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Influence of coating materials on physical parameters of grand naine cultivar of banana during storage at ambient condition

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Abstract

The present investigation entitled “Influence of coating materials on physical parameters of Grand Naine cultivar of Banana during storage at ambient condition” was conducted during 2025-26 at the Horticulture Processing Laboratory, Department of Fruit Science, College of Agriculture, IGKV, Raipur. The study was undertaken to evaluate the effect of different coating materials on physical characteristics of banana fruits. The experiment was laid out in Completely Randomized Design with 3 replication and 11 treatments viz. T₀: Control, T₁: Moringa extract 10%, T₂: Aloe vera 50%, T₃: Rice starch 3%, T₄: Chitosan 2%, T₅: Moringa extract 10% + Chitosan 2%, T₆: Moringa extract 10% + Aloe vera 50%, T₇: Moringa extract 10% + Rice starch 3%, T₈: Aloe vera 50% + Chitosan 2%, T₉: Aloe vera 50% + Rice starch 3% and T₁₀: Rice starch 3% + Chitosan 2% and stored under ambient conditions. Observations on physical parameters were recorded at every 3 day intervals. Results revealed that among the treatments, T₅: Moringa extract 10% + Chitosan 2% performed superiorly and recorded the maximum shelf life (18.48 days), fruit weight (1982.31 g), fruit diameter (13.25 mm) and firmness (3.87 kg/cm²), along with the minimum physiological weight loss (12.46%) after 18 days of storage.

Keywords: Banana, coating materials, moringa extract, edible coating

Introduction

Banana (*Musa paradisiaca* L.), belonging to the family Musaceae, is one of the important tropical fruit crops grown worldwide. It is widely consumed in fresh as well as processed forms due to its good taste, nutritional value, affordability and easy digestibility. The crop is characterized by a tall herbaceous perennial plant with a pseudo stem formed by tightly overlapping leaf sheaths and large spirally arranged leaves, attaining a height of about 6-8 m (Rahman *et al.*, 2006) ^[13]. Banana is considered one of the oldest fruit crops cultivated by humans and has been associated with the cultural and religious traditions of India since ancient times. It is an important energy-rich fruit due to its high carbohydrate and vitamin content. Almost every part of the plant is utilized for different purposes. Cultivated bananas are mainly derived from the wild species *Musa acuminata* and *Musa balbisiana* and are supported by well- developed production and marketing systems (Patel *et al.*, 2018) ^[12]. Banana and plantain are important fruit crops of tropical regions and contribute significantly to food security and agricultural economies. Their cultivation provides employment opportunities and serves as an important source of income for farmers in banana-growing areas (Harrison and Schwarzacher, 2007) ^[7].

India is the leading producer of banana, contributing nearly 25% of global production. The crop is cultivated over about 0.995 million ha with a production of 37.47 million tonnes and productivity of 37-38 tonnes per ha. Tamil Nadu is the major producing state, followed by Maharashtra, Gujarat, Andhra Pradesh and Karnataka (Anon., 2024a). In Chhattisgarh, banana is cultivated across almost all districts, covering about 24.54 thousand ha with a production of 590.157 thousand tonnes and productivity of 24.04 tonnes per ha. Balrampur has the largest cultivated area, while Raigarh records the highest production (Anon., 2024b).

Banana is an important nutritious fruit rich in carbohydrates, dietary fibre, minerals and vitamins. It provides about 89 kcal energy and 21.8 g carbohydrates per 100 g fresh pulp, along with appreciable amounts of potassium, calcium, magnesium and ascorbic acid (Rahman *et al.*, 2020) ^[14].

