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Effect of edible coatings and packaging materials on shelf life and quality of mango (*Mangifera indica* L.) CV. Kesar

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Abstract
The present investigation entitled "Effect of edible coatings and packaging materials on shelf life and quality of Mango (*Mangifera indica* L.) cv. Kesar" was conducted during 2019-20 and 2020-21 at laboratory of Post-Harvest Technology, Department of Horticulture, M.P.K.V., Rahuri, Dist. Ahmednagar (M.S).

The experiment was laid out in Factorial Completely Randomize Design, which is replicated twice with two factors i.e. Factor A: edible coating, *i.e.* C_1-Control (without coated), C_2-Alginate (2%), C_3-Beeswax (2%), C_4-Aloe vera gel (75%), C_5-Tapioca starch (5%), C_6-Cinnamon oil (0.02%), C_7-Chitosan (0.5%), C_8-Acacia gum (5%), C_9-Pectin (2%). Factor B: packaging materials, *i.e.* P_1-Corrugated Fibre Boxe and P_2-Plastic crates. In this experiment, freshly harvested, mature, firm mango fruits were selected for each treatment combination and coated with nine different coating and packed in CFB box and Plastic crates as per the treatments. The treated fruits were stored at two different storage conditions *viz*. ambient temperature (AT) (26-30 ^{0}C with 54-62% R.H) and cold storage (CS) (13 ^{0}C with 90-95% R.H). Observations were taken at 4 days intervals up to the end of shelf life.

The coated fruits of mango packed and were stored at ambient temperature and cold storage it was found that there was increase in Physiological loss in weight, spoilage increase corresponding decrease in fruit firmness upon prolonged storage of mango fruit under both storage condition.

Fruit coated with beeswax 2% (T_2P_1) packed in CFB box at ambient temperature recorded significantly lowest PLW and higher firmness during storage. and also recorded minimum spoilage delay fruit ripening and longest shelf life during storage. Fruit coated with beeswax 2% (T_2P_1) packed in CFB box in cold storage recorded significantly lowest PLW and higher firmness during storag and also recorded no shriveling, minimum spoilage, delay fruit ripening and longest shelf life during storage. Higher sensory score for longer storage period was recorded in treatment T_7P_1 and T_3P_1.

The shelf life of control fruits (without coated) was found to be hardly 12 days at ambient temperature. The shelf life of fruit coated with chitosan 0.5% and beeswax 2% packed in CFB box was extended upto 16 days at ambient temperature during storage.

The shelf life of control fruits (without coated) was found to be hardly 20 days in cold storage. The shelf life of fruit coated with chitosan 0.5% and beeswax 2% packed in CFB box was extended upto 28 days at in cold storage during storage.

Keywords: Mango, Edibal coating, packaging, Kesa, CFB box

Introduction
Mango (*Mangifera indica* L.) is one of the oldest tropical fruit which is rightly known as "King of Fruits". It has intimate association with cultural religious, aesthetic and economic lives of Indians Since time immemorial and hence it is the national fruit of India. It is originated from South East Asia, the Indo Burma region, in foothills of the Himalayans (Mukhrjee, 1997). Mango is member of Anacardiaceae family. Mango can grow on wide variety of soils under varied climatic condition. The temperature between 24 and 27^{0}C is ideal for its cultivation. It can be grown best in region with a rainfall between 25 and 250 cm. Region having bright sunny days moderate humidity during flowering are ideal for mango growing.

The fruit has been in cultivation in Indian sub-continent for well over 4000 years and has been the favorite of the kings and commoners because of its nutritive value, taste, attractive fragrance and health promoting qualities. Due to its wide adaptability, richness in variety, delicious taste, pleasant flavor, attractive appearance, high nutritive value, it enjoys the unique popularity all over the world. The mango is an excellent fruit relished by children and adult alike. It has more nutritional value, which is the rich source of vitamins (vitamin A-4800 I.U.) and minerals as well as carbohydrates. The calorific value per 100 g is 50-60- on an average.

Ripe fruit of mango is fattening, diuretic and laxative. Beside table purpose, fruit of mango can be used for the preparation of pickles, preserves, jam, amchur, (mango powder), mango leather (ampapad) and mango fool (mango + milk + sugars) (Singh, 1992) [11].

The Kesar fruit should be harvested before ripening, when it attains full maturity but being a perishable fruit it causes glut in the market, hence to avoid glut in the market proper post harvest treatments and storage in appropriate packages and essential but at the same time due emphasis must be given on retention of good eating quality, like taste, flavor, colour, sweetness and vitamins. Furthermore, Kesar is an early cultivar having excellent fruit quality; hence it has a great scope for storage as there is no other good quality mango cultivar is available at that time which can competes with Kesar and there by sells at best prices. Various devises like low temperature storage, edible coating, and packing have successfully been tried to prolong the shelf-life of fruits. Kesar mango fruits cannot be stored for a longer period at ambient temperature. For good market price, it becomes essential that fruits must be transported to the distant market without spoilage.

Different effective pre harvest methods to prolong the shelf life are well studied. However, post-harvest treatment to increase shelf life are of immense importance as it will help to reduce or minimize the post harvest losses and cost on post harvest treatments. To minimize the post harvest losses, the post harvest treatments *viz.*, edible coating, packaging, cold storage are found to be effective.

Material and Methods

The present investigation entitled "Effect of edible coatings and packaging materials on shelf life and quality of Mango cv. Kesar (*Mangifera indica* L.)" was conducted during 2019-20 and 2020-21 at laboratory of Post-Harvest technology, Department of Horticulture, M.P.K.V., Rahuri, Dist. Ahmednagar (M.S).

Table 1: Details of treatment combination

C_1 P_1	Without coating+Corrugated fiberboard box
C_1 P_2	Without coating+ Plastic crates
C_2 P_1	Alginate (2%) +Corrugated fiberboard box
C_2 P_2	Alginate (2%) + Plastic crates
C_3 P_1	Beewax (2%) + Corrugated fiberboard box
C_3 P_2	Beewax (2%) + Plastic crates
C_4 P_1	Aloe vera gel (75%) + + Corrugated fiberboard box
C_4 P_2	Aloe vera gel (75%) + Plastic crates
C_5 P_1	Tapioca starch (5%) +Corrugated fiberboard box
C_5 P_2	Tapioca starch (5%) +Plastic crates
C_6 P_1	Cinnamon oil (0.02) + Corrugated fiberboard box
C_6 P_2	Cinnamon oil (0.02) + Plastic crates
C_7 P_1	Chitosan (0.5%) + Corrugated fiberboard box
C_7 P_2	Chitosan (0.5%) + Plastic crates
C_8 P_1	Acacia gum (5%) + Corrugated fiberboard box
C_8 P_1	Acacia gum (5%) +Plastic crates
C_9 P_1	Pectin (2%) + Corrugated fiberboard box
C_9 P_2	Pectin (2%) + Plastic crates

1. Observations recorded

The following physical constituents of Kesar Mango fruits were studied during the course of present investigation. Observation were recorded4 days interval at the end of shelflife offruit.

