250.98			
T ₇	290.44	222.23	200.13	193.70	187.55	148.30	207.06	264.59	258.47	234.23	191.67	167.87	137.42	209.04	277.52	240.35	217.18	192.69	177.71	142.86	208.05			
Mean	290.44	256.25	248.27	242.82	233.50	213.45		264.57	262.36	254.12	243.44	228.58	201.15		277.52	259.31	251.20	243.13	231.04	207.30				
Factors																								
Storage Intervals (S)		CD at 5%			SE(m)		Factors		CD at 5%			SE(m)		Factors		CD at 5%			SE(m)					
Storage Intervals (S)		2.736			0.98		Storage Intervals (S)		2.531			0.907		Storage Intervals (S)		1.895			0.679					
Treatments (T)		4.468			1.601		Treatments (T)		4.134			1.481		Treatments (T)		3.094			1.108					
Interaction (S×T)		10.945			3.921		Interaction (S×T)		10.126			3.627		Interaction (S×T)		7.579			2.715					
Year	Chlorophyll content (mg/g)							Mean	Chlorophyll content (mg/g)							Mean	Chlorophyll content (mg/g)							Pooled Mean
	2017								2018								Pooled data							
	Storage intervals (days)								Storage intervals (days)								Storage intervals (days)							
Treatments	0	3	6	9	12	15		0	3	6	9	12	15		0	3	6	9	12	15				
T ₁	5.06	4.23	3.81	3.11	2.85	1.01	3.34	4.98	4.32	3.56	3.04	2.23	1.23	3.23	5.02	4.27	3.69	3.07	2.54	1.13	3.29			
T ₂	5.06	4.22	8.55	3.11	2.55	1.03	4.08	4.98	4.33	3.54	3.02	2.22	1.22	3.22	5.02	4.28	6.05	3.06	2.39	1.13	3.65			
T ₃	5.06	4.22	3.24	2.56	2.11	1.08	3.04	4.98	4.21	3.34	2.56	2.06	1.11	3.04	5.02	4.21	3.29	2.56	2.08	1.09	3.04			
T ₄	5.06	4.22	3.21	2.55	2.11	1.05	3.03	4.98	4.22	3.33	2.55	2.01	1.12	3.03	5.02	4.22	3.28	2.55	2.06	1.09	3.04			
T ₅	5.06	4.01	3.55	2.61	2.22	1.05	3.08	4.98	4.22	3.45	2.61	1.99	1.11	3.06	5.02	4.11	3.50	2.61	2.11	1.08	3.07			
T ₆	5.06	4.01	3.44	2.74	2.06	1.05	3.06	4.98	4.31	3.45	3.64	2.02	1.14	3.26	5.02	4.17	3.45	3.19	2.04	1.10	3.16			
T ₇	5.06	3.81	2.03	1.78	1.22	0.42	2.38	4.98	4.31	2.50	2.01	1.11	0.34	2.54	5.02	4.06	2.27	1.90	1.17	0.38	2.47			
Mean	5.06	4.10	3.98	2.64	2.16	0.96		4.98	4.27	3.31	2.78	1.95	1.04		5.02	4.19	3.65	2.71	2.06	1.00				
Factors																								
Storage Intervals (S)		CD at 5%			SE(m)		Factors		CD at 5%			SE(m)		Factors		CD at 5%			SE(m)					
Storage Intervals (S)		0.033			0.012		Storage Intervals (S)		0.035			0.012		Storage Intervals (S)		0.024			0.009					
Treatments (T)		0.055			0.02		Treatments (T)		0.057			0.02		Treatments (T)		0.039			0.014					
Interaction (S×T)		0.134			0.048		Interaction (S×T)		0.139			0.05		Interaction (S×T)		0.096			0.034					