Banana is highly susceptible to post-harvest losses of about 30-40% due to improper handling, inadequate storage, senescence, browning and microbial growth. Under ambient conditions, its shelf life is generally limited to 10-12 days, while mechanical injuries further reduce fruit quality and marketability. Edible coatings are safe and eco-friendly post-harvest treatments that form a protective layer on the fruit surface and help reduce moisture and gas exchange. They can be applied by dipping, spraying or brushing and are useful for extending storage life and maintaining fruit quality (Baldwin *et al.*, 2011) ^[4]. An edible coating is a thin, consumable layer that regulates the transfer of moisture, oxygen and solutes between the fruit and its surroundings (McHugh and Senesi, 2000) ^[10]. Due to their edible, non-toxic and biodegradable nature, edible coatings are increasingly used for improving fruit quality and shelf life.

Materials and methods

Fresh, mature and uniform-sized banana fruits were collected from the field of Commercial Tissue Culture Laboratory, Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG) at the appropriate stage of maturity and brought to the Horticulture Processing Laboratory, Department of Fruit Science, College of Agriculture, IGKV, Raipur for the study. The fruits were properly washed and cleaned before the application of treatment. Each fruit was then coated individually with the respective coating materials according to the treatment combinations. The experiment was conducted in a Completely Randomized Design (CRD) with 11 treatments and 3 replications, comprising 396 fruits in total, with 12 fruits per treatment per replication. The treatments were T₀: Control, T₁: Moringa extract 10%, T₂: Aloe vera 50%, T₃: Rice starch 3%, T₄: Chitosan 2%, T₅: Moringa extract 10% + Chitosan 2%, T₆: Moringa extract 10% + Aloe vera 50%, T₇: Moringa extract 10% + Rice starch 3%, T₈: Aloe vera 50% + Chitosan 2%, T₉: Aloe vera 50% + Rice starch 3% and T₁₀: Rice starch 3% + Chitosan 2%.

Following treatment application, the coated fruits were arranged in trays and stored under ambient conditions at 22-24 °C. The experiment was continued until the fruits reached the acceptable quality stage to assess the influence of different coating materials on shelf life, ripening behaviour and physico-chemical characteristics of banana fruits. The observations were recorded at every 3 days interval on fruit weight (g), fruit diameter (mm), physiological loss in weight (%), fruit firmness (kg/cm²) and shelf life (days).

Results and Discussion

Physical parameters of banana fruits: The results obtained for these parameters are presented in Tables 1 to 5.

Fruit weight (g): The fruit weight of banana exhibited significant variation among different coating treatments throughout the storage period. Among the evaluated treatments, fruits treated with T₅ Moringa extract 10% + Chitosan 2% recorded the highest fruit weight of 2250.12, 2242.57, 2189.67, 2080.66 2049.62 and 1982.31g on the 3rd, 6th, 9th, 12th, 15th and 18th day of storage, respectively. In contrast, the lowest fruit weight of 1780.97, 1672.71, 1498.80 and 1299.00 g was

recorded in T₀ (control) on the 3rd, 6th, 9th and 12th day of storage, respectively. Fruits under the control treatment could not be retained up to the 15th and 18th days of storage. The higher fruit weight retention in Moringa extract 10% + Chitosan 2% coated fruits may be attributed to the formation of a protective layer over the fruit surface, which reduces moisture loss during storage. Similar observations were reported by Tareque *et al.* (2020) ^[15, 17] in banana fruits, Saste *et al.* (2023) in sapota, Marupudi *et al.* (2013) in fig and Golhani *et al.* (2013) ^[6] in custard apple.

Fruit diameter (mm): Significant differences were observed among the coating treatments with respect to fruit diameter during storage. The maximum fruit diameter was recorded in fruits treated with T₅ Moringa extract 10% + Chitosan 2% with values of 14.50, 14.38, 14.29, 14.09, 13.90 and 13.25 mm on the 3rd, 6th, 9th, 12th, 15th and 18th day of storage, respectively. On the other hand, the minimum fruit diameter of 13.02, 13.00, 12.78 and 12.07 mm was observed in T₀ (control) on the 3rd, 6th, 9th and 12th day of storage, respectively. No fruits from the control treatment remained available for observation on the 15th and 18th days of storage. The better retention of fruit diameter in Moringa extract 10% + Chitosan 2% treated fruits could be associated with reduced moisture loss and delayed deterioration during storage. These findings are in conformity with the observations of Malmiri *et al.* (2011) ^[8], Tareque *et al.* (2020) ^[17] in banana and Sharmin *et al.* (2015) ^[16] in papaya fruits.