3. Physiological loss in weight (%)

Physiological weight loss was calculated based on weighted before storage and noted as the initial weight as the final weight. Weight loss was determined by the following formula and expressed as percentage.

$$\text{Physiological weight loss} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

4. Spoilage (%)

Each fruit was thoroughly examined for any visible symptoms of infection i.e. disease on every fourth day during storage. Fruit showing any sign of rot or mould was considered as 100% spoilage. The spoilage per cent calculated as,

$$\text{Spoilage (\%)} = \frac{\text{Number of fruit decayed}}{\text{Total number of fruits}} \times 100$$

5. Shelf life (days)

Each fruit was thoroughly scrutinized for any visible symptoms of spoilage and the end of shelf-life was considered when the 20 per cent fruits were shown over ripening or spoilage symptoms.

6. Firmness (N)

Firmness of fresh mango fruit was measured using an Instron Universal Testing Instrument (Make: Shimadzu, Japan; Model: AX-G). Different probe assemblies were used for different tests. Machine was connected to computer via software, this software coverts received signals, collects the data and converts it in graphical representation (texture profile) and prepare the reports of individual tests. The machine was fitted with1kg N load cell and an 8-mm diameter compressive probe, adapting conditions from Bashir and Abu-Goukh (2003) [2] and Reyes and Paull (1995) [10]. The probe was positioned at zero force contact with the 32 surface of the guava fruit. Probe penetration was set at 10 mm at a crosshead speed of 20mm/min and readings were taken at 3 equidistant points on the equatorial region of the fruit. The force (N) required to penetrate the fruit surface up to a specific depth (mm) was recorded.

7. Statistical analysis

The design adopted was completely randomized design with factorial concept and the data were subjected to statistical analysis as per the procedure advocated by Panse and Sukhatme (1995).

Result and Discussion

1. Physiological loss in weight

The data on effect of different coating and packaging on physiological loss in weight (PLW) (per cent) recorded during storage for the year 2019, 2020 and pooled analysis are present in Table 1 (AT) and 2 (CS) and depicted respectively.

The significant differences were observed among the different treatments in respect of physiological loss in weight of fruits at AT. The pooled data clearly showed that the treatment C_3 (beeswax 2%) minimum PLW (10.94%) which was followed by the treatment of C_7 (chitosan 0.5%) (11.45%) whereas, maximum PLW (22.66%) was observed in control C_1 at 16th days of storage. Packaging material exhibited significant

difference during storage. Rate of increase in PLW was slow in P_1 as compared to P_2. Highest PLW recorded by P_1 and P_2 was 14.15 and 16.20 per cent at 16th day respectively.

The interaction effect of different coating and packaging material, during storage on fruits PLW was significant during storage. The data presented in the Table 1 showed that PLW of the fruits in the pooled data shows increasing trend up to 16th day of storage. The minimum PLW (10.20%) was observed in the treatment C_3P_1 (beeswax 2% + CFB box) which was followed by the treatment C_7P_1 (chitosan 0.5% + CFB box) (10.94%), C_3P_2 (beeswax 2% + plastic crates) (11.68%). Whereas, maximum (24.33%) PLW was observed in control (C_1P_2) (uncoated fruit + plastic crates) treatment.

PLW showed significant difference with coatings treatments throughout the storage period in cold storage. Effect of different coatings could be recorded up to 28 days for C_2, C_3, C_4, C_5, C_7, C_8 and C_9. The pooled data clearly showed that the treatment T_3 and T_7 minimum PLW (12.80%) which was followed by the treatment of C_2 (12.85%) whereas, maximum PLW (18.50%) was recorded C_1 (control) up to 24th day of storage.

Packaging material showed significant difference during storage. Rate of increase in PLW was slow in P_1 as compared to P_2. Highest PLW recorded by P_1 and P_2 was 12.76 and 14.74 per cent at 28th day respectively.

The interaction effect of different coating and packaging material during storage on fruit PLW was significant during storage in CS. The data presented in the Table 2 showed that PLW of the fruits in the data showed increasing trend up to 28th day of storage. The minimum PLW (11.81%) was observed in the treatment C_3P_1 (beeswax 2% + CFB box) which was followed by the treatment C_7P_1 (chitosan 0.5% + CFB box), (12.03%), C_2P_1 (alginate 2% + CFB box) (12.23%) Whereas, maximum (19.36%) PLW was observed in control (C_1P_2) (uncoated fruit + plastic crates) treatment up to 24th day of storage.

The continuous increase in PLW could be due to loss of moisture from the fruit through respiration and transpiration. Higher respiration and evapo-transpiration rates in control fruits because of their direct contact with atmosphere could be the cause of higher PLW in control fruits. Similar results were also reported in Mango Castillo *et al.* (2010) [3], Valentina and Giovanna (2016) [12].

Waxing materials can cover fruit peel that reduced respiration and transpiration and finally resulted in reduced percent weight loss. Similarly Abonesh *et al*. (2018) [1], reported that the coating helps to reduce moisture loss and gaseous exchange from the fruits due to formation of a film on the top of the skin acting as an additional barrier.

2. Spoilage

Spoilage is a better indication to determine shelf life of mango fruit. The data on effect of different coating and packaging on spoilage (%) recorded during storage for the year 2019, 2020 and pooled analysis are present in Table 3 (RT) and Table 4(CS)

Table 3 represents effect of different postharvest treatments on spoilage of fruit. Data of individual and two factor interactions showed that at initial and 7th day spoilage percentage is zero, fruit started to spoil from 8th day onwards. This is because fruits under ambient storage started to spoil from 8th day and were discarded at 16th day as shelf life of fruit was ended. The individual factors (coatings and packaging materials) effect showed significant variation in spoilage percentage throughout the storage period. Among the nine coating C_7 (chitosan 0.5%) was found superior by recording minimum spoilage (12.50%) followed by C_3 (beeswax 2%) (1300%) and C_2 (alginate 2%) (15.00%) under ambient temperature at end of storage.

P_1 was found superior to P_2 as it recorded minimum spoilage under AT. While, considering storage conditions fruit under ambient temperature recorded 15.33% spoilage at end of storage period (12th day)

Data of two factor interactions showed that at initial and 7th day spoilage percentage is zero, fruit started to spoil from 8th day onwards. Among the interactions between coating and packaging material, fruits coated with C_7P_1 recorded minimum spoilage (12.00%) followed by C_3P_1, C_3P_2 and C_7P_2 (13.00%) during storage respectively.

Table 4 represents effect of different postharvest treatments on spoilage of fruit. Data of individual and two factor interactions showed that at initial and 15th day spoilage percentage is zero, fruit started to spoil from 16th day onwards. This is because fruit under cold storage started to spoil from 16th day and were discarded at 28th day as shelf life of fruit was ended. The individual factors (coatings) effect showed significant variation in spoilage percentage throughout the storage period. Among the nine coatings C_7 was found superior by recording minimum spoilage (14.50%) followed by C_3 (15.00%) and C_2 (16.50%) under CS at end of storage.

P_1 was found superior to P_2 as it recorded minimum spoilage under CS. While, considering storage conditions fruit under cold storage recorded 16.14 per cent spoilage at end of storage period (28th day).

Among the interactions between coating and packaging material, fruit coated with C_7P_1 recorded minimum spoilage (14.00%) followed by C_3P_1, during in cold storage. maximum spoilage was recorded in C_1P_2 (21.00%) at the end of storage (24th day).

