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Alteration of quality attributes and shelf-life in strawberry (*Fragaria* × *ananassa*) fruits during storage as influenced by edible coatings

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ABSTRACT

The present investigation was carried out during 2015-16 at department of Horticulture, Aromatic and Medicinal Plants, Mizoram University, Aizawl to find out suitable edible coating on prolonging shelf-life of strawberry fruits.The different treatments were: T_1: coconut oil 100%, T_2 : castor oil 100%, T_3 : olive oil 100%, T_4 : Liquid paraffin wax 100%, T_5 : *Aloe vera* gel, T_6 :chitosan (1% w/v), T_7 : chitosan (2%w/v), T_8 : kaolene (1%w/v), T_9 : kaolene (2%w/v), T_{10} : carboxy methyl cellulose (CMC) (1% w/v), and T_{11} : control (Water spray). The results revealed that among the different edible coatings studied, coating with coconut oil resulted lowest PLW (17.57%), maximum marketable fruits retained (56.67%), total sugars (8.82%), ascorbic acid (65.74 mg/100 ml juice), total anthocyanin content (33.38%) of fruits. The various quality parameters in terms of flavour, taste, appearance and overall acceptability were also found superior in this particular treatment.

Key words: Edible coatings, Quality attributes, Shelf-life, Strawberry

Strawberry (*Fragaria* × *ananassa* Duch.), is one of the perennial herb recently gaining popularity all over the world due to its high nutritive value and delicious taste. Delicacy in flavour and richness in vitamins and minerals, makes strawberry a highly preferred food in the diet of millions of people around the globe (Bhat *et al*. 2005). Strawberry fruits are very popular antioxidants having scavenging capacity against free radicals and contain a number of health promoting substances like carotenoids, phenols, flavonoids and dietary glutathionine (Singh *et al.* 2008). In India, because of its early duration, remunerative prices and higher economic return, it has become favourite fruit among the growers during the last decade. Further, availability of day neutral and high yielding varieties have resulted in phenomenal increase in its area and production (Paramanick *et al*. 2005).

The storage and marketing of strawberry fruits is very challenging in domestic and international market because of very high respiration and softening rates of the fruits. After harvest, the fruits start spoilage very rapidly and sometimes even before reaching the consumers. Due to its high metabolism of the fruits, strawberries must be kept at 4.5°C, which can extend its shelf-life and quality for few days. Out of the various methods have been employed to extend the shelf-life of strawberry fruits, application of edible coating is one of the low cost and proven technology which has attained wide popularity among the researchers. They prevent the entry and exit of moisture and gases, controls the growth of microorganisms, retain the original colour of the fruits, and effectively extend the shelf-life of the product (Sehat 2012). The commonly used edible coatings are wax, milk protein celluloses, lipids, starch, zein, and aliquate (Cha and Chinan 2004). Chitosan based coatings are generally used to increase the shelf-life of fruits (Vargas *et al*. 2006). Browning and dehydration of fruits during storage can be reduced by coating with *Aloe vera* gel (Martýnez-Romero *et al*. 2006). The moisture loss of the fruits can be decreased and concentration of internal carbon dioxide can be increased by using sodium carboxy methyl cellulose-based coatings. Keeping all these aspects in view, the present investigation was conducted to find out suitable edible skin coating for prolonging shelf-life of strawberry fruits.

MATERIALS AND METHODS

Fresh, good looking, uniform size, shape and coloured strawberry fruits of cv. Camarosa free from mechanical damage as well as disease and pest infestation were collected from the experimental farm, department of Horticulture, Aromatic and Medicinal Plants, Mizoram University, Aizawl.The fruits were washed in running water to remove

