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Research Article

DETERMINATION OF SUITABLE PRE-STORAGE TREATMENT FOR BANANA IN COLD STORAGE

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Abstract- The purpose of the experiment is to investigate the best suited pre-storage treatment among T_1 (Packaging the produce without pre-packaging material + CFB (Corrugated Fibre Board) boxes)), T_2 (Washing with water + Packaging in LDPE (Low Density Polyethylene film) + CFB), T_3 (Dipping in sodium hypochlorite solution (0.1 ppm) + Packaging in LDPE + CFB boxes). Firm ripe fruits of banana were selected for the investigation. After suitable pre-storage treatment the fruits were kept in cold storage (12±1 °C and 85-90% RH). T_3 had retained most of the biochemical parameters such as total soluble solids (21.22 °Brix), pH (4.91) and mean score for appearance (8.0). Minimum weight loss of 0.693% in T_3 was observed as against 0.865 % in T_2 and 2.259 in T_1. Maximum colour retention was noticed in case of T_3 followed by T_2 and T_1.

Keywords- Banana, CFB, Cold storage, Pre-storage treatments, LDPE and Sodium Hypochlorite.

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Introduction

Indian production of bananas is chiefly focused on local market. Fruits are rich sources of carbohydrates, vitamins and minerals. Despite of enormous production, postharvest losses are predominant in India. So, to minimize losses, among other loss reduction technologies; cold storage of fruits is best method. It extends life of banana fruits by reducing the rate of respiration and keeping bio-chemical changes to minimum. Research gaps identified in storage of bananas were lack of standard pre-storage treatments; disinfectants were not used during postharvest handling of produces. No practice for sorting and grading prior to storage leading to an unavoidable postharvest loss due to lack of knowledge in handling harvested produce [1]. There was huge research gap in the operation and handling of produce with regard to storage of fruits and vegetables in cold store. Therefore, action research on cold storage was needed to give proper guidelines to farmers to store the produce in proper condition to deliver it to consumer when demanded [2].

Cold storage plays an important role in the preservation of perishables especially fruits and vegetables. It has become quintessential to construct cool store facilities within the producing as well as consuming centres to deal with the prevailing and projected production of fruits and vegetables right away after harvest to preclude spoilage of fruits and greens valued at crores of rupees.

Cold storages have been operating for some time; practically no macro level analyses have been undertaken. Packaging of banana fruits in flexible polyethylene bags resulted in longer shelf life (4 weeks) and maintained the chemical qualities of the banana which was followed by packaging in dried banana leaf and teff straw [3]. Therefore, keeping the above points in view, an investigation entitled "Determination of suitable pre-storage treatment for banana in cold storage" was planned.

Materials and Methods

The treatments *viz.*, T_1 (Packaging the produce without pre-packaging material + CFB (Corrugated Fibre Board) boxes)), T_2 (Washing with water + Packaging in LDPE (Low Density Polyethylene film) + CFB), T_3 (Dipping in sodium hypochlorite solution (0.1 ppm) + Packaging in LDPE + CFB boxes) were selected and observations were recorded during the storage period for two consecutive years i.e. for 2013 and 2014. Each treatment was replicated twelve times during the experiments.

Fresh healthy near ripe banana fruits were procured from AICRP on Fruits located at Mandouli farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur. The fruits were washed and selected pre-storage treatments were given. The CFB boxes (8 kg capacity) had length (45 cm), breadth (27 cm) and height (23.5 cm) with five layers. They were given 5 % ventilation. The lining material used in the experiment is LDPE 100 guage with 0.5% ventilation. The cold store was maintained 12±1 °C with relative humidity 85-90 %. Parameters pertaining to storage life, TSS (Total Soluble Solids), pH, Loss in weight and rotting were recorded according to the following methods for 7 days interval.

Storage Life

The shelf life is a period of time which starts from harvesting and extends up to the start of rotting of fruits [4]. Storage life was measured at completely ripened stage or at the limit of acceptability and was expressed in days. The limit of acceptability was determined by fruit or vegetable appearance, visible disease symptoms with or without sign on produce surface, was considered unsuitable for consumption.

