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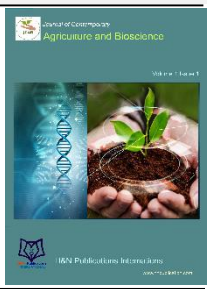

Research Article **Open Access**

Effects of Various Post-harvest Treatments on Quality of Banana

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A b s t r a c t

An experiment was conducted at the laboratory of the Department of Horticulture and Biochemistry, Bangladesh Agricultural University, Mymensingh, to evaluate the pattern of shelf life and quality of banana cv. Amritasagar and Mehersagar under different postharvest chemical treatments. There were six treatments viz. Control, Refrigerator (storage at 14°C), Ascorbic acid, Potassium aluminium sulphate, un-perforated polythene bag containing $KMnO_4$ and calcium chloride. The two-factor experiment was laid out in a completely randomized design (CRD) with three replications. Significant variation was found between the varieties Mehersagar and Amritasagar for fruit characteristics. Among the physical parameters such as total weight loss, pulp to peel ratio, moisture content and titratable acid content decreased during storage in all the treated and untreated banana fruits. Among the treated and untreated banana fruits, potassium permanganate, Ascorbic acid, Poatassium alluminium sulphate, and low temperature treatments exhibited better storage performance. Among all postharvest treatments, $KMnO_4$ were found to be the best in reducing weight loss, pulp to peel ratio, % moisture content and disease incidence. These effects ultimately resulted in remarkably prolonged shelf life.

Keywords: Banana, post-harvest, treatment and quality.

Introduction

Banana is a familiar fruit of Bangladesh. From its native southwestern Pacific home, the banana plant spread to India by about 600 BC and later on it spread all over the tropical world. It is possibly the world's oldest cultivated crop. Banana (*Musa sapientum,* family Musaceae) is one of the tallest herbaceous plants with a pseudostem (Rahman *et al.,* 2006).

Among the fruit crops grown in Bangladesh, banana ranks first in terms of production comprising nearly 24.6% of the total. Bangladesh produced 798012 metric tons of bananas from 117159 hectare of land and its production has been increasing day by day. However, banana being a delicate and highly perishable fruit, the local production is subjected to serious post-harvest losses mainly due to harvesting at improper maturity stage, poor handling and storage practices and post-harvest diseases.Varieties of banana grown in Bangladesh are Amritasagar, Mehersager, Sabri, Champa, ChiniChampa, Kabuli, Jahaji, Agnishwar, Basrai, Seeded banana, Anaji or Kancha Kola and Singapuri, etc. (Haque, 1988).

Nowadays, demand of banana consumption is increasing day by day due to its high caloric and nutritional value, but non-availability of adequate postharvest storage facilities has posed a great threat to the commercial cultivation of banana. Appropriate storage facilities and knowledge about storage are insufficient. As a result, considerable amount of banana is spoiled every year. Banana is a perishable fruit and its postharvest losses range from 25- 50% (Amiruzzaman, 1990). This loss occurs during transporting and marketing due to adverse physiological changes (loss of weight due to increased respiration and transpiration), softening of flesh and lack of resistance capacity against microbial attack.

In Bangladesh postharvest losses of banana due to environmental drivers (high temperature and humidity) ranges from 25-40% and it is only 5-25% in developed countries (Kader, 1992). Recently Hassan (2010) reported that the postharvest loss of banana is 24.62% which accounts for 56.7 crore taka annually. Any success in improving postharvest quality by extending shelf life or preventing postharvest decay is advantageous in enlarging markets and broadening consumer appeal. The postharvest losses of banana can be reduced considerably by applying improved technologies. Prolongation of shelf life of banana may be done by some techniques like using packaging materials, chemicals, hot water, fungicide, ethylene absorbent and growth regulators which are usually employed for this purpose in the developed countries.

Therefore, it is necessary to study and understand the shelf life of banana under different fungicidal and chemical treatments to mitigate the postharvest losses.

