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"Effect of Post-Harvest Treatments on Nutritional Parameters Changes in Banana (*Musa Paradisica l.*) During Ripening Under Different Storage Conditions"

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ABSTRACT

The present experiment entitled "Effect of post-harvest treatments on nutritional parameters changes in banana during ripening under different storage conditions" was carried out during 2009–2010 at the Department of Fruit Science and Post Harvest Technology, ASPEE college of Horticulture and Forestry, Navsari Agricultural University, Navsari, with six different treatments viz., storage at ambient temperature (control), pre-cooling at 130C and 95% RH for 30 minutes and then storage at at 14^0C and 95% RH and dipping in Ethrel @ 500, 1000, 1500 ppm for 10 seconds and storage at ice placed condition for seven days. The experiment was laid out in Complete Randomized Design with four repetitions. After 13^{th} day of storage, it was observed that total soluble solids (TSS), total sugars, reducing sugar and non-reducing sugar, titrable acidity were increased gradually day by day in T3 (Storage at 14^0C and 95% RH) treatment during storage upto 37^{th} day.

On the other hand, the starch content of fruit gradually decreased day by day from 13^{th} up to 37^{th} day.

Key words :*Biochemical changes, Banana, Chemical parameters, Post-harvest treatments, Storage conditions)*

INTRODUCTION

Banana (Musa paradisica L.) is a large herbaceous perennial monocotyledonous and monocarp plant which belongs to family Musaceae. Banana could be considered as "poor man's apple''.At present in Gujarat state, total area under mango cultivation is about 3.168 lakh ha lakh ha with a production of about 58.223 lakh MT [1]. Banana is a rich source of vitamin A and fair source of Vitamin C, B and B1. After the introduction of Grand Nain (Musa AAA) it is getting popularity and approx. 80-90% Basrai cultivation has been replaced. Banana is cultivated in the districts of Bharuch, Surat, Anand, Narmada, Junagadh, Vadodara, Navsari and Valsad because of favorable agro-climatic conditions and abundant supply of irrigation water through well and canal.

The post-harvest loss of banana is 25 to 30 % due to improper handling and lack of storage facilities. Similarly, the post harvest technology have been developed to ripen the fruits as cold storage facilities are also used biochemical changes which undergo during the storage life of banana fruits either at ambient temperature vis-ā-vis may hasten or delay with treatments [2]. Standard use of chemicals, most probably ethrel dipping is not uniform and varies with demand and supply and affects the fruit quality including shelf life. The changes in carbohydrates, pectic substances and tannin, acids, pigments, volatile materials, amino acids, enzymes and vitamins are important.

MATERIAL AND METHODS

The present investigation was carried out at the Department of Fruit Science and Post Harvest Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2009 – 2010. The stage of harvesting was determined on the basis of number of days after inflorescence emergence. Based on the above criteria in cv. Grand Nain (Musa AAA) 75 days after shooting were 75% maturities for harvesting the fruits.

The separated hands from fruit bunch were kept in cold storage at 14^0C and 95% RH, pre cooling at 13^0C and 95% RH for 30 minutes and storage at ambient temperature. The fruits were dipped in ethrel @ 500, 1000, 1500 ppm for 10 seconds and were stored at ice (8 kg/day) placed conditions for seven day, while control fruits were stored at ambient temperature.

On every sampling day i.e. on alternate day from 1st to 13th day and upto 37th day, one finger was sampled from the middle portion of the third hand and utilized for chemical analysis. All the observations for physical parameters were recorded at the interval of alternate day till the fruits were ripened.

Treatments details

Sr.no.	Treatments	
1	T_1	Storage at ambient temperature (control).
2	T_2	Pre-cooling at 13^0C and 95% RH for 30 min. and then storage at ambient temperature.
3	T_3	Storage at 14^0C and 95% RH.
4	T_4	Dipping in Ethrel 500 ppm for 10 seconds and storage at ice (8 kg/day) placed condition for seven days.
5	T_5	Dipping in Ethrel 1000 ppm for 10 seconds and storage at ice (8 kg/day) placed condition for seven days.
6	T_6	Dipping in Ethrel 1500 ppm for 10 seconds and storage at ice (8 kg/day) placed condition for seven days.

RESULTS AND DISCUSSION

The data pertaining to the total soluble solid (%) and total sugar (%) as affected by different post harvest treatments are presented in Table -1.

The total soluble solids and total sugar content of banana fruit was not significantly affected on 1st day of storage, while it was significantly increased from 3rd to 13th day of storage.