Physiological loss in weight (%): The physiological loss in weight (%) of banana fruits differed significantly among the treatments during storage. The minimum weight loss of 3.18, 6.42, 10.23, 12.32, 12.40 and 12.46 % was recorded in fruits treated with T₅: Moringa extract 10% + Chitosan 2% on the 3rd, 6th, 9th, 12th, 15th and 18th day of storage, respectively. In comparison, the maximum weight loss of 8.00, 10.31, 14.92 and 18.52% was recorded in T₀ (control) on the 3rd, 6th, 9th and 12th day of storage, respectively. Fruits under the control treatment were not available for further observations on the 15th and 18th days due to their rapid deterioration. The lower PLW observed in Moringa extract 10% + Chitosan 2% coated fruits may be attributed to the semi-permeable coating formed on the fruit surface, which restricted moisture loss and thereby maintained the fruit weight for a longer period. The present findings are in close agreement with those reported by Golhani *et al.* (2013) ^[6] in custard apple, Marupudi *et al.* (2013) ^[9] in fig and Malmiri *et al.* (2011) ^[8] in banana fruits.

Fruit firmness (kg/cm²): The fruit firmness of banana varied significantly among the different coating treatments during the storage period. The highest fruit firmness of 9.23, 9.10, 7.79, 6.25, 4.19 and 3.87 kg/cm² was recorded in fruits treated with T₅: Moringa extract 10% + Chitosan 2% on the 3rd, 6th, 9th, 12th, 15th and 18th day of storage, respectively. In contrast, the lowest fruit firmness of 8.52, 8.20, 7.00 and 5.12 kg/cm² was observed in T₀ (control) on the 3rd, 6th, 9th and 12th day of storage, respectively. Fruits under the control treatment were not available for further observations on the 15th and 18th days of storage. The higher retention of firmness in Moringa extract 10% + Chitosan 2% treated fruits may be attributed to the

coating layer formed on the fruit surface, which helped to reduce moisture loss and retard the softening process during storage. Similar findings were reported by Mendy *et al.* (2019) ^[1, 11] in papaya Adetunji *et al.* (2012) in pineapple, Brishti *et al.* (2013) ^[5] in papaya and Malmiri *et al.* (2011) ^[8] in banana.

Shelf-life (days): Significant variation in the shelf-life of banana fruits was observed among the different coating treatments. The maximum shelf-life of 18.48 days was recorded in T₅ (Moringa extract 10% + Chitosan 2%), which was statistically at par with T₈ (Aloe vera 50% + Chitosan 2%) having 18.44 days, T₁₀ (Rice starch 3% + Chitosan 2%) having 18.41 days, T₄ (Chitosan 2%) having 18.35 days and T₆ (Moringa extract 10% + Aloe vera 50%) having 18.23 days. A moderate increase in shelf-life (15.00 days) was observed in T₁ (Moringa extract 10%), which stood significantly distinct from the others. In comparison, the minimum shelf-life of 12.35 days was recorded in T₀ (control). The treatment-wise values are presented in Table 5. The present findings are in accordance with the observations of Adetunji *et al.* (2012) ^[1] in pineapple fruits, Sharmin *et al.* (2015) ^[16] in papaya; Malmiri *et al.* (2011) ^[8], Tareque *et al.* (2020) ^[17] in banana fruits.