Colour

For recording colour of the fruits and vegetables colour chart from Royal Horticultural Society (RHS mini colour chart) was used.

Physiological loss in weight

To find out the cumulative physiological loss in weight, freshly harvested litchi fruits from each treatment were weighed with the help of digital weighing machine before subjecting them to different treatments. Same fruits were then weighed after 7 days. The loss in weight was derived by subtracting the weight of fruit on the date from the original fresh weight. The percentage loss in weight was calculated by the formula.

$$\text{Physiological loss in weight (PLW)} = \frac{\text{Loss in weight}}{\text{Original fresh weight}} \times 100$$

Total Soluble Solids (TSS)

The total soluble solids (TSS) of litchi fruits were recorded by the help of hand refractometer and the value were corrected to 20° C and expressed in °Brix.

pH Value

pH value in fruit juice was measured directly with the help of systronic pH meter.

Rotting percentage

The number of fruits rotten during the whole storage period was counted in each treatment replication wise. The percentage of rot was worked out by the formula.

$$\text{Rotting percentage} = \frac{\text{Number of rotten fruits}}{\text{Total number of fruits stored}} \times 100$$

Statistical Design: In this present work Completely Randomized Design was adopted to test significant of treatment means. Pooled data analysis of two selected years was also carried out as suggested by Sahu and Das [5].

Results and Discussion

Storage life

Firm near ripe banana fruits selected and packed as per treatment T_3 (Dipping in sodium hypochlorite solution (0.1 ppm) + Packaging in LDPE + CFB boxes) had 28 days storage life. From [Table-1], fruits with treatments i.e., T_1 [without packaging (simple paper wrapping)], T_2 (Washing with water + Packaging in LDPE + CFB) could be stored for 17 and 20 days. During 2012-13 and 2013-14, identical results were observed. It could be corroborated that T_3 had extended storage life of 11 days from T_1 and 8 days from T_2. Difference between treatments was significant ($P \leq 0.05$) with $CD_{0.05}$=3.63 (pooled mean).

Observations of Maia *et al.*[1] and Hailu *et al.*[3] were also in agreement with the above results who found that matured banana had a storage life of was 36 days at 15±2 °C and 85% relative humidity. Extended shelf life of T_3 might be due to cleaning of the fruits with sodium hypochlorite solution and which had controlled rotting caused by microorganisms [3].

Table-1 *Storage life of banana subjected to different packaging treatments*

Treatments	Storage life		
	2012-13	2013-14	Pooled mean
T_1	16.25	17.75	17.00
T_2	19.75	20.50	20.13
T_3	27.50	28.00	27.75
Mean	21.17	22.08	21.63
SEM	0.75	0.91	0.78
CD	3.47	4.18	3.63

TSS

During 2012-13, initial reading was recorded as 18.44 °Brix and at the end of the storage it was increased to 21.22 °Brix on 28th day of storage in T_3 [Table-2]. During 2013-14, same trend continued with initial reading of 19.29 ° Brix and it closed with 21.90 °Brix. Maximum TSS content was observed in T_1 with 21.03 °Brix on 14th day when compared to T_2 and T_3 (pooled data). Data was homogenous for both years (Hartley F max test).

Similiar findings were in reported by Sarode [6] with total soluble solids of 20.75 °Brix when banana fruits were treated with hormones and stored under low temperature. Starch (polysaccharies) and cell wall substances (pectin and hemi-cellulose) covert into soluble sugars which was responsible for increase in TSS [1,2].

pH

At the beginning of the study pooled mean pH was 4.34 and it increased to 4.91 in case of T_3 [Table-2]. During two consecutive years i.e., 2012-13 and 2013-14, the increase was significant between the treatments ($P \leq 0.05$) and for both years it followed resembling pattern. Least changes in pH were observed in T_3, which was best among the treatments. T_1 and T_2 were at par with each other. Rapid utilization of acids of the pulp in the respiratory process might have caused an increase in pH. Such changes lead to early ripening and senescence in the fruits. A similar study was conducted by Maia *et al.* [1] on banana confirms the present findings.