Materials and method

The experiment was conducted in the laboratory of Department of Horticulture, Bangladesh Agriculture University, Mymensingh. The minimum and maximum temperatures as well as relative humidity ranged in storage room were 20°C to 32°C and 82 % to 90 % respectively. Temperature and humidity of the storage room were recorded with a thermometer, hygrometer respectively. Two varieties of banana Mehersagar and Amritasagar were harvested in the morning hours and transferred to the Horticulture department yard as early as possible firstly by Van with careful handling to avoid injury and placed in shelf life room of Postgraduate Laboratory, Department of Horticulture, Bangladesh Agricultural University. Following their arrival in the laboratory bunches were cooled by air condition to quickly remove the field heat. Both upper and lower 1-2 hands of each cultivar were cut off for ensuring the experimental unit of more or less uniform. Individual fingers were separated from the hands of bunches and one hundred eighty fingers of each varieties were used for the experiment. The two-factor experiment was laid out in completely randomized design (CRD) with three replications of five fruits per replication.

Factor A: Varieties

V1: Amritasagar
V2: Mehersagar

Factor B: Different Postharvest Treatments

T_0: Control
T_1: Fruits were kept in refrigerated incubator at low temperature (14°C)
T_2: Ascorbic acid (50g/1L for 10 minutes)
T_3: Potassium alluminiumsulphate (50g/1L for 10 minutes)
T_4: Fruits were kept in un-perforated transparent polythene bag containing KMnO4
T_5: Calcium chloride (0.5% solution) treatment for 10 minutes.

Application of experimental treatments

Control: About a number of 30 fingers of each variety were selected and randomly arranged with replication and kept on the brown paper placed on the table in the laboratory at ambient atmospheric conditions (30±2°C and 66 to 74% RH).

Storage at low temperature: For low temperature storage, thirty fingers of each variety were selected and randomly arranged with replication and kept in the refrigerated incubator (FOC 255 I, Velp Scientifica) where temperature was maintained at 14°C.

Ascorbic acid: 50g Ascorbic acid was taken in 1 litre of water and made 50g/1L solution. Then banana hands were dipped in the solution for 10 minutes and placed in brown paper.

Potassium alluminium sulphate: 50g potassium alluminium sulphate was taken in 1Litre of water and made 50g/1L solution. Then the banana hands were dipped in the solution for 10 minutes and placed in brown paper.

Un-perforated transparent polythene bag containing $KMnO_4$: The banana fingers were kept in un-perforated transparent polythene cover, which contained a small polybag filled with cotton soaked in $KMnO_4$ solution. The polybag had 4 perforations to make sure that the liberated ethylene can be absorbed through the perforation. The top of the polythene cover was tied with a string, and placed on the brown paper placed on the table in the laboratory at ambient conditions (30±2°C and 66 to 74% RH).

Calcium chloride: Calcium chloride was taken in a 0.5% of water and 5% solution was prepared. The banana hands were dipped into the solution for 10 minutes then placed on brown paper.

Parameters studied:

Determination of weight loss (%): The banana hands used in this study were weighed using a top balance and kept for storage. Percent total weight loss was calculated at intervals of 3, 6, 9 ,12 and 15 days of storage using the following formula:

$$\text{Percent weight loss (WL)} = \left(\frac{IW-FW}{FW}\right) \times 100$$

Where,

% WL = Percentage total weight loss IW= Initial fruit weight and FW= Final fruit weight

Pulp to peel ratio: The fruits were peeled at the intervals of 3, 6, 9 12 and 15 days of storage. After separation of peel from pulp, the peel and pulp weights were also taken separately by using an electric balance and then the pulp to peel ratio was calculated. The pulp was then used for other chemical analysis.

Moisture content (%): Five grams of banana pulp were weighed in a petridish from each treatment out of each replication. The petridish was placed in an electric oven at 80°C for 72 hours until the weight became constant. It was then cooled and weighed again. Finally, the per cent moisture content of banana pulp was calculated using the following formula:

$$\text{Percent moisture} == \left(\frac{IW-FW}{IW}\right) \times 100$$

IW =Initial weight of pulp, and
FW =Final weight of oven dried pulp

Titratable acid content of banana pulp: Titratable acid content of banana pulp was determined by Ranganna (1979). The following reagents were used for the determination of titratable acidity

i. Standard NAOH solution (0.1N)
ii. 1% phenolphthalein solution

Procedure: 10g of fruit pulp was taken and homogenized with distilled water in a blender. The blended materials were boiled for 1 hour under refluxing. The whole mass was then transferred to a 100ml volumetric flask and the volume was made up in the mark with distilled water. Ten ml pulp solution was taken in a conical flask. Two to three drops of phenolphthalein indicator was added and then flask was shaken vigorously. It was then titrated immediately with 0.1 N NaOH solution from a burette till a permanent pink colour was appeared. The volume of NaOH solution required from titration was noted and percent titrable acidity was caculated by suing the following formula:

$$\text{Percent titratable acidity} = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 1000} \times 100$$