Spoilage is mainly due to infestation of microbes during storage. After harvest there is a continuous biochemical change in fruits which leads to fruit softening. Soft fruits are susceptible to microbe infestation. These fruit under control ripened earlier and became soft, as a result the infestation of microbes started at faster rate. Chitosan coating limits the growth of fungi, and decrease the spoilage without affecting the ripening characteristics of fruit Abonesh *et al*. (2018) [1].CFB box packaging recorded minimum spoilage similar results observed by Mounika *et al*. (2017) [8] packaging films reduces spoilage and higher in fruits in control.

Maximum spoilage was recorded in ambient storage as compared to cold storage. It may be due to high temperature congenial for growth of microorganism was available at ambient storage. Present findings are in agreement with the results reported by Khanbarad *et al*. (2013) [5].

3. Shelf life (days)

The data on shelf-life of Kesar mangoes during storage for the year 2019, 2020 and pooled are presented in Table 5. There was significant difference in shelf-life of fruits influenced by different coating at ambient storage (AT). The data presented in the Table 5 it can be revealed that, in the pooled data significantly higher shelf-life (16.00 days) was found in fruits treated with chitosan (0.5%) + CFB box (C_7P_1), chitosan (0.5%) + plastic crates (C_7P_2), beeswax (2%) + CFB box

(C_3P_1), and beeswax (2%) + plastic crates (C_3P_2) which was statistically at par with fruit treated with alginate (2%) + CFB box (C_2P_1) and alginate (2%) + plastic crates (C_2P_2) (15.50 days). Minimum shelf-life (11.00 days) was observed in without coating + plastic crates (C_1P_2) treatment.

Significant difference in shelf-life of fruits influenced by different coating in cold storage (CS). The data presented in the Table 5 it can be revealed that, in the pooled data significantly higher shelf-life (28.00 days) was found in fruits treated with chitosan (0.5%) + CFB box (C_7P_1), chitosan (0.5%) + plastic crates (C_7P_2) and beeswax (2%) + CFB box (C_3P_1). which was statistically at par with fruit treated with beeswax (2%) + plastic crates (C_3P_2), alginate (2%) + CFB box (C_2P_1), and alginate (2%) + plastic crates (C_2P_2) (27.00 days). Minimum shelf-life (20.00 days) was observed in without coating + plastic crates (C_1P_2) treatment.

Generally, the fruits treated with beeswax 2 per cent and chitosan (0.5%) showed higher shelf-life with different quality attributes as compared to other treatments. This could be correlated with other quality attributes as the shelf-life extension is a cumulative effect of maintaining different quality attributes. The present results were similar with the studies of Penchaiya *et al*. (2006) [9]

Fruits packed CFB box recorded highest shelf life. This might be due to accumulation or maintenance of high relative humidity in the CFB box that reduced rate of transpiration. Similar results were obtained by Mounika *et al*. (2017) [8] in mango.

With respect to shelf life, cold storage fruits recorded maximum shelf life as compared to ambient temperature stored fruits. This might be due to the reduction in field heat in shortest possible time, restricted metabolic and respiratory activities, lower moisture loss, and inhibition in water loss and reduction in ethylene production in fruits (Hardenburg *et al*., 1990) [4].

4. Firmness (N)

The data on firmness (N) of mango fruit cv. kesar influenced by different postharvest coating is presented in Table 6 and 7 for the year 2019, 2020 and pooled depicted in (AT) and 7(CS) respectively. From the data it was understood that, fruit firmness maintained decreasing trend with extending storage period.

In pooled data individual effect of different coating showed significant variation in data C_3 recorded higher firmness (3.97 N) followed by C_7 (3.91 N) and C_2 (3.56 N) whereas, minimum firmness (2.76 N) was observed in control T_1 at 16th day of storage.

Packaging material exhibited significant difference during storage. Rate of decrease in firmness was slow in P_1 as compared to P_2. Highest firmness recorded by P_1 and P_2 was 3.19 N and 3.12 N at 16th day respectively.

The data presented in the Table 6 showed that firmness (N) of the fruits in the data shows decreasing trend up to 16th day of storage. The maximum firmness (3.97 N) was observed in the treatment C_3P_1 (beeswax 2% + CFB box) which is satatisticaly at par with the treatment C_3P_2 (beeswax 2% + Plastic crates), C_7P_1 (chitosan 0.5% + CFB box). Whereas, minimum (2.75N) firmness was observed in control (uncoated fruit + plastic crates) (C_1P_2) treatment up to 16th day of storage.

In case of storage condition, the fruit firmness was decreased rapidly in fruit stored in ambient storage than cold storage. Individual effect of different coating showed significant variation in pooled data. C_3 recorded higher firmness (3.78N) up to 28th day of storage followed by C_7 (3.67 N) and C_2 (3.60 N) whereas, minimum firmness (3.23 N) was observed in control C_1 at 24th day of storage.

Packaging material exhibited significant difference during storage. Rate of decrease in firmness was slow in P_1 as compared to P_2. Highest firmness recorded by P_1 and P_2 was 3.38 N and 3.20 N at 16th day respectively.

The interaction effect of different coating and packaging material during storage on fruit firmness (N) was significant during storage. The data presented in the Table 7 showed that firmness (N) of the fruits in the data shows decreasing trend up to 28th day of storage. The maximum firmness (3.94 N) was observed in the treatment C_3P_1 (beeswax 2% + CFB box) which was followed by the treatment C_7P_1 (chitosan 0.5% + CFB box), C_3P_2 (beeswax 2% + Plastic crates), C_7P_2 (chitosan 0.5% + Plastic crates), Whereas, minimum (3.12N) firmness (N) was observed in control (uncoated fruit + plastic crates) (C_1P_2) treatment up to 24th day of storage.

The firmness of mango cv. Kesar showed a decreasing pattern with the advancement of the storage period and the change being faster for untreated fruits than in any other treatments. The faster changes observed from untreated control might be as a result of enhanced ripening that lead to early softening. Fruit softening is associated with the processes of solubilization of pectic substances break down of starch to soluble sugars and loss of water from peel (Mebratie *et al*., 2015). Application of 2% beeswax and 0.5% chitosan was the most effective treatment resulting in higher firmness values throughout the storage period than all the rest treatments. This might be due to barrier properties of edible coatings towards O_2 as a physical barrier decreases respiration rate of the fruits. The reduction in respiration rate in turn reduced the activities of hydrolysis enzymes and retarded the softening of mango. In similar manner Abonesh *et al*. (2018) [1] reported that of wax coating had strong effect on retention of banana firmness.