Loss in weight

Physiological loss weight was maximum in T_1 (1.843% for 2012-13 and 2.674% for 2013-14) followed by T_2 and T_3. From the [Table-2], pooled mean values suggest that T_3 had least changes in loss in weight when compared to other treatments ($CD_{0.05}$ = 0.39). T_1 had greater loss in weight due to high rate of metabolic activities than T_2 and T_3. Lower water vapour transpiration rate (WVTR) of LDPE might have provided a barrier to exchange of gases and moisture in case of T_2 and T_3. Increase in loss in weight could be due to liberation of heat and gaseous exchange of the produce as a result of metabolic processes Reports from Hailu *et al.* [3] and Sarode [6] were in accordance with present study.

Appearance

From the [Table-2], comparable readings could be made on 14th day with a mean score of 8.0 for T_3 followed by T_2 (7.65) and T_1 (6.50) from initial reading of 8.5. Higher score for appearance might be due to non occurrence of rotting and good colour which could be perceived by human eye [Fig-1]. Kudachikar *et al.* [7] reported sensory scores for banana on colour, flavor and taste was in accordance with present report.

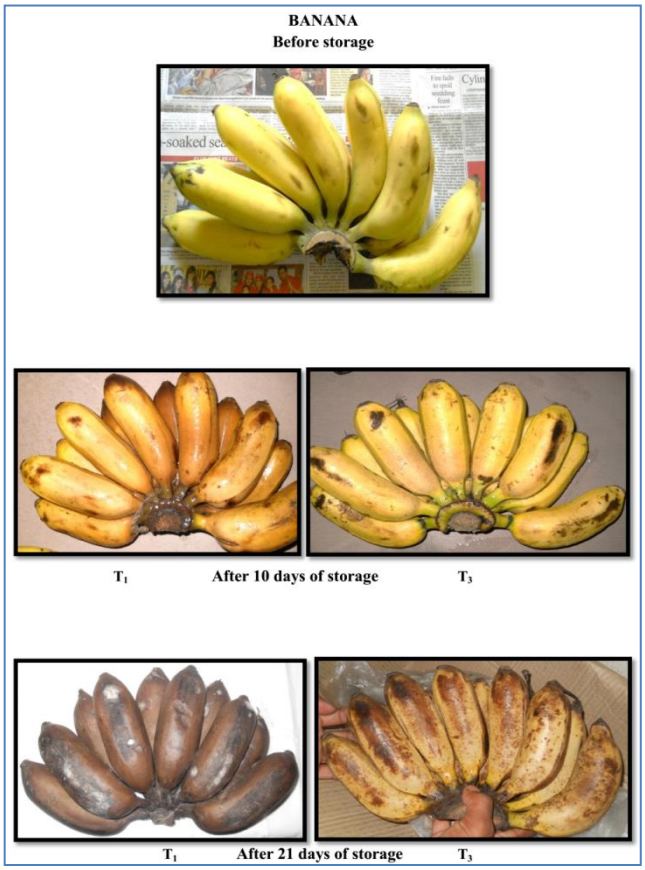

Fig-1 Banana as influenced by pre-storage treatments at different storage intervals

Rotting

During 2013-14, rotting of fruits in T_1 was highest with 46.3% on 14th day when compare to T_2 (21.6% on 21st day) and T_3 (10.2 % on 28th day). Fruits in T_1 had higher rotting percent because of improper packaging and discarded from further study due to poor marketability [Table-3]. Enhancement of storage life till 28th day in T_3 was due to sodium hypochlorite treatment which might had played a role in keeping out micro-organisms. Our results were in accordance with reports by Mary and Sathiamoorthy [8] and Kudachikar *et al.*[7] who worked on cold storage of different varieties of banana.

Shelf life of banana after cold storage

Fully mature yellow firm marthaman bananas stored in cold storage at 12.5 °C had shelf life of two days after 21 days of storage in T_3 [Table-3]. **T_3** was best among the treatments. Analogous findings had been given by [1].