Where T₁: Olive oil (100%) + TE (0.5%), T₂: Olive oil (100%)+ TE (0.5%) +AO (0.1%), T₃: Aloe vera (1:1) + TE (0.5%), T₄: Aloe vera(1:1) + TE (0.5%) +AO (0.1), T₅: Sodium Alginate (2%) +TE (0.5%), T₆: Sodium Alginate (2%) + TE (0.5%) +AO (0.1%), T₇: Control (without coating), CMC - Carboxymethyl Cellulose, TE- Calcium gluconate and AO- Ascorbic acid

Maximum fruit titratable acidity (0.21%) was recorded in (T₁) followed by (0.20%) in T₂ and minimum (0.15%) was recorded in control (T₇) in winter season of 2017. During winter season 2018, maximum titratable acidity (0.27%) was recorded in (T₁) and minimum (0.18%) was recorded in control (T₇). In pooled data analysis maximum titratable acidity (0.24 %) was recorded in T₁ i.e. Olive oil (100%) + TE (0.5%) and minimum (0.16%) was recorded in control (T₇). Slower decline in acidity in treated fruits compared to control might be due to delayed senescence and lower respiration rate in the fruits. Similar observations were also reported by Iqbal *et al.*, 2017 in sweet orange and Baraiya *et al.*, 2014 in carambola who also observed that coated fruits showed less reduction in acidity content during storage period. The data related to the effect of composite coatings during storage period on ascorbic acid of guava fruits cv. Sardar are given in Table 3. Persual of the data (Table 3) showed that maximum fruit ascorbic acid (276.26 mg/100g) was recorded in (T₁) and minimum (207.06 mg/100) was found in control (T₇) in winter season of 2017. During winter season 2018 maximum ascorbic acid (258.85 mg/100g) was recorded in (T₁) and minimum (209.04 mg/100g) was recorded in control (T₇). Similarly, in pooled data maximum ascorbic acid (267.56 mg/100 g) was recorded in T₁ (Olive oil (100%) + TE 0.5%) followed by (266.38 mg/100 g) in T₂, and minimum (208.05 mg/100 g) was recorded in control (T₇). Similarly, Iqbal *et al.*, 2017 in sweet orange and Kumar *et al.*, 2017 in guava were also reported that edible coating coated fruits retained higher ascorbic acid content during storage conditions. Kamboj and Kaur, 2018 observed that olive oil coated guava fruits cv. Allahabad Safeda had higher level of ascorbic acid content as compared to uncoated fruits during cold storage period. Further, olive oil coating was found more effective in the retention of ascorbic acid content because of the lowest gas permeability that inhibited the respiration rate. Maximum fruit chlorophyll content (4.08 mg/g) was found in T₂ (Olive oil 100% + TE 0.5% + AO 0.1%) and minimum chlorophyll content (2.38 mg/g)

was retained in control (T₇) in winter season of 2017 (Table 3). Chlorophyll content during winter season 2018 was observed maximum (3.23 mg/g) in T₁ (Olive oil 100% + TE 0.5%) and minimum (2.54 mg/g) was observed in control (T₇). Similarly, in pooled data (Table 3), maximum chlorophyll content (3.65 mg/g) was recorded in T₂ (Olive oil 100% + TE 0.5% +AO 0.1%) and minimum (2.47 mg/g) was noticed in control (T₇). Storage intervals affected chlorophyll content of fruit significantly which decreased gradually irrespective of the treatment as the storage period progressed. The change in colour of fruits from green to yellow continued over the storage period. Loss of chlorophyll is mediated through several processes involving the action of the enzyme chlorophyllase and photodegradation (Hussain *et al.*, 2010). The green colour retention by application of coatings was reported by Shahid and Abbasi (2011) in sweet orange.

On the basis of findings, it may be concluded that olive oil + calcium guconate 0.1% and olive oil + calcium guconate 0.1%+ ascorbic acid 0.1% were found quite effective in extending the shelf life as they retained greater physico-chemical properties like firmness, ascorbic acid, chlorophyll content with minimum physiological loss in weight during storage days.

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