Table 2: Effect of edible coatings and packaging materials on changes in physiological loss in weight (%) of Kesar mango fruit during storage at ambient temperature

Treatment	4 DAS			8 DAS			12 DAS			16 DAS		
	2019	2020	Pooled mean	2019	2020	Pool	2019	2020	Pooled mean	2019	2020	Pooled mean
A. Edible coating												
C_1: Control	5.93	6.33	6.13	9.98	11.63	10.80	15.57	17.15	16.36	22.50	22.83	22.66
C_2: Alginate (2%)	2.75	3.85	3.30	5.73	7.65	6.69	10.19	12.00	11.10	13.67	13.73	13.70
C_3: Beewax (2%)	2.53	3.93	3.23	5.58	6.76	6.17	10.25	8.85	9.55	10.85	11.03	10.94
C_4: Aloe vera gel (75%)	4.50	4.68	4.59	8.45	9.38	8.91	10.94	12.07	11.50	13.67	17.83	15.75
C_5: Tapioca starch (5%)	3.75	3.02	3.38	8.92	9.98	9.45	11.26	12.62	11.94	14.34	15.00	14.67
C_6: Cinnamon oil (0.02)	4.94	3.40	4.17	8.78	9.50	9.14	13.67	14.50	14.08	18.90	19.03	18.96
C_7: Chitosan (0.5%)	2.25	3.39	2.82	6.78	6.62	6.70	9.30	10.50	9.90	10.78	12.13	11.45

C_8: Acacia gum (5%)	2.96	3.26	3.11	7.78	8.89	8.33	10.50	11.58	11.04	12.25	13.43	12.84
C_9: Pectin (2%)	4.88	3.86	4.37	9.60	8.04	8.82	12.62	11.43	12.02	16.80	14.38	15.59
S.Em. (±)	0.05	0.08	0.07	0.01	0.04	0.03	0.04	0.04	0.04	0.06	0.03	0.05
CD at 1%	0.19	0.34	0.26	0.05	0.17	0.12	0.15	0.17	0.15	0.24	0.11	0.18
B. Packaging materials												
P_1: CFB box	3.31	3.06	3.18	7.18	8.03	7.61	10.56	11.10	10.83	13.75	14.54	14.15
P_2: Plastic crates.	4.35	4.88	4.61	8.73	9.39	9.06	12.62	13.49	13.06	15.97	16.43	16.20
S.Em. (±)	0.02	0.04	0.03	0.01	0.02	0.01	0.02	0.02	0.02	0.03	0.01	0.02
CD at 1%	0.09	0.16	0.12	0.02	0.08	0.06	0.07	0.08	0.07	0.12	0.05	0.08
C. Interaction (A x B)												
C_1 P_1	5.05	4.75	4.90	9.05	11.05	10.05	14.10	15.30	14.70	20.00	22.00	21.00
C_1 P_2	6.80	7.90	7.35	10.90	12.20	11.55	17.03	19.00	18.02	25.00	23.65	24.33
C_2 P_1	2.50	3.00	2.75	5.05	7.10	6.08	8.08	11.00	9.54	13.33	12.26	12.80
C_2 P_2	3.00	4.70	3.85	6.41	8.19	7.30	12.30	13.00	12.65	14.00	15.20	14.60
C_3 P_1	2.05	3.00	2.53	4.16	5.30	4.73	9.50	7.70	8.60	10.40	10.00	10.20
C_3 P_2	3.00	4.85	3.93	7.00	8.22	7.61	11.00	10.00	10.50	11.30	12.05	11.68
C_4 P_1	4.00	3.10	3.55	7.90	8.75	8.33	10.38	11.13	10.76	13.25	17.06	15.16
C_4 P_2	5.00	6.25	5.63	9.00	10.00	9.50	11.50	13.00	12.25	14.08	18.59	16.34
C_5 P_1	3.19	2.63	2.91	8.79	9.45	9.12	10.41	11.03	10.72	13.68	14.00	13.84
C_5 P_2	4.30	3.40	3.85	9.05	10.50	9.78	12.10	14.20	13.15	15.00	16.00	15.50
C_6 P_1	4.50	2.80	3.65	8.00	9.00	8.50	12.33	13.00	12.67	16.80	18.50	17.65
C_6 P_2	5.38	4.00	4.69	9.56	10.00	9.78	15.00	16.00	15.50	21.00	19.55	20.28
C_7 P_1	1.90	3.00	2.45	5.33	6.11	5.72	8.50	10.00	9.25	10.23	11.65	10.94
C_7 P_2	2.60	3.78	3.19	8.23	7.13	7.68	10.10	11.00	10.55	11.32	12.60	11.96
C_8 P_1	2.62	2.02	2.32	7.40	8.23	7.82	9.50	10.15	9.83	11.50	12.35	11.93
C_8 P_2	3.30	4.50	3.90	8.15	9.55	8.85	11.50	13.00	12.25	13.00	14.50	13.75
C_9 P_1	4.00	3.21	3.61	8.90	7.32	8.11	12.20	10.60	11.40	14.60	13.05	13.83
C_9 P_2	5.75	4.50	5.13	10.30	8.75	9.53	13.03	12.25	12.64	19.00	15.70	17.35
S.Em. (±)	0.07	0.12	0.10	0.02	0.06	0.04	0.05	0.06	0.06	0.08	0.04	0.07
CD at 1%	0.27	0.48	0.37	0.07	0.24	0.17	0.21	0.24	0.21	0.35	0.15	0.25

Table 3: Effect of edible coatings and packaging materials on changes in physiological loss in weight (%) of Kesar mango fruit during storage in cold storage

Treatment	4 DAS			8 DAS			12 DAS		
	2019	2020	Pooled mean	2019	2020	Pool	2019	2020	Pooled mean
A. Edible coating									
C_1: Control	2.69	2.34	2.51	4.12	4.34	4.23	8.80	8.73	8.76
C_2: Alginate (2%)	1.63	1.13	1.38	2.00	3.03	2.51	6.08	8.15	7.11
C_3: Beewax (2%)	1.24	0.93	1.08	1.75	2.60	2.18	5.88	6.00	5.94
C_4: Aloe vera gel (75%)	1.66	1.44	1.55	2.49	3.05	2.77	7.60	6.55	7.08
C_5: Tapioca starch (5%)	1.32	1.70	1.51	2.12	3.05	2.58	7.90	6.39	7.15
C_6: Cinnamon oil (0.02)	1.65	1.60	1.63	3.06	2.72	2.89	7.98	6.10	7.04
C_7: Chitosan (0.5%)	1.08	1.32	1.20	1.86	2.51	2.19	4.75	6.54	5.64
C_8: Acacia gum (5%)	1.21	1.53	1.37	2.05	2.53	2.29	7.20	6.26	6.73
C_9: Pectin (2%)	1.23	2.19	1.71	2.56	3.04	2.80	6.69	6.28	6.48
S.Em. (±)	0.05	0.01	0.03	0.01	0.02	0.02	0.01	0.02	0.02
CD at 1%	0.19	0.03	0.13	0.05	0.09	0.07	0.05	0.09	0.07
B. Packaging materials									
P_1: CFB box	1.36	1.15	1.25	2.23	2.18	2.21	6.33	5.90	6.11
P_2: Plastic crates.	1.69	2.00	1.84	2.66	3.79	3.22	7.64	7.65	7.65
S.Em. (±)	0.02	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01
CD at 1%	0.09	0.02	0.06	0.02	0.04	0.03	0.02	0.04	0.03
C. Interaction (A x B)									
C_1 P_1	2.50	1.63	2.07	3.93	2.98	3.45	8.55	7.45	8.00
C_1 P_2	2.88	3.05	2.96	4.30	5.70	5.00	9.05	10.00	9.53
C_2 P_1	1.25	0.90	1.08	1.20	2.50	1.85	5.00	7.10	6.05
C_2 P_2	2.00	1.35	1.68	2.80	3.55	3.18	7.15	9.20	8.18
C_3 P_1	0.92	0.85	0.89	1.40	1.60	1.50	5.15	5.00	5.08
C_3 P_2	1.55	1.01	1.28	2.10	3.60	2.85	6.60	7.00	6.80
C_4 P_1	1.02	0.98	1.00	1.70	2.50	2.10	7.10	6.05	6.58
C_4 P_2	2.30	1.90	2.10	3.27	3.60	3.44	8.10	7.05	7.58
C_5 P_1	1.00	1.15	1.08	1.73	2.10	1.92	6.80	5.60	6.20
C_5 P_2	1.64	2.25	1.95	2.50	4.00	3.25	9.00	7.18	8.09
C_6 P_1	1.60	1.10	1.35	3.05	1.90	2.48	7.10	5.01	6.06
C_6 P_2	1.70	2.10	1.90	3.07	3.54	3.31	8.86	7.19	8.03
C_7 P_1	1.29	0.80	1.05	2.38	1.90	2.14	4.50	5.90	5.20