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all the dust and dirts and treated with chlorinated water (0.25 g/l) according to methods of Garcia *et al.* (1998a,) and dried using tissue paper.To select the fruits having uniform maturity, the fruits were graded by density gradation method. There were eleven treatments comprising of various edible coatings, i.e. T_1: coconut oil 100%, T_2 : castor oil 100%, T_3 : olive oil 100%, T_4 : liquid paraffin wax 100%, T_5 : *Aloe vera* gel, T_6 :chitosan (1% w/v), T_7 : chitosan (2% w/v), T_8 : kaolene (1%w/v), T_9 : kaolene (2%w/v), T_{10} : carboxy methyl cellulose (CMC) (1% w/v), and T_{11} : control (Water spray). Fruits were dipped for 2 min in 1 and 2% (w/v) chitosan with 1% acetic acid (v/v), according to the method described by Jiang *et al*. (2005). CMC (1%,w/v) formulations was prepared by dispersion of carboxy methyl starch in distilled water with constant stirring at room temperature. Before application of the coating treatment, the solutions were left for 12 hr for the withdrawal of bubbles. Then, glycerol was added as plasticizer, and the solutions were emulsified using a homogenizer. Fresh *Aloe vera* leaves were collected from the experimental farm, department of Horticulture, Aromatic and Medicinal Plants, Mizoram University, Aizawl, Mizoram and the outer layer of the leaves were removed to obtain *Aloe* gel matrix and the fibre particles adhered there were removed by filtration. The liquid obtained was the fresh *Aloe* gel (AG; 100%). It was then pasteurized at 70 ºC for 45 min and cooled at ambient temperature.The paraffin wax was manually applied by small paint brush at ambient temperature. For control, the fruits were sipped in distilled water. For studying the changes in shelf-life and physico-chemical characteristics, the boxes containing the fruits were kept under refrigerated conditions at 4°C.There were three replications in each treatment and 30 fruits were taken for each replication.The experiment was laid in a completely randomized design. Observations on various physico-chemical attributes of fruits were taken on same day of harvest and after 4, 8, 12, and 16 days of storage.The physiological loss in weight (PLW) of the fruits was calculated on initial weight basis and expressed in percent. The TSS of fruit was measured with the help of Zeiss Hand Refractometer of 0–32° Brix range. The acidity, sugar and vitamin 'C' contents were determined as per the method of AOAC (2002).Total anthocyanins content (TAC) was determined spectrophotometrically by the pH differential method as described by Ghasemnezhad *et al*. (2013). Sensory quality parameters such as appearance, taste, flavour and overall acceptability of each sample was evaluated by asemi trained panel of 5 judges using the 9 point Hedonic rating scale (Amerrine *et al*. 1965). Subjective (non-destructive) fruit texture was recorded by following the methods of Shahnawaz and Sheikh (2011) by using 6 point scale.

RESULTS AND DISCUSSION

Physiological loss in weight (PLW)

The different edible coatings have significant effect in reducing the physiological loss in weight of the strawberry fruits (Table 1). Among the various treatments, coconut oil treated fruits showed the significantly lowest PLW of 2.73, 4.77, 10.10 and 17.57% after 4, 8, 12 and 16 days of storage, respectively, it was followed by paraffin wax and castor oil. Coconut oil coating and paraffin wax closed the opening of stomata and lenticels thereby, reducing the rate of transpiration and respiration, which increases retention of moisture in the fruit (Das and Medhi 1996). Similar findings were noted by Bishen *et al*. (2012) and Jagadeesh *et al*. (2001) in guava fruits. Among the various coatings, the highest (5.20, 8.63, 17.97 and 25.27%) PLW

Table 1 Physiological loss in weight PLW (%), marketable fruits, marketable fruits over control and texture at different days of storage