Colour

RHS 12A (Yellow) was recorded initially for both the years i.e., 2012-13 and 2013-14. Colour faded as storage period progressed and ended with RHS 167B (brown yellow) on 14th day in T_1. T_2 and T_3 were at par with each other. T_3 had fruits with attractive colour till 21st day with RHS 6A (light yellow colour); might be due to washing of fruits with sodium hypochlorite solution and film packaging with LDPE (0.5% perforation) provided ambient conditions for colour extention. Change of colour to brown yellow might be due to disappearance of carotenoid pigments from the peel [Table-4]. Similar findings were reported by Hailu *et al.*[3], they used a scale given by Dadzie and Orchard [9].

Table-2 *Influence of different pre-storage treatments on physico-chemical parameters of banana*

TSS (°Brix)								pH					
Days		T_1	T_2	T_3	Mean	SEM	CD	T_1	T_2	T_3	Mean	SEM	CD
0	Y1	18.44	18.44	18.44	18.44	0.51	NS	4.34	4.34	4.34	4.34	0.12	NS
	Y2	19.29	19.29	19.29	19.29	0.36	NS	4.96	4.96	4.96	4.96	0.18	NS
	P	18.87	18.87	18.87	18.87	0.44	NS	4.65	4.65	4.65	4.65	0.15	NS
7	Y1	19.52	18.78	18.64	18.98	0.23	1.04	4.82	4.34	4.34	4.50	0.14	0.66
	Y2	22.87	19.37	19.38	20.54	0.15	0.67	5.29	5.12	4.96	5.12	0.13	0.62
	P	21.20	19.08	19.01	19.76	0.19	0.86	5.06	4.73	4.65	4.81	0.14	0.64
14	Y1	20.18	19.78	19.38	20.54	0.15	0.47	5.08	4.71	4.96	5.12	0.13	0.62
	Y2	21.88	20.52	19.90	20.77	0.18	NS	5.21	5.02	4.90	5.04	0.11	0.53
	P	21.03	20.15	19.64	20.66	0.17	NS	5.15	4.87	4.93	5.08	0.12	NS
21	Y1	-	20.89	19.45	-	0.33	NS	-	4.80	4.71	-	0.33	NS
	Y2	-	21.31	20.45	-	0.11	NS	-	5.18	5.03	-	0.12	NS
	P	-	21.10	19.95	-	0.22	NS	-	4.99	4.87	-	0.23	NS
28	Y1	-	-	21.22	-	-	-	-	-	4.91	-	-	-
	Y2	-	-	21.90	-	-	-	-	-	5.03	-	-	-
	P	-	-	21.56	-	-	-	-	-	4.97	-	-	
Appearance								Loss in weight (%)					
Days		T_1	T_2	T_3	Mean	SEM	CD	T_1	T_2	T_3	Mean	SEM	CD
0	Y1	8.40	8.40	8.40	8.40	0.33	NS	-	-	-	-	-	-
	Y2	8.60	8.60	8.60	8.60	0.34	NS	-	-	-	-	-	-
	P	8.50	8.50	8.50	8.50	0.34	NS	-	-	-	-	-	-
7	Y1	7.40	8.30	8.40	8.03	0.33	1.88	0.981	0.305	0.299	0.530	0.310	NS
	Y2	7.60	8.00	8.20	7.93	0.36	1.64	1.087	0.457	0.432	0.660	0.080	0.360
	P	7.50	8.15	8.30	7.98	0.35	1.76	1.034	0.381	0.366	0.595	0.195	0.360
14	Y1	6.80	7.60	8.00	7.47	0.33	2.16	1.843	0.865	0.602	1.100	0.330	NS
	Y2	6.20	7.70	8.00	7.30	0.39	1.80	2.674	0.865	0.783	1.440	0.070	0.390
	P	6.50	7.65	8.00	7.39	0.36	1.98	2.259	0.865	0.693	1.270	0.200	0.390
21	Y1	-	7.10	7.70	-	0.33	NS	-	1.227	1.012	0.750	0.330	NS
	Y2	-	7.00	7.60	-	0.12	NS	-	1.504	1.455	0.990	0.070	NS
	P	-	7.05	7.65	-	0.23	NS	-	1.366	1.234	0.870	0.200	NS
28	Y1	-	-	6.90	-	-	-	-	-	1.922	-	-	-
	Y2		-	6.80	-	-	-		-	2.340	-	-	-
	P	-	-	6.85	-	-	-	-	-	2.131	-	-	-

Y1: 2012-13 and Y2: 2013-14 NS- Non significant P- Pooled mean; significant differences at P≤0.01 (LSD test). (-) Indicate treatments in which fruits were already discarded.