C_7 P_2	0.87	1.83	1.35	1.34	3.12	2.23	5.00	7.17	6.09
C_8 P_1	1.48	1.05	1.27	2.55	1.95	2.25	6.39	5.49	5.94
C_8 P_2	0.93	2.00	1.47	1.55	3.11	2.33	8.00	7.03	7.51
C_9 P_1	1.15	1.85	1.50	2.15	2.20	2.18	6.35	5.50	5.93
C_9 P_2	1.30	2.52	1.91	2.98	3.88	3.43	7.02	7.05	7.04
S.Em. (±)	0.07	0.01	0.05	0.02	0.03	0.03	0.02	0.03	0.02
CD at 1%	0.27	0.05	0.18	0.07	0.13	0.07	0.12	0.09	0.07

Table 3: Contd….

Treatment	16 DAS			20 DAS			24 DAS			28 DAS		
	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
A. Edible coating												
C_1: Control	10.43	8.88	9.65	12.50	13.31	12.90	19.34	17.65	18.50	-	-	-
C_2: Alginate (2%)	8.37	7.60	7.99	10.71	9.95	10.33	10.76	11.60	11.18	12.76	12.94	12.85
C_3: Beewax (2%)	7.08	7.15	7.11	9.25	9.53	9.39	11.26	10.10	10.68	12.26	13.35	12.80
C_4: Aloe vera gel (75%)	8.65	7.65	8.15	10.55	9.60	10.08	12.89	12.73	12.81	15.42	14.01	14.71
C_5: Tapioca starch (5%)	9.10	8.35	8.72	11.08	10.59	10.83	12.63	12.09	12.36	15.15	14.30	14.72
C_6: Cinnamon oil (0.02)	11.04	9.00	10.02	12.80	11.42	12.11	13.60	12.69	13.14	-	-	-
C_7: Chitosan (0.5%)	6.77	6.68	6.72	8.25	9.08	8.66	10.58	10.95	10.76	11.84	13.77	12.80
C_8: Acacia gum (5%)	8.12	8.82	8.47	10.04	10.60	10.32	12.88	13.48	13.18	14.50	14.85	14.68
C_9: Pectin (2%)	7.78	7.95	7.86	10.11	10.85	10.48	12.87	13.53	13.20	15.63	11.74	13.68
S.Em. (±)	0.02	0.04	0.03	0.05	0.01	0.03	0.07	0.04	0.06	0.01	0.01	0.01
CD at 1%	0.10	0.15	0.12	0.19	0.05	0.13	0.29	0.15	0.22	0.03	0.04	0.03
B. Packaging materials												
P_1: CFB box	8.02	7.17	7.60	9.99	9.91	9.95	12.04	12.01	12.02	13.08	12.44	12.76
P_2: Plastic crates.	9.16	8.84	9.00	11.18	11.18	11.18	13.91	13.50	13.71	14.79	14.69	14.74
S.Em. (±)	0.01	0.02	0.01	0.02	0.01	0.02	0.03	0.02	0.03	0.01	0.01	0.01
CD at 1%	0.05	0.07	0.06	0.09	0.02	0.06	0.14	0.07	0.10	0.02	0.02	0.02
C. Interaction (A x B)												
C_1 P_1	9.85	8.00	8.93	11.50	12.56	12.03	18.22	17.05	17.63	-	-	-
C_1 P_2	11.00	9.75	10.38	13.50	14.05	13.78	20.47	18.25	19.36	-	-	-
C_2 P_1	7.39	7.00	7.20	10.25	9.00	9.63	8.73	10.89	9.81	11.96	12.50	12.23
C_2 P_2	9.35	8.20	8.78	11.16	10.90	11.03	12.80	12.30	12.55	13.56	13.37	13.47
C_3 P_1	6.15	6.50	6.33	8.00	8.50	8.25	10.51	9.00	9.76	11.41	12.20	11.81
C_3 P_2	8.00	7.80	7.90	10.50	10.56	10.53	12.00	11.20	11.60	13.10	14.50	13.80
C_4 P_1	7.30	6.80	7.05	9.30	9.10	9.20	11.56	12.00	11.78	14.56	12.32	13.44
C_4 P_2	10.00	8.50	9.25	11.80	10.10	10.95	14.21	13.45	13.83	16.27	15.70	15.99
C_5 P_1	8.20	7.69	7.95	10.10	9.85	9.98	11.25	11.33	11.29	13.40	13.00	13.20
C_5 P_2	10.00	9.00	9.50	12.05	11.33	11.69	14.00	12.85	13.43	16.89	15.60	16.25
C_6 P_1	10.64	8.80	9.72	12.60	10.80	11.70	13.20	12.03	12.62	-	-	-
C_6 P_2	11.43	9.20	10.32	13.00	12.03	12.52	14.00	13.34	13.67	-	-	-
C_7 P_1	6.50	5.36	5.93	7.69	8.65	8.17	10.00	9.85	9.93	11.22	12.83	12.03
C_7 P_2	7.03	8.00	7.52	8.80	9.50	9.15	11.15	12.05	11.60	12.45	14.70	13.58
C_8 P_1	9.19	7.41	8.30	10.63	10.27	10.45	12.20	12.95	12.58	14.00	13.20	13.60
C_8 P_2	7.05	10.23	8.64	9.44	10.93	10.19	13.55	14.00	13.78	15.00	16.50	15.75
C_9 P_1	7.00	7.00	7.00	9.87	10.44	10.16	12.68	13.00	12.84	15.00	11.02	13.01
C_9 P_2	8.55	8.90	8.73	10.35	11.25	10.80	13.05	14.05	13.55	16.26	12.45	14.36
S.Em. (±)	0.04	0.05	0.04	0.07	0.02	0.05	0.10	0.05	0.08	0.01	0.01	0.01
CD at 1%	0.14	0.21	0.17	0.27	0.07	0.19	0.42	0.21	0.31	0.05	0.06	0.05

Table 4: Effect of edible coatings and packaging materials on changes in spoilage (%) of Kesar mango fruit during storage at ambient temperature