Treatment	Physiological loss in weight PLW (%)				Marketable fruits (%)				Marketable fruits over control				Texture				
	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days
T_1	2.83	4.93	10.93	18.77	100.00	100.00	87.78	56.67	21.11	37.78	44.44	40.00	5.76	5.33	4.62	3.85	5.76
T_2	3.53	4.97	12.67	18.83	96.67	85.55	58.89	43.33	17.78	23.33	15.56	26.66	5.58	4.85	4.20	3.57	5.58
T_3	4.27	5.33	12.97	19.33	91.11	82.22	52.22	40.00	12.22	20.00	8.89	23.33	5.54	5.12	4.13	3.53	5.54
T_4	2.73	4.77	10.10	17.57	100.00	100.00	84.44	54.44	21.11	37.78	41.11	37.77	5.64	5.26	3.87	3.70	5.64
T_5	4.83	5.07	14.07	20.27	93.34	86.67	66.67	34.45	14.45	24.45	23.34	17.78	5.38	4.75	3.93	3.42	5.38
T_6	3.77	5.47	15.50	19.13	93.33	77.78	60.00	33.33	14.45	15.55	16.67	16.66	5.28	4.68	4.20	3.37	5.28
T_7	4.77	5.77	15.63	19.10	94.47	87.78	57.78	34.45	15.58	25.56	14.45	17.78	5.26	4.35	3.97	3.40	5.26
T_8	5.03	7.87	17.53	23.73	85.56	72.22	46.67	23.33	6.67	10.00	3.33	6.66	5.48	4.08	3.75	2.77	5.48
T_9	4.63	7.47	17.13	22.03	86.67	74.44	47.78	25.56	7.78	12.22	4.45	8.89	5.42	3.93	3.27	2.78	5.42
T_{10}	3.73	6.37	16.03	20.20	93.33	76.67	52.00	27.78	14.45	14.44	8.67	11.11	5.33	4.17	3.53	2.72	5.33
T_{11}	5.20	8.63	17.97	25.27	78.89	62.22	43.33	16.67					5.13	3.88	3.23	2.58	5.13
SEm (±)	0.32	0.25	1.50	1.83	2.88	4.44	5.02	4.39	4.86	8.26	6.28	4.39	0.09	0.20	0.33	0.20	0.09
CD (P=0.05)	0.66	0.52	3.11	3.80	5.98	9.22	10.42	9.11	10.07	17.14	13.02	9.11	0.18	0.41	0.68	0.42	0.18

was recorded under control at 4, 8, 12 and 16 days of storage. The higher PLW in control treatment might be due to upsurge in respiration rate, transpiration process and ethylene production.

Marketable fruits retained and marketable fruits over control

Pure coconut oil and liquid paraffin wax treated fruits retained 100% marketable fruits till 8th day (Table 1). Our results are in close conformity with the findings of Bishen *et al*. (2012) in kagzi lime fruits. The maximum (56.67%) marketable fruits at 16 days of storage was reported under pure coconut oil, while the minimum (16.67%) was under control.The maximum marketable fruits with coconut oil might be due to slow degradation of chlorophyll and decreased enzymatic acidity which are responsible for delay in ripening. Delay the ripening by oil and wax coating was reported by Dhemre and Waskar (2003) in mango fruits.

Similarly, the maximum marketable fruits over control (40.00%) was reported with coconut coatings, followed by paraffin wax (37.77%), whereas the minimum (6.66%) was recorded in kaolene coating. Thomas *et al*. (2005) reported that coating retard ethylene emission and enhance texture as compared to control and 30% less weight loss than control. Similar observations were also made by Bishen *et al*. (2012) in kagzi lime fruits.

Fruit texture

The fruit texture decreased from 4th day till 16th day of storage (Table 1). Among the different treatments, coconut oil coated fruits retained the maximum texture (5.76, 5.33, 4.62, 3.85) at 4, 8, 12 and 16 days after storage closely flowed by paraffin wax (5.64, 5.26, 3.87 and 3.70). The controlled fruits registered the lowest texture (5.13, 3.88, 3.23 and 2.58) at all the days.The decrease in fruit texture with the storage periods might be due to breakdown of insoluble pectin to soluble form and also due to cellular disintegration leading to permeability of the cell membrane which ultimately helps in gaseous exchange (Mahajan *et al*. 2013).The higher texture in coconut oil and paraffin wax coated fruits might be due to reduced transpiration and respiration along with delay ethylene production and thus retained more turgidity of the cells of the fruits (Nanda *et al*. 2001).