The maximum total soluble solids and total sugar content at 3rd and 5th day of storage was observed in T_6 treatment which was at par with T_5 and T_4 treatments. On 7th and 9th day of storage was found in treatment T_5 which was at par with T_4 and T_6 treatments. On 11th day of storage, treatment T_2 significantly recorded maximum which was at par with T_1 treatment (control). While on 13th day of storage had the maximum in treatment T_2 over rest of the treatments.

On the contrary, minimum total soluble solids and total sugar content, on 3rd, 5th, 7th, 9th, 11th and 13th day of storage, was recorded in T_3 treatment.

After 13th day of storage, the data (Table-4) revealed that total soluble solids and total sugar content of fruits of T_3 treatment exhibited higher values during the storage period up to 37th day. Whereas, the total soluble solids content, of the fruits under other treatments viz., T_6, T_5, T_4, T_2 and T_1 (control) were not recorded due to loss of shelf life.

Increasing trend in total soluble solids, this might be due to consequences of release of sugars by the hydrolysis of starch reserved during the post-harvest storage, leading to slow rate of respiration, oxidation and ripening process.

Significant increase in total sugar content was observed in T_3 treatment. The ripening of banana like the hydrolysis of starch and accumulation of sugar untreated bananas ripen slowly and irregularly. An exogenous application of ethylene formulation like ethrel triggers ripening and endogenous ethylene production.

The data pertaining to reducing sugar (%) and non-reducing sugar (%) content of fruit recorded at alternate day intervals upto fully ripened stage of banana fruit in are presented in Table -2.

The present observations are in conformity with the results reported by [3] who revealed that ethylene treated bananas possessed significantly greater total soluble solids than untreated bananas.

There was no significant effect of any treatment on reducing sugar and non-reducing sugar content at 1st day of storage, while reducing sugar was significantly increased from 3rd to 13th day of storage.

Significantly the maximum reducing sugar and non-reducing sugar content on 3rd and 5th day of storage was recorded in T_6 treatment, which was at par with T_5 and T_4 treatments. On 7th day of fruit storage, maximum reducing sugar and non-reducing sugar was observed in T_5 treatment which was at par with T_6 and T_4 treatments. On 9th day of storage, significantly maximum was observed in T_5 treatment which was at par with T_4, T_6, T_2 and T_1 treatments. On 11th and 13th day of storage, significantly maximum reducing sugar and non-reducing sugar was observed in T_2 treatment which was at par with T_1 (control).

Whereas, minimum reducing sugar and non-reducing sugar was recorded on 3rd, 5th, 7th, 9th, 11th and 13th day of storage.

After 13th day of storage, it is clearly seen from the data given in (Table- 4) that reducing sugar and non-reducing sugar gradually increased in T_3 treatment during storage upto 37th day. Whereas,

the fruits under other treatments T_6, T_5, T_4, T_2 and T_1 (control) were discarded due to early ripening and loss of shelf life.

Ripening process was enhanced in all the treatments except the fruits stored at 14^0C and 95%RH. The level of endogenous ethylene and higher ambient temperature might have hastened fruit ripening resulting into increase in reducing sugar content. During ripening increase in the respiration rate might have converted starch into sugars.

[4] and [5]who reported that pre-cooling treatment gave minimum reducing sugar percentage as compared to without cooling treatment in guava fruits.

Increase in non-reducing sugar is because of increase in respiration rate and enzymatic activity in control as well as in ethrel treated fruits.

The data recorded to titrable acidity (%)noted at alternate day intervals upto fully ripened stage of banana fruit are presented in Table-3.

The titrable acidity and moisture of fruit was not significantly influenced on 1st day of storage, while it significantly decreased from 3rd to 13th day of storage.

The lower titrable acidity on 3rd, 5th, 7th and 9th day of storage was recorded in T_3 treatment which was at par with T_2 treatment. On 11th day of storage was observed in T_3 treatment which was followed by T_5 treatment. While on 13th day of storage, it was T_6 treatment which was at par with that of T_5 and T_4 treatments.

On the other hand, the titrable acidity increased during storage in various treatments on 11th and 13th day of storage was observed in T_1 treatment (control).

On the other hand, after 13th day of storage, it is quite apparent from the data (Table-4) that further extending the period of storage upto 37th day, titrable acidity of banana fruit increased in T_3 treatment over rest of the treatments. Whereas, the fruits under other treatments T_6, T_5, T_4, T_2 and T_1 (control) were not in the condition of recording the observations.