Discussion: The overall results indicated that coating treatments were effective in maintaining the physical quality and extending the storage life of banana fruits under ambient conditions. T₅ (Moringa extract 10% + Chitosan 2%) consistently performed better than the other treatments by retaining higher fruit weight and fruit diameter, recording lower weight loss and maintaining higher fruit firmness throughout storage, which was reflected in its maximum shelf-life of 18.48 days. The better retention of fruit weight and diameter and the lower weight loss may be attributed to the protective coating layer formed on the fruit surface, which reduced moisture loss during storage. The higher retention of firmness may likewise be associated with reduced moisture loss and retardation of the softening process. The prolonged shelf-life may be related to reduced physiological deterioration, moisture loss and softening, thereby delaying the overall ripening process. These findings are in agreement with observations reported by Tareque *et al.* (2020) ^[17] in banana fruits, Saste *et al.* (2023) ^[15] in sapota, Marpudi *et al.* (2013) ^[9] in fig, Golhani *et al.* (2013) ^[6] in custard apple, Malmiri *et al.* (2011) ^[8] in banana.

Table 1: Effect of different coating materials on Fruit weight (g) of banana cv. Grand Naine during storage

Notations	Treatments	Fruit weight (g)					
		3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS
T0	Control (No Coating)	1780.97d	1672.71g	1498.80f	1299.00g	0.00*	0.00*
T1	Moringa extract 10%	1924.32b	1877.22d	1794.08c	1682.02d	1518.04c	0.00*
T2	Aloe vera 50%	1845.44bcd	1765.20efg	1645.21e	1567.23ef	0.00*	0.00*
T3	Rice starch 3%	1822.39cd	1726.18fg	1625.09e	1520.06f	0.00*	0.00*
T4	Chitosan 2%	2212.98a	2105.02bc	2049.56b	1967.45bc	1949.31b	1932.19b
T5	Moringa extract 10% + Chitosan 2%	2250.12a	2242.57a	2189.67a	2080.66a	2049.62a	1982.31a
T6	Moringa extract 10% + Aloe vera 50%	2185.45a	2087.35c	1978.22b	1923.08c	1919.09b	1899.29c
T7	Moringa extract 10% + Rice starch 3%	1922.35b	1826.39de	1739.12cd	1625.10de	0.00*	0.00*
T8	Aloe vera 50% + Chitosan 2%	2229.65a	2219.62a	2185.66a	2025.67ab	1965.19b	1955.30ab
T9	Aloe vera 50% + Rice starch 3%	1882.69bc	1781.25ef	1677.28de	1577.04ef	0.00*	0.00*
T10	Rice starch 3% + Chitosan 2%	2218.59a	2185.58ab	2136.44a	2019.29ab	1952.22b	1939.20b
	SE (m) ±	26.92	28.54	29.58	24.97	20.62	10.84
	C.D. at 5%	78.97	83.72	86.76	73.23	60.48	31.79

DAS: Days after storage

* value shows rotted/ discarded fruits

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

Table 2: Effect of different coating materials on Fruit diameter (mm) of banana cv. Grand Naine during storage

Notations	Treatments	Fruit diameter (mm)					
		3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS
T0	Control (No Coating)	13.02c	13.00c	12.78d	12.07d	0.00*	0.00*
T1	Moringa extract 10%	13.23c	13.20c	13.19cd	13.09bc	12.40d	0.00*
T2	Aloe vera 50%	13.13c	13.10c	13.04cd	12.97bc	0.00*	0.00*
T3	Rice starch 3%	13.09c	13.06c	12.86cd	12.82c	0.00*	0.00*
T4	Chitosan 2%	14.00ab	13.84ab	13.79ab	13.49ab	13.33bc	13.03ab
T5	Moringa extract 10% + Chitosan 2%	14.50a	14.38a	14.29a	14.09a	13.90a	13.25a
T6	Moringa extract 10% + Aloe vera 50%	13.42bc	13.38bc	13.36bc	13.12bc	13.00c	12.72b
T7	Moringa extract 10% + Rice starch 3%	13.20c	13.18c	13.16cd	13.02bc	0.00*	0.00*
T8	Aloe vera 50% + Chitosan 2%	14.34a	14.30a	14.27a	14.00a	13.60ab	13.19a
T9	Aloe vera 50% + Rice starch 3%	13.16c	13.12c	13.08cd	13.00bc	0.00*	0.00*
T10	Rice starch 3% + Chitosan 2%	14.02ab	14.00a	13.95a	13.82a	13.56ab	13.10a
	SE (m) ±	0.21	0.19	0.16	0.18	0.17	0.11
	C.D. at 5%	0.61	0.58	0.47	0.55	0.55	0.32