Total soluble solids (TSS)

The data presented in Table 2 revealed that the TSS of the fruits increased from 4th day to 12th day of storage and thereafter it decreased (Table 2). The maximum TSS (10.52%) at 16 days of storage was recorded in paraffin wax coating followed by coconut oil while, the least TSS was recorded in control (6.22%).The gradual increase in TSS up to 12th day might be due to complete hydrolysis into sugars and the gradual decline after this period is due to no further increase in sugar since it is the primary substitute for respiration (Wills *et al*. 1980).The increase in TSS in wax coated fruits till 12th day and then gradual decrease might be due to the fact that wax has the capacity to delay the metabolic activities during ripening and storage of fruits (Fan *et al*. 1999).

Acidity

The titratable acidity of the strawberry fruits was increased with the storage. Among the different treatments, at 16 days of storage, significantly highest titratable acidity was found in the fruits treated with wax emulsion (0.177%), followed by (0.176%) coconut oil (Table 2).In paraffin wax treated fruits, due to lesser availability of oxygen to the fruits in later stages of storage may lead to higher acidity in the fruits. In wax treated fruits, the organic acid, which participates in the respiratory process but not oxidized therefore, their level remained high. Our study is in close

Table 2 TSS, titrable acidity and TSS/ acidity ratio at different days after storage

Treatment	TSS (%)				Titrable acidity (%)				TSS/ acidity			
	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days
T_1	10.21	10.33	10.48	9.79	0.164	0.166	0.171	0.176	62.24	62.35	61.46	55.73
T_2	9.78	10.13	10.20	9.49	0.161	0.162	0.166	0.170	60.79	62.42	61.58	55.70
T_3	9.49	10.00	10.30	9.24	0.160	0.163	0.168	0.172	59.18	61.21	61.66	53.72
T_4	10.78	10.97	11.33	10.52	0.166	0.168	0.174	0.177	64.96	65.27	65.12	59.59
T_5	9.42	9.68	9.92	9.27	0.156	0.159	0.161	0.168	60.32	61.03	61.47	55.18
T_6	8.58	8.63	8.90	8.27	0.157	0.160	0.164	0.166	54.77	54.07	54.30	49.70
T_7	8.27	8.55	8.83	8.10	0.154	0.157	0.159	0.165	53.80	54.52	55.46	49.19
T_8	7.67	7.88	7.98	7.52	0.146	0.149	0.157	0.165	52.50	52.98	50.73	45.55
T_9	7.63	7.93	7.80	7.32	0.147	0.149	0.155	0.162	51.90	53.19	50.30	45.35
T_{10}	6.68	6.85	7.45	6.38	0.149	0.151	0.157	0.163	44.97	45.45	47.58	39.13
T_{11}	6.35	6.70	6.93	6.22	0.145	0.148	0.153	0.161	44.02	45.24	45.45	39.56
SEm (±)	0.45	0.48	0.59	0.41	0.003	0.002	0.004	0.003	2.82	2.93	3.94	2.68
CD(P=0.05)	0.93	1.00	1.22	0.84	0.007	0.005	0.009	0.006	5.85	6.08	8.16	5.56

conformity with the study of Jagadeesh *et al*. (2001) who also reported significant role of wax in increasing the acidity of guava fruits. The maximum utilization of acid in the metabolism of organic acid during respiratory process might be the reason for minimum acidity in control.

TSS: acid ratio

The TSS: acid ratio is increased with the storage period till 8th day of storage and thereafter it gradually declines irrespective of all the treatments (Table 2). Among all the treatments, at 16th day of storage, the maximum TSS: acid was found in the fruits treated with paraffin wax (59.59%), followed by coconut oil (55.73%). The higher ratio in paraffin wax coated fruits might be due to high TSS and low acidity value. The high TSS in paraffin wax treated fruits might be due to more moisture loss from the fruits leading to more concentration of juice resulting in higher content of sugars, whereas minimum acidity may be due to increased respiration rate and more utilization of acids in biochemical activities leading to depletion of organic acids.