Table-3 *Influence of different packaging materials on rotting and shelf life of banana after storage*

Shelf life of banana after cold storage						Rotting (%)			
Days		T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
0	Y1	-	-	-	-	-	-	-	-
	Y2	-	-	-	-	-	-	-	-
	P	-	-	-	-	-	-	-	-
7	Y1	1	2	3	2.0	-	-	-	-
	Y2	1	1	3	1.7	20.6	-	-	20.6
	P	1	2	3	2.0	20.6	-	-	20.6
14	Y1	-	1	3	2.0	21.7	8.3	-	15.0
	Y2	-	1	2	1.5	46.3	7.0	-	26.15
	P	-	1	3	2.0	34.0	7.65	-	26.325
21	Y1	-	-	2	2.0	-	21.6	-	21.6
	Y2	-	-	2	2.0	-	13.0	3.5	8.25
	P	-	-	2	2.0	-	17.2	3.5	10.35
28	Y1	-	-	1	1.0	-	-	8.8	8.8
	Y2	-	-	-	-	-	-	10.2	10.2
	P	-	-	1	1.0	-	-	9.5	9.5

Y1: 2012-13 and Y2: 2013-14, NS- Non significant P- Pooled mean; significant differences at P≤0.01 (LSD test). (-) Indicate treatments in which fruits were already discarded

Table-4 *Colour of banana subjected to different packaging treatments*

Treatments	0		7		14		21		28	
	2012-13	*2013-14*	*2012-13*	*2013-14*	*2012-13*	*2013-14*	*2012-13*	*2013-14*	*2012-13*	*2013-14*
T_1	RHS12A	RHS12A	RHS6A	RHS6A	RHS167B	RHS167B	-	-	-	-
							-	-	-	-
T_2	RHS12A	RHS12A	RHS12A	RHS12A	RHS6A	RHS6A	RHS167B	RHS167B	-	-
									-	-
T_3	RHS12A	RHS12A	RHS12A	RHS12A	RHS6A	RHS6A	RHS6A	RHS6A	RHS167B	RHS167B

(-) Indicate treatments in which fruits were discarded.

Conclusion

It can be concluded from the investigation that pre-storage treatment i.e., dipping in sodium hypochlorite solution (0.1 ppm) + Packaging in LDPE + CFB boxes was best suited treatment in extending storage life of bananas. The above stated treatment also ensures least biochemical changes and retention of peel colour during storage period.

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Conflict of Interest: None declared

References

[1] Maia V.M., Salomao L.C.C., Siqueira D.L., Aspiazu I. and Maia L.C.B. (2014) *Australian Journal of Crop Science*, 8(7), 1029-1037.

[2] Stab A.L., Cambell A.F. (1936) Citrus fruits: The biochemistry of fruits and their products *Academic Press,* London, pp 107-167.

[3] Hailu M.T.S., Workneh S., Belew D. (2012) *African Journal of Agricultural Research* ,7(7), 1226-1237.

[4] Mondal M.F. (2000) Production and storage of fruits (in Bangla),*Published by Mrs.* AfiaMondal. *BAU Campus*, pp312.

[5] Sahu P.K. and Das A.K. (2009) Agriculture and Applied Statistics-II. Kalyani Publishers, New Delhi.

[6] Sarode S.C. (2009) *Asian Journal of Environmental Science*, 4(2), 129-132.

[7] Kudachikar V.B., Kulkarni S.G. and Keshava P.M.N. (2011) *Journal of Food Science Technology*, 48(3), 319–324.

[8] Mary, A.E. and Sathiamoorthy S. (2003) *Indian Journal of Agricultural Research,* 37 (1), 72-75.

[9] Dadzie B.K. and Orchard J.E. (1997) Routin postharvest screening of banana/plantain hybrids criteria and methods. *International network for banana and plantain (Inibap), Technical Guidelines*, Rome, Italy