Where

T= Titre	V_1 = Volume made up
N= Normality of NAOH	V_2 = Volume of extract
E= Equivalent weight	W = Weight of Sample

Disease incidence: Disease incidence means percentage of bananas infected with diseases. The incidence of banana was recorded at every 2 day intervals. The diseased fruits were identified symptomatically. The disease incidence was calculated as follows:

$$\text{Disease Incidence (\%)} = \frac{\text{Number of banana infected}}{\text{Total number of banana}} \times 100$$

The collected data on various parameters were statistically analyzed using MSTAT statistical package to find out the variation resulting from experimental treatments following F variance test. The significance of difference between the pair of means was compared by LSD test at 1% and 5% level of probability (Gomez and Gomez, 1984).

Results and discussions

In respect of weight loss of banana, we observed a significant variation among the varieties at all the days of storage period. At 3rd days of storage the total weight loss was highest in Mehersagar (3.28%) variety and lowest in Amritasagar (3.08%). The weight loss

at 15th days, the highest value was recorded in Mehersagar (24.716%) variety and lowest in Amritasagar (23.166%) (Fig. 1). From this result it was found that the total weight loss was minimum in Amritasagar at early date of storage but later days of storage the weight loss was maximum in Mehersagar.

The different postharvest treatments exhibited more pronounced effect on weight loss of banana during storage. Variation among the treatments was highly significant during all days of storage. Total weight loss treated and untreated banana was increased with the duration of storage. The maximum weight loss (15.61%) was in control treatment at 9th days of storage then at 15th days of storage total weight loss decline (6.03%). The maximum total weight loss was found in T_5 treatment (28.89%) and minimum in T_4 treatment (17.38%) at 15th days of storage (Fig. 2). The minimum rate of weight loss in all days of observation was also recorded in T_4 treatment. These results are supported by the findings of Bhadra and Sen (1997). They found that polythene cover with $KMnO_4$ was the best for reducing physiological weight loss of custard apple during storage.

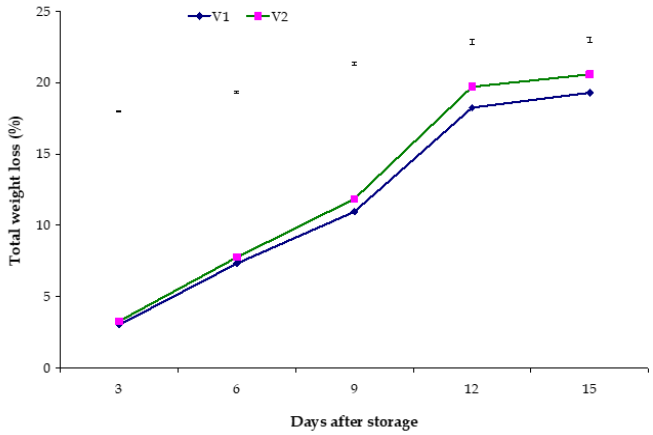

Fig 1. Main effect of postharvest treatments on percent total weight loss of banana at different days after storage. Vertical bars represent LSD at 5% level of significance.

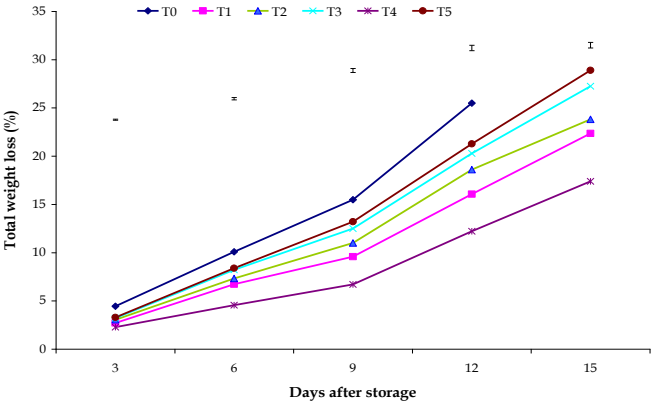

Fig 2. Main effect of postharvest treatments on percent total weight loss of banana at different days after storage. Vertical bars represent LSD at 5% level of significance.