Total sugars

There was significant variation among the different coatings with respect to the total sugar content of the strawberry fruits. The total sugars of the fruits increased up to 8th day of storage and then followed by slight decline at 12th day of storage irrespective of treatments. At 16th day of storage, among all the treatments, coconut oil coating scored the maximum value with respect to total sugars (8.82%), followed by paraffin wax (8.27%).The increase in sugars up to 8th day of storage might be due to rapid conservation of polysaccharides into sugars.The decrease in sugars after 12th day might be due to metabolic breakdown and senescence of fruits during storage (Ryall and Pentzer 1982). These findings are in conformation with Jain and Mukherjee (2011) in mango.

Reducing sugars

Various coatings had significant effect irrespective of storage period on reducing sugar. The reducing sugars of the fruits increased with the increase in storage period from 4th day to 8th day of storage and thereafter it declined (Table 3).Among all the edible coatings, fruits treated with coconut oil have the maximum reducing sugars (5.74%), while the control have the lowest reducing sugars (4.86%) at 16th days of storage.The increase in sugars during storage period up to 8 days and thereafter a gradual decline might be due to conversion of organic acid into sugars (Baviskar *et al.* 1995). The decrease in sugars after 8th day might be due to use of sugars for metabolic activities like respiration and other energy sources of fruits.Yadav *et al.* (2010) also reported increase in reducing sugars with the storage period in mandarin orange and passion fruits.

Ascorbic acid

Ascorbic acid is one of the powerful antioxidant and scavenger of the reactive oxygen species (ROS) produced in the body thus helps to save the human from many serious diseases (Patel *et al*. 2011). The data presented in Table 3 indicated that during storage, in both coated and uncoated fruits, ascorbic acid had increased till 8th day of storage and thereafter decreases from 12th day of storage.The fruits coated with coconut oil and paraffin wax maintained the higher levels of ascorbic acid compared to other tested coatings. It might possibly be due to retardation of oxidation process and consequently slow rate of conversion of L-ascorbic acid into dehydroascorbic acid by ascorbic acid oxidase. The retention of higher ascorbic acid in wax

Table 3 Reducing sugars, total sugars, ascorbic acid and total anthocyanin content at different days after storage

Treatment	Reducing sugars (%)				Total sugars (%)				Ascorbic acid (mg/100 g)				Total anthocyanin content (mg/100 g)			
	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days
T_1	5.85	6.19	5.97	5.74	8.94	9.22	9.07	8.82	67.02	70.93	68.86	65.74	43.05	48.50	46.07	38.38
T_2	5.77	6.10	5.84	5.56	8.67	8.90	8.78	8.33	64.63	68.07	65.31	62.82	38.04	42.91	40.82	34.52
T_3	5.63	6.03	5.77	5.37	8.30	8.88	8.73	8.15	62.78	67.60	64.60	62.03	38.58	43.99	41.97	34.74
T_4	5.80	6.08	5.91	5.63	8.47	8.95	8.64	8.27	65.22	69.85	67.40	63.19	40.56	46.40	45.04	37.68
T_5	5.33	5.54	5.43	5.29	8.33	8.84	8.45	8.18	63.16	68.09	64.85	60.50	36.23	40.11	39.45	33.90
T_6	5.70	5.96	5.87	5.32	8.57	8.97	8.66	8.41	61.97	62.63	61.02	59.97	34.69	37.94	35.53	31.96
T_7	5.63	5.95	5.78	5.43	8.23	8.65	8.43	8.14	62.92	63.37	63.10	61.26	35.76	38.71	37.74	32.70
T_8	5.37	5.56	5.46	5.28	8.54	8.87	8.66	8.29	62.68	66.07	65.17	61.19	31.59	38.72	37.39	28.90
T_9	5.63	5.81	5.72	5.40	8.69	8.96	8.73	8.33	60.93	65.61	63.28	59.33	36.59	42.78	40.09	28.70
T_{10}	5.19	5.35	5.28	5.13	8.39	8.72	8.51	8.16	60.12	64.66	62.17	58.31	32.46	38.57	36.54	28.81
T_{11}	5.09	5.28	5.17	4.86	8.07	8.40	8.23	7.96	57.57	60.79	59.41	55.52	28.37	32.93	31.38	25.83
SEm (±)	0.30	0.22	0.08	0.14	0.36	0.13	0.08	0.07	1.74	2.04	1.65	1.16	2.49	2.86	2.05	1.96
CD(P=0.05)	0.61	0.46	0.17	0.29	0.75	0.28	0.17	0.14	3.62	4.24	3.41	2.40	5.15	5.94	4.25	4.07

