Research Article

POSTHARVEST TREATMENT WITH BENZYL ADENINE TO IMPROVE PHYSICAL AND SENSORY QUALITIES OF NENDRAN BANANA (*Musa* spp.) DURING STORAGE

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Abstract: An experiment was undertaken during 2016-2018 to study the effect of Benzyl Adenine as postharvest treatments on physical and sensory changes of Nendran banana. Nendran banana treated with Benzyl Adenine at 30 ppm, 50 ppm and 80 ppm for an immersion time of 10 minutes along with distilled water as control and without any treatment (absolute control) were stored in Corrugated Fibre Board boxes under room temperature (30±°C, RH 80-85%) till the end of shelf life. Nendran banana fruits treated with Benzyl Adenine at 50 ppm for 10 minutes delayed increase in pulp percentage, peel percentage and pulp to peel ratio and also recorded highest sensory score for appearance (8.97), Colour (8.97), flavour (8.93), taste (8.97), texture (8.90) and overall acceptability (8.93) after 15 days of storage as compared to fruits treated with distilled water and without any treatment.

Keywords: Postharvest, Benzyl adenine, banana, Physical, sensory properties

Introduction

Banana is one of the largely consumed tropical fruits. It is the major fruit crop of India with 0.86 million ha under cultivation and production of 30.48 million tonnes [1]. Among the different banana varieties grown in India, cultivar 'Nendran' (Musa AAB) is the most popular variety of Kerala for domestic and export markets. There is a growing demand for Nendran because of its high nutritional value, being rich in starch, sugars, vitamins and minerals. For long distant transport of banana and domestic storage, green life is the major concern so that banana arrive at retail market in ripening stage with high marketability. Accelerated ripening and short shelf life of banana under tropical climate are the major constraints in postharvest handling. Research on appropriate methods to extend the shelf life of banana to maintain fruit quality for long distant to domestic and export markets is vital. Nendran banana is a climacteric fruit and series of physiological and biochemical changes occur during ripening which is triggered by ethylene, the fruit ripening phytohormone. Due to its rapid ripening nature, huge amount of postharvest losses occurs and which in turn affect the farmer's benefit. To slow down the ripening process of Nendran banana, it is needed to inhibit ethylene synthesis by an ethylene inhibitor like benzyl adenine. Therefore, the present study was undertaken with the objective to study the effect of benzyl adenine for delayed ripening in Nendran banana (*Musa* spp.).

Materials and Methods

The experiment was conducted at Department of Post-Harvest Technology, College of Agriculture, Vellayani, Kerala Agricultural University during the year 2016-18. Nendran banana bunches of uniform maturity, free from pest, diseases and mechanical injury were harvested. The fruits were de-handed and treated with benzyl adenine (BA) at three different concentration for 10 minutes. Treated banana fruits were air dried and stored under room temperature (30 ± 2°C, RH 80-85%) in Corrugated Fibre Board boxes till the end of shelf life. The experiment was designed in completely randomized design (CRD) with four replications. The treatments are: T₁- Benzyl adenine at 30 ppm, T₂- Benzyl adenine at 50 ppm, T₃-

Benzyl adenine at 80 ppm, T₄- Distilled water and T₅- Absolute control (without any treatment).

Preparation of Benzyl adenine

A stock solution of 2000 ppm BA was prepared and 15 mL, 25 mL and 40 mL of this stock solution was drawn and made up into 1 litre with distilled water separately in order to prepare 30 ppm, 50 ppm and 80 ppm solutions respectively. To each of the solution, 0.1 per cent Tween 80 was added as a wetting agent. De-handed banana fruits were dipped in the prepared solution of BA for 10 minutes.