DAS: Days after storage* value shows rotted/ discarded fruits

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

Table 3: Effect of different coating materials on Physiological loss in weight (%) of banana cv. Grand Naine during storage

Notations	Treatments	Physiological loss in weight (%)					
		3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS
T0	Control (No Coating)	8.00a	10.31a	14.92a	18.52a	0.00*	0.00*
T1	Moringa extract 10%	5.02e	7.98c	12.82b	14.44e	15.82a	0.00*
T2	Aloe vera 50%	6.10c	8.89b	13.00b	17.82b	0.00*	0.00*
T3	Rice starch 3%	7.79b	8.92b	13.02b	18.49a	0.00*	0.00*
T4	Chitosan 2%	3.62g	6.97d	10.75cd	12.92f	12.98c	12.99b
T5	Moringa extract 10% + Chitosan 2%	3.18i	6.42e	10.23d	12.32g	12.40d	12.46c
T6	Moringa extract 10% + Aloe vera 50%	3.89f	6.98d	11.02c	13.00f	13.49b	13.89a
T7	Moringa extract 10% + Rice starch 3%	5.54d	8.65b	12.85b	15.53d	0.00*	0.00*
T8	Aloe vera 50% + Chitosan 2%	3.28hi	6.71de	10.40cd	12.54fg	12.62cd	12.80bc
T9	Aloe vera 50% + Rice starch 3%	5.68d	8.74b	12.90b	16.73c	0.00*	0.00*
T10	Rice starch 3% + Chitosan 2%	3.42h	6.81d	10.55cd	12.89f	12.92c	12.82bc
	SE (m) $\pm$	0.06	0.10	0.19	0.15	0.16	0.12
	C.D. at 5%	0.18	0.31	0.57	0.44	0.47	0.35