Treatment	0 DAS			4 DAS			8 DAS			12 DAS			16 DAS		
	2019	2020	Pooled mean	2019	2020	Pool	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
A. Edible coating															
C_1: Control	0.00	0.00	0.00	0.00	0.00	0.00	7.00	5.00	6.00	16.00	17.00	16.50	20.00	19.00	19.50
C_2: Alginate (2%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	7.00	7.00	14.00	16.00	15.00
C_3: Beewax (2%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	7.00	6.00	12.00	14.00	13.00
C_4: Aloe vera gel (75%)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	9.00	9.00	9.00	17.00	18.00	17.50
C_5: Tapioca starch (5%)	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	8.00	8.00	8.00	16.00	17.00	16.50
C_6: Cinnamon oil (0.02)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.50	9.00	7.00	8.00	17.00	16.00	16.50
C_7: Chitosan (0.5%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	7.00	7.00	13.00	12.00	12.50
C_8: Acacia gum (5%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	5.00	8.00	6.50	16.00	15.00	15.50
C_9: Pectin (2%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	7.00	7.00	16.00	17.00	16.50
S.Em. (±)	-	-	-	-	-	-	0.03	0.05	0.04	0.12	0.08	0.10	0.08	0.12	0.10
CD at 1%	-	-	-	-	-	-	0.14	0.19	0.16	0.48	0.34	0.39	0.34	0.48	0.39

B. Packaging materials															
P_1: CFB box	0.00	0.00	0.00	0.00	0.00	0.00	1.33	1.11	1.22	8.67	8.00	8.33	15.11	15.56	15.33
P_2: Plastic crates.	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.67	0.89	7.56	9.11	8.33	16.22	16.44	16.33
S.Em. (±)	-	-	-	-	-	-	0.02	0.02	0.02	0.06	0.04	0.05	0.04	0.06	0.05
CD at 1%	-	-	-	-	-	-	0.06	0.09	0.07	0.23	0.16	NS	0.16	0.23	0.19
C. Interaction (A x B)															
C_1 P_1	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	16.00	16.00	16.00	20.00	18.00	19.00
C_1 P_2	0.00	0.00	0.00	0.00	0.00	0.00	8.00	4.00	6.00	16.00	18.00	17.00	20.00	20.00	20.00
C_2 P_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	6.00	7.00	14.00	16.00	15.00
C_2 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	8.00	7.00	14.00	16.00	15.00
C_3 P_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	12.00	14.00	13.00
C_3 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	8.00	6.00	12.00	14.00	13.00
C_4 P_1	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	2.00	10.00	10.00	10.00	16.00	18.00	17.00
C_4 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	8.00	18.00	18.00	18.00
C_5 P_1	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	8.00	8.00	8.00	14.00	16.00	15.00
C_5 P_2	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	8.00	8.00	8.00	18.00	18.00	18.00
C_6 P_1	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	1.00	10.00	6.00	8.00	16.00	16.00	16.00
C_6 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	8.00	18.00	16.00	17.00
C_7 P_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	6.00	7.00	12.00	12.00	12.00
C_7 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	8.00	7.00	14.00	12.00	13.00
C_8 P_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	6.00	8.00	7.00	16.00	14.00	15.00
C_8 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	4.00	8.00	6.00	16.00	16.00	16.00
C_9 P_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	16.00	16.00	16.00
C_9 P_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	8.00	16.00	18.00	17.00
S.Em. (±)	-	-	-	-	-	-	0.05	0.07	0.06	0.17	0.12	0.14	0.12	0.17	0.14
CD at 1%	-	-	-	-	-	-	0.19	0.27	0.22	0.68	0.48	0.56	0.48	0.68	0.56

Table 5: Effect of edible coatings and packaging materials on changes in spoilage (%) of Kesar mango fruit during storage in cold storage

Treatment	16 DAS			20 DAS			24 DAS			28 DAS		
	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
A. Edible coating												
C_1: Control	5.00	5.00	5.00	16.00	18.00	17.00	19.00	20.00	19.50	-	-	-
C_2: Alginate (2%)	0.00	1.50	0.75	4.00	4.00	4.00	11.00	12.00	11.50	15.00	18.00	16.50
C_3: Beewax (2%)	0.00	0.00	0.00	7.00	6.00	6.50	12.00	13.00	12.50	14.00	16.00	15.00
C_4: Aloe vera gel (75%)	0.00	0.00	0.00	7.00	8.00	7.50	13.00	14.00	13.50	16.00	18.00	17.00
C_5: Tapioca starch (5%)	0.00	0.00	0.00	5.00	7.00	6.00	11.00	14.00	12.50	18.00	17.00	17.50
C_6: Cinnamon oil (0.02)	0.00	0.00	0.00	5.00	10.00	7.50	16.00	15.00	15.50	-	-	-
C_7: Chitosan (0.5%)	0.00	0.00	0.00	2.00	2.00	2.00	11.00	14.00	12.50	14.00	15.00	14.50
C_8: Acacia gum (5%)	0.00	0.00	0.00	5.00	5.00	5.00	15.00	14.00	14.50	20.00	17.00	18.50
C_9: Pectin (2%)	0.00	1.00	0.50	4.00	6.00	5.00	18.00	15.00	16.50	20.00	19.00	19.50
S.Em. (±)	0.08	0.03	0.06	0.03	0.08	0.06	0.09	0.05	0.07	0.04	0.05	0.05
CD at 1%	0.34	0.14	0.24	0.14	0.34	0.24	0.37	0.19	0.28	0.16	0.23	0.18
B. Packaging materials												
P_1: CFB box	0.44	1.00	0.72	5.11	6.67	5.89	13.11	13.11	13.11	16.29	16.00	16.14
P_2: Plastic crates.	0.67	0.67	0.67	7.11	8.00	7.56	14.89	16.00	15.44	17.14	18.29	17.71
S.Em. (±)	0.04	0.02	0.03	0.02	0.04	0.03	0.04	0.02	0.03	0.02	0.03	0.02
CD at 1%	0.16	0.06	NS	0.06	0.16	0.12	0.17	0.09	0.13	0.09	0.12	0.10
C. Interaction (A x B)												
C_1 P_1	4.00	4.00	4.00	16.00	16.00	16.00	18.00	18.00	18.00	-	-	-
C_1 P_2	6.00	6.00	6.00	16.00	20.00	18.00	20.00	22.00	21.00	-	-	-
C_2 P_1	0.00	3.00	1.50	2.00	4.00	3.00	10.00	10.00	10.00	14.00	18.00	16.00
C_2 P_2	0.00	0.00	0.00	6.00	4.00	5.00	12.00	14.00	13.00	16.00	18.00	17.00
C_3 P_1	0.00	0.00	0.00	6.00	4.00	5.00	12.00	12.00	12.00	14.00	16.00	15.00
C_3 P_2	0.00	0.00	0.00	8.00	8.00	8.00	12.00	14.00	13.00	14.00	16.00	15.00
C_4 P_1	0.00	0.00	0.00	6.00	8.00	7.00	12.00	12.00	12.00	16.00	16.00	16.00
C_4 P_2	0.00	0.00	0.00	8.00	8.00	8.00	14.00	16.00	15.00	16.00	20.00	18.00
C_5 P_1	0.00	0.00	0.00	4.00	8.00	6.00	12.00	12.00	12.00	16.00	16.00	16.00
C_5 P_2	0.00	0.00	0.00	6.00	6.00	6.00	10.00	16.00	13.00	20.00	18.00	19.00
C_6 P_1	0.00	0.00	0.00	2.00	10.00	6.00	14.00	14.00	14.00	-	-	-
C_6 P_2	0.00	0.00	0.00	8.00	10.00	9.00	18.00	16.00	17.00	-	-	-
C_7 P_1	0.00	0.00	0.00	0.00	2.00	1.00	10.00	12.00	11.00	14.00	14.00	14.00
C_7 P_2	0.00	0.00	0.00	4.00	2.00	3.00	12.00	16.00	14.00	14.00	16.00	15.00
C_8 P_1	0.00	0.00	0.00	4.00	4.00	4.00	12.00	14.00	13.00	20.00	16.00	18.00
C_8 P_2	0.00	0.00	0.00	6.00	6.00	6.00	18.00	14.00	16.00	20.00	18.00	19.00
C_9 P_1	0.00	2.00	1.00	6.00	4.00	5.00	18.00	14.00	16.00	20.00	16.00	18.00
C_9 P_2	0.00	0.00	0.00	2.00	8.00	5.00	18.00	16.00	17.00	20.00	22.00	21.00