Data collection and observation
Physical parameters

Physical parameters of postharvest treated Nendran banana fruits were recorded at an interval of three days till the end of shelf life. Physical parameters such as pulp percentage, peel percentage and pulp to peel ratio of banana fruit sample after postharvest treatments were analysed. Pulp percentage of treated Nendran banana was estimated by recording the whole fruit weight and pulp weight and its average was expressed in percentage.

$$Pulp\ \% = \frac{Pulp\ weight}{Whole\ fruit\ weight} \times 100$$

Peel percentage of treated Nendran banana was estimated by recording the whole fruit weight and peel weight at three days interval and its average was expressed in percentage. Peel percentage was calculated as follows:

$$Peel\ \% = \frac{Peel\ weight}{Whole\ fruit\ weight} \times 100$$

Pulp and peel weight of treated Nendran banana fruits were recorded and their ratio was calculated as follows:

$$Pulp\ to\ Peel\ ratio = \frac{Pulp\ weight}{Peel\ weight}$$

Postharvest Treatment with Benzyl Adenine to Improve Physical and Sensory Qualities of Nendran Banana (*Musa* spp.) During Storage

Table-1 Effect of postharvest treatments on pulp (%) of banana *cv.* Nendran during storage

Postharvest treatments (T)	Days after storage (D)					Treatment (T) mean	15
	At the time of storage	3	6	9	12		
T₁ (BA 30 ppm)	63.39	67.13	69.15	69.45	70.88	68.00	72.88
T₂ (BA 50 ppm)	63.52	64.19	65.11	66.07	66.85	65.15	69.38
T₃ (BA 80 ppm)	63.45	66.47	68.22	68.51	69.75	67.28	71.88
T₄ (Distilled water)	63.27	69.35	71.13	71.49	72.46	69.54	-
T₅ (Absolute control)	63.22	69.95	71.88	72.50	73.55	70.22	-
Days (D) mean	63.37	67.42	69.10	69.60	70.70		
		SE+ (m)		CD (0.05)		SE+ (m) 0.175 CD (0.05) 0.567	
Treatments (T)		0.119		0.336			
Days (D)		0.119		0.336			
Treatments (T) X Days (D)		0.266		0.751			

- Banana fruits stored were discarded due to spoilage after 12th day of storage
T1- BA 50 ppm, T2- BA 50 ppm, T3- 80 ppm, T4-Distilled water, T5- Absolute control

Table 2. Effect of postharvest treatments on peel (%) of banana *cv.* Nendran during storage

Postharvest treatments (T)	Days after storage (D)					Treatment (T) mean	15
	At the time of storage	3	6	9	12		
T₁ (BA 30 ppm)	36.61	32.87	30.85	30.55	29.12	32.00	27.12
T₂ (BA 50 ppm)	36.48	35.81	34.89	33.93	33.15	34.85	30.62
T₃ (BA 80 ppm)	36.55	33.53	31.78	31.49	30.25	32.72	28.12
T₄ (Distilled water)	36.73	30.65	28.87	28.51	27.54	30.46	-
T₅ (Absolute control)	36.78	30.05	28.12	27.50	26.45	29.78	-
Days (D) mean	36.63	32.58	30.90	30.40	29.30		
		SE+ (m)		CD (0.05)		SE+ (m) 0.219 CD (0.05) 0.709	
Treatments (T)		0.094		0.265			
Days (D)		0.094		0.265			
Treatments (T) X Days (D)		0.210		0.592			

- Banana fruits stored were discarded due to spoilage after 12th day of storage
T1- BA 50 ppm, T2- BA 50 ppm, T3- 80 ppm, T4-Distilled water, T5- Absolute control

Table-3 Effect of postharvest treatments on pulp to peel ratio of banana *cv.* Nendran during storage