DAS: Days after storage

* value shows rotted/ discarded fruits

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

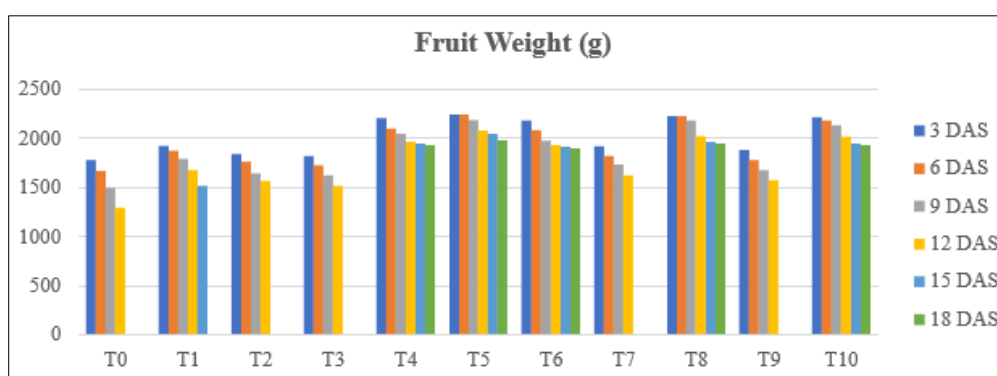
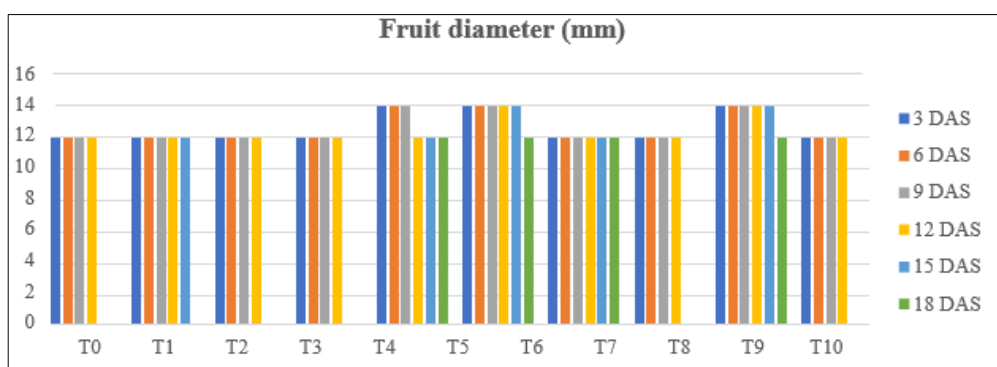
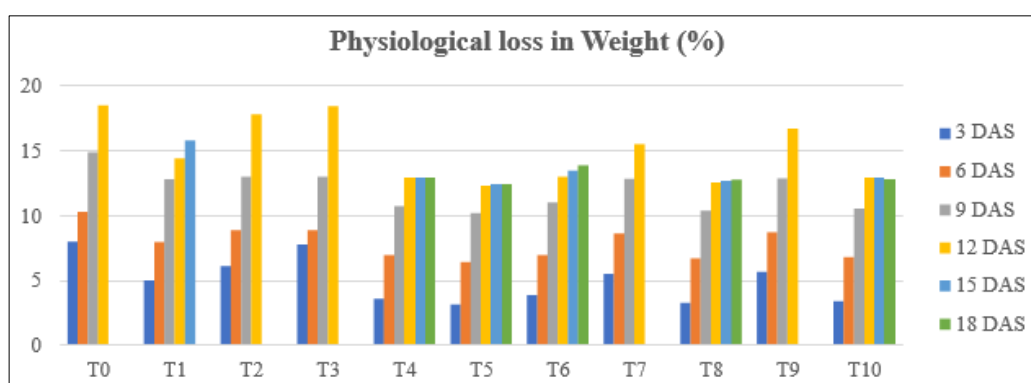
**Fig 1:** Effect of different coating materials on Fruit weight (g) of banana cv. Grand Naine during storage**Fig 2:** Effect of different coating materials on Fruit diameter (mm) of banana cv. Grand Naine during storage**Fig 3:** Effect of different coating materials on Physiological loss in weight (%) of banana cv. Grand Naine during storage

Table 4: Effect of different coating materials on Fruit firmness (kg/cm²) of banana cv. Grand Naine during

Notations	Treatments				Fruit firmness(kg/cm ²)			
		3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS	
T0	Control (No Coating)	8.52d	8.20b	7.00d	5.12e	0.00*	0.00*	
T1	Moringa extract 10%	8.85bcd	8.55b	7.46abc	5.87bc	3.88c	0.00*	
T2	Aloe vera 50%	8.65d	8.35b	7.27bcd	5.52d	0.00*	0.00*	
T3	Rice starch 3%	8.62d	8.33b	7.20cd	5.23e	0.00*	0.00*	
T4	Chitosan 2%	9.02abc	9.01a	7.51abc	6.17a	4.09ab	3.04c	
T5	Moringa extract 10% +Chitosan 2%	9.23a	9.10a	7.79a	6.25a	4.19a	3.87a	
T6	Moringa extract 10% +Aloe vera 50%	9.01abc	9.00a	7.48abc	6.07ab	4.00b	2.89d	
T7	Moringa extract 10% + Rice starch 3%	8.76cd	8.49b	7.42bc	5.72cd	0.00*	0.00*	
T8	Aloe vera 50% + Chitosan 2%	9.20a	9.08a	7.61ab	6.22a	4.17a	3.79a	
T9	Aloe vera 50% + Rice starch 3%	8.68d	8.39b	7.39bc	5.65cd	0.00*	0.00*	
T10	Rice starch 3 % + Chitosan 2%	9.15ab	9.04a	7.59ab	6.20a	4.11ab	3.51b	
	SE (m) ±	0.10	0.12	0.10	0.07	0.04	0.03	
	C.D. at 5%	0.29	0.36	0.30	0.22	0.12	0.09	