The combined effect of two varieties and postharvest treatments were statistically significant at all days of observation. The higher level of weight loss (26.60%) was recorded in Mehersagar with control treatment at 12th days of storage and 15th days of storage was not observed due to rotting. At 15th days of storage, the maximum weight loss (29.09%) was observed in Mehersagar with T_5 treated fruits followed by (28.70%) Amritasagar with T_5 treated fruit and minimum (16.69%) was observed in Mehersagar with polythene bag containing $KMnO_4$ treated fruits (Table 1). The minimum weight loss in polythene bag containing $KMnO_4$ treatment is supported by the finding of Sarker *et al*. (1997).

Table 1. Combined effects of variety and post-harvest treatment on percent weight loss at different days after storage of banana

Treatment combination	Weight loss (%) at different days after storage				
	3	6	9	12	15
V_1T_0	4.05	9.25	14.66	24.40	0.00
V_1T_1	2.70	6.69	9.55	15.50	20.21
V_1T_2	3.02	7.27	10.64	18.40	22.05
V_1T_3	3.17	8.20	12.08	19.52	26.80
V_1T_4	2.05	4.36	6.45	11.65	18.07
V_1T_5	3.21	8.21	12.37	20.04	28.70
V_2T_0	4.85	10.90	16.30	26.60	0.00
V_2T_1	2.70	6.75	9.60	16.61	24.50
V_2T_2	3.05	7.38	11.35	18.80	25.60
V_2T_3	3.25	8.22	12.90	21.04	27.70
V_2T_4	2.50	4.75	6.96	12.79	16.69
V_2T_5	3.35	8.55	14.02	22.50	29.09
$LSD_{0.05}$	0.18	0.40	0.68	0.91	0.93
$LSD_{0.01}$	0.25	0.55	0.92	1.23	1.27
Level of significance	**	**	**	*	**

** = Significant at 1% level of probability

Two banana varieties showed wide magnitude of changes in the pulp to peel ratio at different days of storage. The pulp to peel ratio increased in both varieties gradually at 12th days of storage and declined at 15th days of storage. Higher ratios were observed in Amritasagar (2.24, 2.86, 2.96, 3.16) than Mehersagar (2.15, 2.69, 2.88, 2.91) at 3rd, 6th, 9th and 12th days of storage respectively and then declined in Amritasagar (2.64) and Mehersagar (2.44) at 15th days of storage (Table 2). From the above result it can be remarked that peel of Amritasagar became dry and lose in weight rapidly than Mehersagar.

The treatments showed a noticeable effect on pulp to peel ratio and variation among the treatments were statistically significant at different days of storage. In control the highest pulp to peel ratio was recorded (2.57) at 12th days of storage and at 15th days of storage the value was (0) due to rotten. But except control, pulp to peel ratio was increasing up to 15th days of storage for other treatments. At 15th day of storage the ratio was (3.85) in T_4 treatment followed by T_1 treatment (3.54). Gradual increase of pulp to peel ratio was observed in all successive days of storage (Table 3).

The combined effects of varieties and different postharvest treatments were statistically significant. In control the highest pulp to peel ratio (2.62) was found in Amritasagar with control treatment followed by Mehersagar with control treatment (2.51) and both combinations were not possible to measure at 15th day of storage (Table 4). On the other hand, without control combination pulp to peel ratios were gradually increased up to 15th days of storage. The increase in pulp to peel ratio during ripening was observed by Tripathi *et al*. (1981), Krishnamurthy (1993). The increased ratio during storage may be related to the change in sugar concentration in the pulp compared to the peel thus contributing to different change in osmotic pressure. Water is lost from the peel of banana both by transpiration and osmosis. As a result the peel weight is reduced and pulp to peel ratio increases.

Significant variation in respect of percent moisture content was observed between two varieties of banana used in the present study at 3rd, 6th, 9th, 12th, 15th day of storage. The highest moisture content (70.33%) was found in Mehersagar variety at 12th days of storage (Table 5).