Postharvest treatments (T)	Days after storage (D)					Treatment (T) mean	15
	At the time of storage	3	6	9	12		
T₁ (BA 30 ppm)	1.73	2.04	2.24	2.27	2.43	2.14	2.69
T₂ (BA 50 ppm)	1.74	1.79	1.87	1.96	2.02	1.88	2.26
T₃ (BA 80 ppm)	1.74	1.98	2.15	2.18	2.31	2.07	2.56
T₄ (Distilled water)	1.72	2.26	2.46	2.51	2.63	2.32	-
T₅ (Absolute control)	1.72	2.33	2.56	2.64	2.78	2.40	-
Days (D) mean	1.73	2.08	2.26	2.31	2.43		
		SE+ (m)		CD (0.05)		SE+ (m) 0.097 CD (0.05) 0.313	
Treatments (T)		0.023		0.065			
Days (D)		0.023		0.065			
Treatments (T) X Days (D)		0.051		0.145			

- Banana fruits stored were discarded due to spoilage after 12th day of storage
T1- BA 50 ppm, T2- BA 50 ppm, T3- 80 ppm, T4-Distilled water, T5- Absolute control

Table-4 Effect of postharvest treatments on sensory parameters of banana *cv.* Nendran after 9th day of storage

Postharvest treatments (T)	Appearance	Flesh colour	Flavour	Taste	Texture	Overall acceptability
	Mean score	Mean score	Mean score	Mean score	Mean score	Mean score
T₁ (BA 30 ppm)	8.87	8.90	8.87	8.70	8.87	8.90
T₂ (BA 50 ppm)	8.70	8.80	7.60	6.70	6.80	7.60
T₃ (BA 80 ppm)	8.80	8.70	8.80	8.70	8.80	8.90
T₄ (Distilled water)	8.97	9.00	9.00	8.90	8.97	8.97
T₅ (Absolute control)	8.97	9.00	9.00	8.90	8.97	8.97
KW value	12.87**	16.98**	46.46**	100.44**	116.81**	104.07**
χ² (0.05)	9.49					

T1- BA 50 ppm, T2- BA 50 ppm, T3- 80 ppm, T4-Distilled water, T5- Absolute control

Scores

Like extremely- 9   Like very much- 8   Like moderately- 7   Like slightly- 6   Neither like nor dislike- 5
Dislike slightly- 4   Dislike moderately- 3   Dislike very much- 2   Dislike extremely- 1 **Significant

Table-5 Effect of postharvest treatments on sensory parameters of banana *cv.* Nendran after 12th day of storage

Postharvest treatments (T)	Appearance Mean score	Flesh colour Mean score	Flavour Mean score	Taste Mean score	Texture Mean score	Overall acceptability Mean score
T_1 (BA 30 ppm)	8.80	8.70	8.60	8.53	8.20	8.70
T_2 (BA 50 ppm)	8.97	8.90	8.97	8.93	8.90	8.93
T_3 (BA 80 ppm)	8.80	8.70	8.60	8.53	8.20	8.70
T_4 (Distilled water)	7.90	7.60	7.40	7.20	7.60	7.80
T_5 (Absolute control)	7.87	7.50	7.20	7.10	7.40	7.57
KW value	47.55**	91.51**	93.34**	91.55**	75.37**	96.27**
χ^2 (0.05)	9.49					

T1- BA 50 ppm, T2- BA 50 ppm, T3- 80 ppm, T4-Distilled water, T5- Absolute control

Scores
Like extremely- 9   Like very much- 8   Like moderately- 7   Like slightly- 6   Neither like nor dislike- 5
Dislike slightly- 4   Dislike moderately- 3   Dislike very much- 2   Dislike extremely- 1
**-Significant

Table 6. Effect of postharvest treatments on sensory parameters of banana *cv.* Nendran after 15th day of storage

Postharvest treatments (T)	Appearance Mean score	Flesh colour Mean score	Flavour Mean score	Taste Mean score	Texture Mean score	Overall acceptability Mean score
T_1 (BA 30 ppm)	7.30	8.00	7.93	7.27	7.80	8.07
T_2 (BA 50 ppm)	8.97	8.97	8.93	8.97	8.90	8.93
T_3 (BA 80 ppm)	7.90	8.50	8.70	8.63	8.57	8.37
T_4 (Distilled water)	-	-	-	-	-	-
T_5 (Absolute control)	-	-	-	-	-	-
KW value	42.46**	55.49**	56.89**	61.77**	53.31**	46.34**
χ^2 (0.05)	5.99					