S.Em. (±)	0.12	0.05	0.09	0.05	0.12	0.09	0.13	0.07	0.10	0.05	0.08	0.07
CD at 1%	0.48	0.19	0.35	0.19	0.48	0.35	0.52	0.27	0.39	0.23	0.32	0.26

Table 6: Effect of edible coatings and packaging materials on shelf life of Kesar mango fruit during storage

Treatment	Ambient temperature			Cold storage		
	2019	2020	Pooled mean	2019	2020	Pooled mean
Interaction (A x B)						
C_1 P_1	12.00	12.00	12.00	20.00	22.00	21.00
C_1 P_2	10.00	12.00	11.00	20.00	20.00	20.00
C_2 P_1	16.00	15.00	15.50	28.00	26.00	27.00
C_2 P_2	16.00	15.00	15.50	28.00	26.00	27.00
C_3 P_1	16.00	16.00	16.00	28.00	28.00	28.00
C_3 P_2	16.00	16.00	16.00	28.00	26.00	27.00
C_4 P_1	15.00	13.00	14.00	26.00	24.00	25.00
C_4 P_2	14.00	13.00	13.50	24.00	24.00	24.00
C_5 P_1	15.00	14.00	14.50	26.00	26.00	26.00
C_5 P_2	13.00	14.00	13.50	26.00	24.00	25.00
C_6 P_1	14.00	13.00	13.50	24.00	22.00	23.00
C_6 P_2	13.00	13.00	13.00	22.00	22.00	22.00
C_7 P_1	16.00	16.00	16.00	28.00	28.00	28.00
C_7 P_2	16.00	16.00	16.00	28.00	28.00	28.00
C_8 P_1	15.00	15.00	15.00	26.00	26.00	26.00
C_8 P_2	15.00	15.00	15.00	24.00	24.00	24.00
C_9 P_1	15.00	14.00	14.50	22.00	24.00	23.00
C_9 P_2	15.00	14.00	14.50	22.00	24.00	23.00

Table 7: Effect of edible coatings and packaging materials on changes in firmness (N) of Kesar mango fruit during storage at ambient temperature

Treatment	0 DAS			4 DAS			8 DAS			12 DAS			16 DAS		
	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
A. Edible coating															
C_1: Control	16.10	16.05	16.08	12.21	11.85	12.03	7.85	8.10	7.98	5.08	5.05	5.07	2.92	2.60	2.76
C_2: Alginate (2%)	16.11	16.06	16.08	12.86	12.47	12.66	10.78	10.29	10.53	7.40	7.46	7.43	3.63	3.50	3.56
C_3: Beewax (2%)	16.11	16.04	16.07	13.02	12.74	12.88	10.78	10.43	10.60	7.91	7.81	7.86	4.32	3.62	3.97
C_4: Aloe vera gel (75%)	16.11	16.06	16.08	12.62	12.42	12.52	10.65	9.17	9.91	7.28	6.90	7.09	2.82	3.02	2.92
C_5: Tapioca starch (5%)	16.10	16.06	16.08	12.61	12.58	12.60	10.39	9.23	9.81	7.37	6.88	7.13	2.93	2.95	2.94
C_6: Cinnamon oil (0.02)	16.11	16.06	16.08	12.32	12.01	12.16	8.91	8.31	8.61	5.37	5.90	5.63	2.71	2.21	2.46
C_7: Chitosan (0.5%)	16.10	16.06	16.08	12.93	12.77	12.85	11.07	10.29	10.68	7.90	7.55	7.72	3.95	3.88	3.91
C_8: Acacia gum (5%)	16.11	16.06	16.08	12.56	12.54	12.55	10.31	10.16	10.24	7.40	7.02	7.21	2.90	3.07	2.98
C_9: Pectin (2%)	16.11	16.06	16.08	12.30	12.13	12.21	10.20	8.73	9.46	6.90	6.42	6.66	3.05	2.75	2.90
S.Em. (±)	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
CD at 1%	NS	NS	NS	0.07	0.11	0.09	0.08	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05
B. Packaging materials															
P_1: CFB box	16.11	16.06	16.08	12.70	12.51	12.61	10.21	9.49	9.85	7.01	6.81	6.91	3.30	3.08	3.19
P_2: Plastic crates.	16.10	16.05	16.08	12.51	12.26	12.38	9.99	9.34	9.66	6.90	6.74	6.82	3.19	3.05	3.12
S.Em. (±)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD at 1%	NS	NS	NS	0.03	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
C. Interaction (A x B)															
C_1 P_1	16.10	16.05	16.08	12.36	11.90	12.13	7.90	8.20	8.05	5.20	5.10	5.15	3.00	2.50	2.75
C_1 P_2	16.10	16.05	16.08	12.06	11.80	11.93	7.80	8.00	7.90	4.97	5.00	4.98	2.84	2.70	2.77
C_2 P_1	16.11	16.06	16.08	12.84	12.63	12.74	10.90	10.36	10.63	7.55	7.54	7.54	3.75	3.50	3.63
C_2 P_2	16.11	16.06	16.08	12.87	12.30	12.59	10.65	10.21	10.43	7.25	7.38	7.31	3.50	3.50	3.50
C_3 P_1	16.11	16.05	16.08	13.10	12.98	13.04	10.95	10.38	10.67	7.90	7.90	7.90	4.35	3.60	3.97
C_3 P_2	16.11	16.03	16.07	12.94	12.50	12.72	10.60	10.48	10.54	7.91	7.71	7.81	4.29	3.63	3.96
C_4 P_1	16.12	16.05	16.09	12.74	12.46	12.60	10.70	9.33	10.02	7.34	6.89	7.11	2.90	3.03	2.97
C_4 P_2	16.10	16.06	16.08	12.50	12.37	12.44	10.60	9.00	9.80	7.23	6.91	7.07	2.74	3.00	2.87
C_5 P_1	16.10	16.07	16.09	12.69	12.65	12.67	10.53	9.37	9.95	7.38	6.91	7.14	3.00	3.00	3.00
C_5 P_2	16.09	16.04	16.07	12.53	12.51	12.52	10.24	9.10	9.67	7.37	6.85	7.11	2.85	2.90	2.88
C_6 P_1	16.11	16.05	16.08	12.44	12.11	12.27	8.99	8.29	8.64	5.38	5.89	5.64	2.71	2.28	2.50
C_6 P_2	16.11	16.06	16.08	12.20	11.90	12.05	8.84	8.33	8.58	5.35	5.90	5.63	2.70	2.14	2.42
C_7 P_1	16.11	16.07	16.09	13.00	13.03	13.02	11.13	10.38	10.75	7.96	7.51	7.74	4.00	3.90	3.95
C_7 P_2	16.10	16.05	16.07	12.86	12.50	12.68	11.00	10.20	10.60	7.84	7.58	7.71	3.90	3.85	3.88
C_8 P_1	16.11	16.05	16.08	12.64	12.63	12.64	10.43	10.33	10.38	7.40	7.00	7.20	2.90	3.13	3.02
C_8 P_2	16.11	16.06	16.08	12.48	12.45	12.46	10.19	10.00	10.09	7.39	7.04	7.22	2.90	3.00	2.95
C_9 P_1	16.11	16.07	16.09	12.46	12.25	12.35	10.40	8.75	9.57	7.00	6.59	6.79	3.10	2.77	2.94