coated fruits might be due to the ripening retarding effect and slow rate of biological activities during storage. Similar observations have also been recorded in mango (Jain and Mukherjee 2011) and mandarin orange (Yadav *et al*. 2010).

Total anthocyanins content

Anthocyanin is one of the important constituent which determines the attractiveness of the fruits and required for evaluation of maturity standards of strawberries (Ayala-Zavala *et al*. 2004).The results of the present study showed that (Table 3) the TAC significantly increased in the strawberry fruits during the first 8 days, but thereafter decreased up to the end of storage. Among all the treatments, fruits coated with coconut oil showed the highest TAC of 43.05, 48.50, 46.07 and 38.38 mg/100 g at 4, 8, 12 and 16th day of storage followed by paraffin wax. Among all the treatments, control recorded the lowest value with respect to total anthocyanin. The increase of TAC till 8th day of storage might be due to activation of its related enzymes as anthocyanins are the major phenolic compounds being synthesized in mature fruit during storage (Miguel *et al*. 2004).The decreased in TAC after 8th day of storage might be due to reduced activity of PPO and POD enzymes in coated fruits in response to changes in the internal atmosphere (Varasteh *et al*. 2012).Our study is in close conformity with the study of Wang and Gao (2012), who reported that in strawberry fruits, TAC increased substantially and reached a peak at 6th day and then decreased.

Appearance

The external appearance of fruit was affected adversely with the advancement of storage period irrespective of all the treatments (Table 4).The fruits treated with coconut oil scored maximum value for appearance of fruits (8.32, 7.70, 6.94 and 6.53) at 4, 8, 12 and 16 of storage, respectively followed by liquid paraffin wax. On the other hand, control fruits registered the minimum value (7.31, 6.37, 5.53 and 5.04) with respect to appearance respectively at 4, 8, 12 and 16th day of storage. The maximum score in the coconut oil coated fruits could be possibly due to creation of favourable gaseous atmosphere under congenial temperature and also due to delay in ripening and uniform colour development.The minimum score under control might be due to development of dark brown brownish spot on skin and softening of tissue by skin injury. Our results corroborated the findings of Jagadeesh *et al*. (2001) in guava fruits.

Flavour

Among the various treatments, the highest value for flavour (7.63, 8.28, 7.77 and 6.67) was recorded under coconut oil coating, followed by liquid paraffin wax (7.37, 8.13, 7.68 and 6.60), whereas control recorded the least value of flavour (6.93, 7.17, 6.99 and 5.97) at 4, 8, 12 and 16 days of storage. Among all the coatings, highest value for flavour in coconut oil till 8th days may be due to increase in sugars and TSS/acid ratio whereas;it decreased from12 days of storage due to degradation of the same. Our study is in close conformity with the study of Pandey *et al*. (2010).