T1- BA 50 ppm, T2- BA 50 ppm, T3- 80 ppm, T4-Distilled water, T5- Absolute control
- Banana fruits stored were discarded due to spoilage after 12th day of storage

Scores
Like extremely- 9   Like very much- 8   Like moderately- 7   Like slightly- 6   Neither like nor dislike- 5
Dislike slightly- 4   Dislike moderately- 3   Dislike very much- 2   Dislike extremely- 1
**-Significant

Sensory parameters (after ripening)

Treated Nendran banana were subjected to sensory analysis after ripening (from 9th day of storage) till the end of shelf life and evaluated for sensory characteristics *viz.*, appearance, colour, flavour, taste, texture and overall acceptability by 30 semi - trained panel members. Each character was given a nine-point score according to Hedonic rating [2]. The score was analyzed statistically using Kruskall-Wallis test (*Chi Square Value*) [3] nine-point hedonic scale.

Results and Discussion
Physical parameters
Pulp %

Effect of postharvest treatments on pulp (%) of Nendran banana during storage is depicted in [Table-1]. Pulp percentage increased with the advancement of storage of Nendran banana during ripening. Pulp percentage of banana fruits ranged from 63.22% to 63.52% which showed no significant difference among the treatments at the time of storage. The highest pulp percentage of 69.95%, 71.88%, 72.50% and 73.55% was recorded for T_5 (absolute control) after 3rd, 6th, 9th and 12th day of storage and the lowest pulp percentage (64.19%, 65.11%, 66.07%, 66.85% and 69.83% was recorded by T_2 (BA 50 ppm) after 3, 6, 9, 12 and 15 days of storage. As pulp percentage increased, peel percentage decreased which might be due to the increased moisture content in the pulp as well as reduction in thickness or softening of banana peel associated with ripening. This result is in conformity with the findings of [4].

Peel (%)

Effect of postharvest treatments on peel (%) of Nendran banana during storage is depicted in Table 2. With the advancement of storage, peel percentage decreased in banana *cv.* Nendran. Peel percentage of banana fruits at the time of storage ranged from 36.48% to 36.78% which showed no significant difference among the treatments. The treatment T_2 (BA 50 ppm) recorded the maximum peel percentage of 35.81%, 34.89%, 33.93%, 33.15% and 30.65% after 15 days of storage and the minimum peel percentage of 30.05%, 28.12%, 27.50%, 26.45% was recorded for T_5 (absolute control) after 12 days of storage. Decrease in peel

thickness and cell layer continuously during the initial stage of ripening which caused due to migration of moisture from peel to pulp which in turn reduce the peel percentage [5]. During ripening, cell wall gets modified with loss of firmness and finally void space empty with a reduction in peel percentage [6]. Transpiration loss is also responsible for decreased peel thickness towards ripening [7].

Pulp to peel ratio

Effect of postharvest treatments on pulp to peel ratio of Nendran banana during storage is depicted in [Table-3]. Pulp to peel ratio of Nendran banana fruits increased during storage and indicated the ripening behaviour. Pulp to peel ratio of banana fruits at the time of storage ranged from 1.72 to 1.74 which showed no significant difference among the treatments. The highest pulp to peel ratio of 2.33, 2.56, 2.64 and 2.78 was recorded for T_5 (absolute control) after 3rd, 6th, 9th and 12th day of storage were recorded by T_5 (absolute control) that was on par with T4 (distilled water). The treatment T_2 (BA 50 ppm) recorded the lowest pulp to peel ratio of 1.79,1.87, 1.96, 2.02 and 2.26 after 3rd, 6th, 9th, 12th and 15th day of storage. Increase in pulp to peel ratio of banana is related to ripening and high transpiration loss of moisture from peel than pulp which contributes an increase in pulp to peel ratio and also the accumulation of moisture from peel to pulp by osmosis [8]. This result is in agreement with [9] in banana in which Benzyl adenine at 50 ppm recorded a decreased pulp to peel ratio (2.15) which might be due to reduced conversion of ACC into ethylene that resulted in delayed ripening and decreased the pulp content.