The variation among the treatments was found highly significant during storage. The moisture content was gradually rise up to 15th

days of storage except control. Maximum moisture content (74.85%) was recorded in fruits under T5 treatment and the minimum moisture content (67.90%) was found in fruits under modified atmosphere packaging with KMnO4 at 15th days of storage (Table 6).

Table 2. Main effect of variety on pulp to peel ratio at different days after storage of banana

Variety	Pulp to peel ratio at different days after storage				
	3	6	9	12	15
V_1	2.24	2.86	2.96	3.16	2.64
V_2	2.15	2.69	2.88	2.91	2.44
$LSD_{0.05}$	0.031	0.022	0.022	0.038	0.038
$LSD_{0.01}$	0.042	0.029	0.029	0.051	0.051
Level of significance	**	**	**	**	**

V_1 =Amritasagar, V_2 =Mehersagar, ** = Significant at 1% level of probability

Table 3. Main effect of post-harvest treatment on pulp to peel ratio at different days after storage of banana.

Post-harvest treatments	Pulp to peel ratio at different days after storage				
	3	6	9	12	15
T_0	2.09	2.22	2.39	2.57	0.00
T_1	2.24	3.15	3.28	3.42	3.54
T_2	2.19	2.86	3.05	3.08	3.27
T_3	2.15	2.77	2.90	2.78	3.13
T_4	2.36	3.23	3.41	3.70	3.85
T_5	2.13	2.42	2.52	2.68	3.00
$LSD_{0.05}$	0.053	0.038	0.038	0.065	0.065
$LSD_{0.01}$	0.072	0.051	0.051	0.088	0.088
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability

Table 4. Combined effects of variety and post-harvest treatment on pulp to peel ratio at different days after storage of banana

Treatment combination	Pulp to peel ratio at different days after storage				
	3	6	9	12	15
V_1T_0	2.10	2.23	2.40	2.62	
V_1T_1	2.28	3.20	3.35	3.56	3.64
V_1T_2	2.21	3.01	3.12	3.28	3.32
V_1T_3	2.17	2.98	2.91	2.98	3.14
V_1T_4	2.51	3.28	3.41	3.73	3.85
V_1T_5	2.15	2.43	2.59	2.80	3.12
V_2T_0	2.08	2.20	2.37	2.51	-
V_2T_1	2.19	3.10	3.21	3.28	3.43
V_2T_2	2.17	2.71	2.98	2.88	3.22
V_2T_3	2.12	2.55	2.88	2.57	3.12
V_2T_4	2.20	3.17	3.40	3.66	3.75
V_2T_5	2.11	2.41	2.44	2.55	2.87
$LSD_{0.05}$	0.075	0.053	0.053	0.092	0.092
$LSD_{0.01}$	0.102	0.072	0.072	0.125	0.125
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability

Table 5. Main effect of variety on percent moisture content at different days after storage of banana

Variety	Moisture content (%) at different days after storage				
	3	6	9	12	15
V_1	57.24	60.01	64.19	66.80	57.91
V_2	60.46	61.42	65.04	70.33	61.79
$LSD_{0.05}$	0.24	0.16	0.09	0.13	0.12
$LSD_{0.01}$	0.32	0.22	0.12	0.17	0.16
Level of significance	**	**	**	**	**

V_1 =Amritasagaar, V_2 =Mehersagar ** = Significant at 1% level of probability, NS = Not significant

The combined effect of varieties and postharvest treatments varied significantly in respect of moisture content at different days of storage period. At 15th day of storage, the highest moisture content (78.40%) was found in V_2T_5 and the lowest moisture content (65.25%) was found in Amritasagar variety under modified atmosphere packaging with KMnO4 at 15th day of storage (Table 7).