DAS: Days after storage

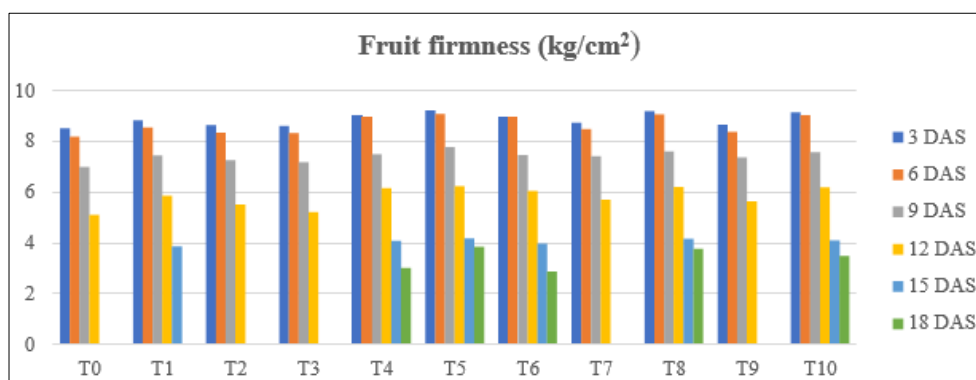
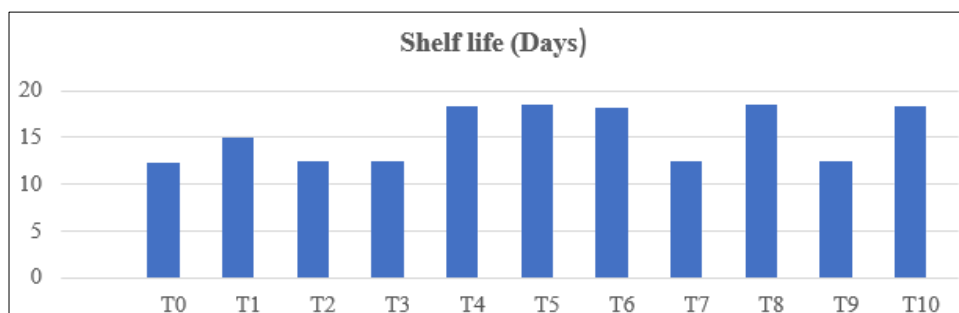
* value shows rotted/ discarded fruits

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

Table 5: Effect of different coating materials on Shelf life (days) of banana cv. Grand Naine during storage

Notation	Treatments	Shelf life (days)
T0	Control (No Coating)	12.35c
T1	Moringa extract 10%	15.00b
T2	Aloe vera 50%	12.43c
T3	Rice starch 3%	12.42c
T4	Chitosan 2%	18.35a
T5	Moringa extract 10% +Chitosan 2%	18.48a
T6	Moringa extract 10% +Aloe vera 50%	18.23a
T7	Moringa extract 10% + Rice starch 3%	12.46c
T8	Aloe vera 50% + Chitosan 2%	18.44a
T9	Aloe vera 50% + Rice starch 3%	12.44c
T10	Rice starch 3 % + Chitosan 2%	18.41a
	Se(m)±	0.24
	C.D. at 5%	0.71

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD-value comparison of treatment means.

**Fig 4:** Effect of different coating materials on Fruit firmness (kg/cm²) of banana cv. Grand Naine during storage**Fig 5:** Effect of different coating materials on Shelf life (Days) of banana cv. Grand Naine during storage

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