Sensory parameters

Sensory parameters *viz.* appearance, colour, flavour, taste, texture and overall acceptability of banana fruits shows high on the marketability of fruits. The scores for these attributes increased at optimum ripening stage and thereafter it decreased (Table 4). After 9 days of storage, Nendran banana without any treatment (absolute control -T_5) and distilled water (T_4) recorded the highest mean score for appearance (8.97), flesh colour (9.00), flavour (9.00), taste (8.90), texture (8.97) and overall acceptability (8.97). The lowest mean score for appearance (8.70), flesh colour (7.80), flavour (7.60) and overall acceptance

(7.60) was observed in BA 50 ppm (T_2). After 12 days of storage, BA 50 ppm (T_2) treated fruits recorded the highest mean score for appearance (8.97), colour (8.90), flavour (8.97), taste (8.93), texture (8.90) and overall acceptance (8.93). The lowest mean score for appearance (7.87), flesh colour (7.50), flavour (7.20), taste (7.10), texture (7.40) and overall acceptance (7.57) was observed in absolute control (T_5) (Table 5). After 15 days of storage, BA 50 ppm (T_2) recorded the highest mean score for appearance (8.97), colour (8.97), flavour (8.93), taste (8.97), texture (8.90) and overall acceptance (8.93) (Table 6). The treatment with BA showed higher sensory scores for appearance, colour, flavour, taste, texture and overall acceptability in Nendran banana and similar result was reported by [10] in guava fruit which might be due to high absorption or diffusion of BA through dipping resulted into high retention of soluble sugars, firmness, colour and overall appearance.

Conclusion

From the present study, it is concluded that postharvest treatments with benzyl adenine delayed the ripening and enhanced the marketability of Nendran banana.

Application of research: Nendran banana dipped in BA 50 ppm for 10 minutes showed better retention of physical and sensory quality attributes during storage and recorded a shelf life of 15 days

Research Category: Post Harvest Technology

Abbreviations: BA- Benzyl Adenine, SEm- Standard Error mean, %- Percentage, ppm -parts per million, RH- relative humidity, mL- milli litre, CD- Critical difference, KW- Kruskal Wallis, $\chi2$ – Chi square

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References

[1] NHB. (2017) *Ministry of Agriculture, Govt. of India. http://nhb.go.in.area-pro/database-2018.pdf*. (Accessed on April 2018).

[2] Ranganna S. (1986) *Handbook of Analysis and Quality Control for Fruit and vegetable Products*, 182.

[3] Shamrez B., Aftab S., Junaid M., Ahmed M. and Ahmed S. (2013) *Journal of Environmental Science, Toxicology and Food Technology*, 7, 21-24.

[4] Srivastava M.K. and Dwivedi U.N. (2000) *Plant Science*, 158(1), 87-96.

[5] Parker R. and Maalekuu B.K. (2013) *Agricultural Biology Journal of North America*, 4(3), 252-259.

[6] Patil S.K. and Shanmugasundaram S. (2015) *International Journal of Technology Enhancements and Emerging Engineering Research*, 3(2), 2347-4289.

[7] Rathore H.A., Masud T., Sammi S. and Soomro A.H. (2007) *Pakistan Journal of Nutrition*, 6(2), 143-148.

[8] Simmonds N.W. (1960) *Notes on Banana Taxonomy*, 14(2), 198-212.

[9] Ngoh N.G., Tomekpe T. and Dhuique-Mayer C. (2010) *Acta Horticulture*, 879, 401-406.

[10] Deepthi V.P. and Sekhar R.C. (2015). *International Journal of Processing and Post Harvest Technology*, 6(2), 128-143.