Table 6. Main effect of post-harvest treatments on percent moisture content at different days after storage of banana

Post-harvest treatments	Moisture content (%) at different days after storage				
	3	6	9	12	15
T_0	63.67	65.30	68.19	0.00	0.00
T_1	55.51	57.99	61.50	66.75	69.95
T_2	56.68	59.65	64.45	68.84	73.05
T_3	61.75	63.21	66.39	69.50	73.38
T_4	52.75	54.33	60.15	65.19	67.90
T_5	62.78	63.83	67.05	72.56	74.85
$LSD_{0.05}$	0.41	0.28	0.15	0.22	0.20
$LSD_{0.01}$	0.56	0.38	0.20	0.30	0.27
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability

Table 7. Combined effects of variety and post-harvest treatment on percent moisture content at different days after storage of banana

Treatment combination	Moisture content (%) at different days after storage				
	3	6	9	12	15
V_1T_0	61.35	63.80	68.05	-	
V_1T_1	54.34	57.72	60.68	64.79	68.80
V_1T_2	55.36	58.90	64.35	67.84	70.70
V_1T_3	59.75	62.74	65.79	68.60	71.30
V_1T_4	51.71	53.75	59.74	62.83	65.25
V_1T_5	60.95	63.15	66.55	69.93	71.30
V_2T_0	65.98	66.80	68.32	-	-
V_2T_1	56.67	58.25	62.31	68.71	71.10
V_2T_2	58.00	60.39	64.54	69.84	75.40
V_2T_3	63.75	63.67	66.98	70.40	75.46
V_2T_4	53.78	54.90	60.55	67.54	70.40
V_2T_5	64.60	64.50	67.55	75.18	78.40
$LSD_{0.05}$	0.59	0.39	0.21	0.32	0.28
$LSD_{0.01}$	0.79	0.53	0.29	0.43	0.38
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability

The varietal difference in terms of titratable acidity was statistically significant during storage. It was observed that Amritasagar had higher (0.68%, 0.57%, 0.49%, 0.47% and 0.36%) titratable acidity than Mehersagar (0.64%, 0.52%, 0.47%, 0.44% and 0.31%) at 3rd, 6th, 9th, 12th and 15th day of storage. Titratable acidity was decreased gradually with the progresses of storage time (Table 8). Significant difference was found in titratable acidity of banana fruits subjected to different treatments at different days of storage. The maximum titratable acidity was recorded (0.76%, 0.63%, 0.55%,0.52% and 0.47%) at 3rd, 6th , 9th ,12th and 15th day of storage in T4 while the minimum titratable acidity (0.55%, 0.47%, 0.43%, 00% and 00%) was observed in control, respectively followed by 0.65%, 0.53%, 0.48%, 0.45% and 0.37% in T3 treated fruits (Table 9). This result is supported by Ulrich (1974). He stated that, the decrease titratable acidity during storage may be attributed to the utilization of organic acids in respiration process and other bio-degradable reactions.

The combined effects of variety and different treatments in respect of titratable acidity were statistically non-significant at different days of storage. The highest titratable acidity (0.78%, 0.64%, 0.56%,0.54%and 0.50%) recorded in Amritasagar with T4 treatment combination which was followed by Mehersagar with T4 (0.73%, 0.62%, 0.53%,0.50% and 0.45%) and Amritasagar with T5 (0.60%, 0.52%, 0.45%,0.42% and 0.40%)) treatment combination.

On the other hand, the lowest (0.55%, 0.48%, 0.43% and 00%) was found in Amritasagar with control treatment combination at 3rd, 6th, 9th and 12th days of storage (Table 10).

Table 8. Main effect of variety on percent titratable acidity at different days after storage of banana

Variety	Titratable acidity (%) at different days after storage				
	3	6	9	12	15
V_1	0.68	0.57	0.49	0.47	0.36
V_2	0.64	0.52	0.47	0.44	0.31
$LSD_{0.05}$	0.016	0.012	0.015	0.017	0.015
$LSD_{0.01}$	0.022	0.016	0.020	0.023	0.020
Level of significance	**	**	*	**	**

** = Significant at 1% level of probability, NS = Not significant, V_1 = Amritasagar, V_2 =Mehersagar

Table 9. Main effect of post-harvest treatment on percent titratable acidity at different days after storage of banana