Taste

The taste of the fruits is one of the important attributes which determines the quality of the fruits. In our present investigation, the taste of the fruits increases up to 8th day of storage and thereafter decreases from 12th day till 16th day of storage. Among all the edible coatings, coconut oil coating recorded the highest value of taste (7.53) followed by paraffin wax (7.13) while, the minimum value was recorded in control (5.87) at 16 days of storage (Table 4). The gradual increase in the taste of the fruits till 8th day of storage might be due to the increase in the concentration of

Table 4 Appearance, flavour, taste and overall acceptability at different days after storage

Treatment	Appearance				Flavour				Taste				Overall acceptability			
	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days	4 days	8 days	12 days	16 days
T_1	8.32	7.70	6.94	6.53	7.63	8.28	7.77	6.67	7.97	8.40	8.17	7.53	8.10	7.60	6.91	6.58
T_2	7.61	7.08	6.22	5.98	7.32	8.01	7.59	6.50	7.59	8.17	7.82	7.10	7.38	7.03	6.57	5.70
T_3	7.52	6.82	6.50	5.87	7.21	7.58	7.25	6.33	7.60	7.97	7.73	6.93	7.00	6.60	6.17	5.53
T_4	8.25	7.56	6.76	6.19	7.37	8.13	7.68	6.60	7.80	8.33	8.07	7.13	7.70	7.07	6.67	5.80
T_5	7.67	6.57	6.18	5.84	7.20	7.84	7.47	6.43	7.34	8.03	7.67	6.90	7.23	6.43	5.93	5.50
T_6	7.65	6.80	6.20	5.83	7.27	8.03	7.43	6.27	7.43	8.27	7.73	6.88	7.38	6.92	6.40	5.77
T_7	7.63	6.92	6.53	6.19	7.33	7.93	7.47	6.40	7.25	7.90	7.63	6.77	7.47	6.80	6.23	5.62
T_8	7.75	7.06	6.48	5.81	7.22	7.70	7.34	6.28	7.20	8.07	7.48	6.55	7.50	6.90	6.13	5.57
T_9	7.68	6.82	6.35	5.92	7.20	7.85	7.58	6.30	7.47	7.90	7.57	6.63	7.40	6.80	6.29	5.40
T_{10}	7.79	6.93	6.27	5.63	7.18	7.57	7.40	6.23	7.41	7.93	7.43	5.93	7.53	6.97	6.07	5.53
T_{11}	7.31	6.37	5.53	5.04	6.93	7.17	6.99	5.97	7.19	7.67	7.14	5.87	7.18	6.38	5.87	5.27
SEm (±)	0.18	0.25	0.21	0.23	0.11	0.19	0.12	0.16	0.22	0.15	0.13	0.23	0.20	0.28	0.23	0.26
CD (P=0.05)	0.38	0.51	0.44	0.48	0.24	0.40	0.24	0.33	0.46	0.31	0.27	0.47	0.41	0.58	0.47	0.53

total sugars and TSS as well as TSS/acid ratio contributing to the typical taste and thereafter decreases of these parameters from 12th days onwards.

Overall acceptability

The overall acceptability of fruit decreased with the advancement of storage period irrespective of the treatments (Table 4). The fruits treated with coconut oil had maximum score for overall acceptability (8.10, 7.60, 6.91 and 6.58) at 4, 8, 12 and 16 of storage period, followed by liquid paraffin wax. On the other hand, control fruits registered the minimum score (7.18, 6.38, 5.87 and 5.27).The overall acceptability of fruits depends on balance of sugars, acids, phenolicsand aromatic compounds along with visual appearance. The lowest score in control might be due to skin injury which further caused tissue softening and deflection of colour pigments leading to change in overall acceptability of fruits.

Conclusion

These results of the present investigation reflected the ability of the edible coatings on the quality retention and shelf-life extension of strawberry fruits. The coatings of paraffin wax have a beneficial impact in delaying in the weight loss,TSS, acidity and TSS/acid ratio.Similarly, coatings with coconut oil proved best in retaining marketability, total and reducing sugars, ascorbic acid, total anthocyanin content. Application of coconut oil retained maximum score of appearance, taste, flavour, texture and overall acceptability of strawberry fruits during storage. Hence, it can be concluded that coating of coconut oil maintained the best quality fruits and prolonged the shelf-life of strawberry fruits.

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