C_9 P_2	16.11	16.05	16.08	12.13	12.02	12.08	10.00	8.70	9.35	6.80	6.25	6.53	3.00	2.73	2.86
S.Em. (±)	0.03	0.02	0.02	0.02	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
CD at 1%	NS	NS	NS	0.10	0.16	NS	0.11	0.08	0.09	0.09	0.08	0.08	0.07	0.07	0.07

Table 8: Effect of edible coatings and packaging materials on changes in firmness (N) of Kesar mango fruit during storage in cold storage

Treatment	0 DAS			4 DAS			8 DAS			12 DAS		
	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean	2019	2020	Pooled mean
A. Edible coating												
C_1: Control	16.10	16.05	16.08	13.68	13.83	13.76	12.35	12.00	12.18	9.90	9.82	9.86
C_2: Alginate (2%)	16.11	16.06	16.08	15.15	14.18	14.67	13.41	13.52	13.47	11.90	11.38	11.64
C_3: Beewax (2%)	16.11	16.04	16.07	14.97	14.41	14.69	14.10	13.71	13.91	12.18	11.71	11.94
C_4: Aloe vera gel (75%)	16.11	16.06	16.08	14.54	14.23	14.38	13.74	13.32	13.53	11.00	11.09	11.04
C_5: Tapioca starch (5%)	16.10	16.06	16.08	14.70	14.04	14.37	13.42	13.23	13.32	11.47	11.12	11.30
C_6: Cinnamon oil (0.02)	16.11	16.06	16.08	14.25	14.10	14.17	12.24	12.20	12.22	10.36	11.13	10.74
C_7: Chitosan (0.5%)	16.10	16.06	16.08	15.01	14.38	14.70	14.14	13.69	13.92	11.99	11.98	11.99
C_8: Acacia gum (5%)	16.11	16.06	16.08	14.67	14.27	14.47	13.66	13.22	13.44	11.38	11.05	11.21
C_9: Pectin (2%)	16.11	16.06	16.08	13.82	14.19	14.01	12.80	12.34	12.57	10.94	10.72	10.83
S.Em. (±)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02
CD at 1%	NS	NS	NS	0.07	0.07	0.06	0.10	0.12	0.11	0.09	0.10	0.09
B. Packaging materials												
P_1: CFB box	16.11	16.06	16.08	14.59	14.25	14.42	13.51	13.11	13.31	11.44	11.22	11.33
P_2: Plastic crates.	16.10	16.05	16.08	14.47	14.11	14.29	13.13	12.94	13.03	11.03	11.00	11.02
S.Em. (±)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD at 1%	NS	NS	NS	0.03	0.03	0.03	0.05	0.06	0.05	0.04	0.05	0.04
C. Interaction (A x B)												
C_1 P_1	16.10	16.05	16.08	13.58	13.90	13.74	12.66	12.01	12.33	10.00	9.85	9.92
C_1 P_2	16.10	16.05	16.08	13.78	13.77	13.77	12.05	12.00	12.03	9.80	9.80	9.80
C_2 P_1	16.11	16.06	16.08	15.19	14.23	14.71	13.59	13.37	13.48	12.00	11.48	11.74
C_2 P_2	16.11	16.06	16.08	15.11	14.13	14.62	13.23	13.67	13.45	11.80	11.28	11.54
C_3 P_1	16.11	16.05	16.08	15.00	14.45	14.72	14.20	13.92	14.06	12.25	12.00	12.13
C_3 P_2	16.11	16.03	16.07	14.95	14.37	14.66	14.00	13.51	13.75	12.10	11.41	11.76
C_4 P_1	16.12	16.05	16.09	14.53	14.20	14.36	14.00	13.42	13.71	11.50	11.18	11.34
C_4 P_2	16.10	16.06	16.08	14.55	14.25	14.40	13.48	13.22	13.35	10.50	11.00	10.75
C_5 P_1	16.10	16.07	16.09	14.71	14.12	14.41	13.87	13.30	13.58	11.67	11.12	11.40
C_5 P_2	16.09	16.04	16.07	14.69	13.95	14.32	12.98	13.16	13.07	11.27	11.13	11.20
C_6 P_1	16.11	16.05	16.08	14.59	14.42	14.50	12.32	12.31	12.31	10.63	11.14	10.88
C_6 P_2	16.11	16.06	16.08	13.90	13.79	13.84	12.16	12.10	12.13	10.10	11.12	10.61
C_7 P_1	16.11	16.07	16.09	15.03	14.38	14.70	14.24	13.80	14.02	12.10	12.05	12.08
C_7 P_2	16.10	16.05	16.07	15.00	14.38	14.69	14.05	13.58	13.81	11.89	11.91	11.90
C_8 P_1	16.11	16.05	16.08	14.83	14.33	14.58	13.75	13.44	13.59	11.75	11.31	11.53
C_8 P_2	16.11	16.06	16.08	14.50	14.20	14.35	13.57	13.00	13.28	11.00	10.80	10.90
C_9 P_1	16.11	16.07	16.09	13.89	14.23	14.06	12.97	12.46	12.71	11.08	10.85	10.96
C_9 P_2	16.11	16.05	16.08	13.75	14.16	13.95	12.64	12.22	12.43	10.80	10.60	10.70
S.Em. (±)	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.03	0.03
CD at 1%	NS	NS	NS	0.10	0.10	0.09	0.14	0.17	0.15	0.13	0.14	0.13

Conclusion

From the presented research it can be said that edible coating technology is a green technology and need of present era. Various food and drug administrations and Food safety regulatory bodies have not only approved but also have prescribed the safe limits of edible coatings. The advantage of storage of fruit by using edible coating is easily applicable with cheap and locally available raw materials

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