Post-harvest treatments	Titratable acidity (%) at different days after storage				
	3	6	9	12	15
T_0	0.55	0.47	0.43	0.00	0.00
T_1	0.74	0.59	0.53	0.49	0.44
T_2	0.68	0.57	0.48	0.46	0.40
T_3	0.65	0.53	0.48	0.45	0.37
T_4	0.76	0.63	0.55	0.52	0.47
T_5	0.58	0.51	0.44	0.39	0.36
$LSD_{0.05}$	0.028	0.021	0.026	0.030	0.026
$LSD_{0.01}$	0.039	0.028	0.035	0.041	0.035
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability; T_0 = Control, T_1 = Refrigerator, T_2 = Ascorbic acid, T_3 = Potassium Aluminium sulphate, T_4 = Potassium permanganet, T_5 = Calcium chloride

Table 10. Combined effects of variety and post-harvest treatment on percent titratable acidity at different days after storage of banana

Treatment combination	Titratable acidity (%) at different days after storage				
	3	6	9	12	15
V_1T_0	0.55	0.48	0.43	-	-
V_1T_1	0.78	0.63	0.55	0.50	0.45
V_1T_2	0.70	0.62	0.48	0.46	0.42
V_1T_3	0.66	0.55	0.48	0.45	0.41
V_1T_4	0.78	0.64	0.56	0.54	0.50
V_1T_5	0.60	0.52	0.45	0.42	0.40
V_2T_0	0.54	0.45	0.42	-	-
V_2T_1	0.70	0.54	0.50	0.47	0.42
V_2T_2	0.66	0.52	0.48	0.45	0.38
V_2T_3	0.64	0.50	0.48	0.44	0.33
V_2T_4	0.73	0.62	0.53	0.50	0.45
V_2T_5	0.55	0.49	0.43	0.35	0.31
$LSD_{0.05}$	0.040	0.030	0.037	0.042	0.037
$LSD_{0.01}$	0.055	0.040	0.050	0.057	0.050
Level of significance	NS	**	NS	NS	**

** = Significant at 1% level of probability; V_1 = Amritasagar, V_2 =Mehersagar and T_0 = Control, T_1 = Refrigerator, T_2 = Ascorbic acid, T_3 = Potassium Aluminium sulphate, T_4 = Potassium permanganet, T_5 = Calcium chloride

There were significant disease incidence found in all the two varieties during ripening and storage stage. At the 15th day Mehersagar showed highest (0.70%) incidence than Amritasagar (0.48%), which suggested that Amritasagar is relatively toleratant to postharvest diseases than that of Mehersagar (Table 11). Postharvest treatments exhibited significant differences in influencing disease incidence. Potassium permanganate and low temperature storage caused lower disease incidence as compared to those of other postharvest treatments examined. Ascorbic acid, potassium alluminium sulphate also resulted in appreciable suppression of disease during storage and ripening (Table 12).

Table 11. Main effect of variety on percent disease incidence at different days after storage of banana

Variety	Disease incidence (%) at different days after storage			
	6	9	12	15
V_1	4.63	11.33	16.83	0.48
V_2	5.54	12.05	16.86	0.70
$LSD_{0.05}$	0.74	0.60	0.022	0.031
$LSD_{0.01}$	1.01	0.82	0.029	0.042
Level of significance	**	*	*	**

** = Significant at 1% level of probability, NS = Not significant

Table 12. Main effect of post-harvest treatments on percent disease incidence at different days after storage of banana

Post-harvest treatments	Disease incidence (%) at different days after storage			
	6	9	12	15
T_0	30.52	70.14	100.00	0.00
T_1	0.00	0.00	0.00	0.31
T_2	0.00	0.00	0.00	0.50
T_3	0.00	0.00	0.39	0.92
T_4	0.00	0.00	0.00	0.08
T_5	0.00	0.00	0.68	1.17
$LSD_{0.05}$	-	-	0.038	0.053
$LSD_{0.01}$	-	-	0.051	0.072
Level of significance	-	-	**	**

** = Significant at 1% level of probability

Conclusions

Various observations were made on the physical properties as well as quality of two banana varieties. Among all postharvest treatments with $KMnO_4$ was found to be the best in weight loss; pulp to peel ratio and disease incidence. These effects ultimately resulted in remarkably prolonged shelf life. So from this results, it can be concluded that, postharvest treatments with $KMnO_4$ would be effective for long term storage of banana and useful in long distance transportation and export purposes. Further investigation is suggested for determining optimum amount of potassium permanganate of this technique with more banana varieties.

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Conflicts of interest:

There is no Conflict of interest exists among the authors.

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