Acidity is an important determinant of the eating quality of the fruit as the fruit taste is decided by the balance between sugar and acid contents. The increase in acidity might be due to excess biosynthesis of oxalic acid in green stage and with advancement of maturity, the oxalic acid constantly decreased while malic acid biosynthesis predominated. Similar results were found by [6].

CONCLUSION

From the results obtained in the present investigation, it could be inferred revealed that banana fruits cv. Grand Nain (Musa AAA) treated with different chemical and stored at various conditions exhibited variable results for chemical parameters. Increase in total soluble solid, total sugar, reducing sugar and non-reducing sugar on 7th and 9th day of storage observed in fruits dipped in ethrel @1000 ppm for 10 second and stored at ice (8 kg/day) placed condition. Similarly significant reduction in titrable acidity was also recorded in ethrel treated fruits during ripening and storage.

The fruits of untreated control treatment i.e. stored at ambient temperature ripened earlier than those of pre-cooling at 13^0C and 95% RH for 30 min. and storage at ambient temperature, as well as storage at 14^0C and 95% RH (cold storage).

The shelf life of banana fruits can be extended upto 37th day in T_3 Storage at 14^0C and 95% RH (cold storage). They remained marketable for longer period and can be supplied during shortage in the market. While the early ripened fruits of ethrel treatment can be supplied instantly in domastic market at the time of high demand on festivals and religious period of 'Shravan' festivals, 'Navratri' including 'Dashera', 'Deepawali', Muslim festival of 'Ramzan' month etc.

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Table 1. Effect of post-harvest treatments on total soluble solid (%) and total sugar (%) of banana cv. Grand Nain (*Musa AAA*) during ripening under different storage conditions

	Treatments	Total soluble solid (%) (No. of storage day)							Total sugar (%) (No. of storage day)						
		1st	3rd	5th	7th	9th	11th	13th	1st	3rd	5th	7th	9th	11th	13th
T_1	Storage at ambient temperature (control)	3.25	4.52	7.25	11.13	16.43	19.63	21.75	2.58	4.00	6.39	9.62	15.82	16.92	18.45
T_2	Pre-cooling at 13⁰C and 95 % RH. for 30 min. and then storage at ambient temperature	3.25	4.45	7.18	11.15	16.48	19.75	22.78	2.58	3.90	6.37	9.63	15.85	17.07	18.49
T_3	Storage at 14⁰C and 95 % RH.	3.25	4.12	4.28	5.05	5.65	6.13	7.20	2.58	3.37	4.88	5.94	6.25	6.71	8.04
T_4	Dipping in Ethrel 500 ppm for 10 seconds and storage at ice placed condition for seven day	3.25	11.05	15.20	17.45	18.23	18.28	18.23	2.58	6.68	11.71	14.47	16.10	16.11	15.80
T_5	Dipping in Ethrel 1000 ppm for 10 seconds and storage at ice placed condition for seven day	3.25	11.12	15.48	17.55	18.35	18.20	18.20	2.58	6.73	11.74	14.52	16.16	16.00	15.77
T_6	Dipping in Ethrel 1500 ppm for 10 seconds and storage at ice placed condition for seven day	3.25	11.15	15.50	17.43	18.18	18.13	18.08	2.58	6.74	11.78	14.45	16.05	15.95	15.75
	S. Em±	0.06	0.07	0.11	0.15	0.18	0.20	0.22	0.01	0.03	3.90	0.07	0.10	0.10	0.10
	C. D. at 5%	NS	0.23	0.34	0.44	0.53	0.59	0.64	NS	0.09	0.17	0.22	0.28	0.31	0.31
	CV %	3.97	2.05	2.11	2.24	2.29	2.37	2.44	0.85	1.20	1.29	1.31	1.33	1.39	1.35

Table 2. Effect of post-harvest treatments on reducing sugar (%) and non-reducing sugar (%) of banana cv. Grand Nain (Musa AAA) during ripening under different storage conditions

	Treatments	Reducing sugar (%)(No. of storage day)							Non-reducing sugar (%)(No. of storage day)						
		1st	3rd	5th	7th	9th	11th	13th	1st	3rd	5th	7th	9th	11th	13th
T_1	Storage at ambient temperature (control)	0.96	1.46	3.07	5.87	8.77	8.87	9.44	1.62	2.53	3.32	3.75	7.05	8.06	9.02
T_2	Pre-cooling at 13^{0}C and 95 % RH. for 30 min. and then storage at ambient temperature	0.96	1.44	3.06	5.88	8.74	8.90	9.44	1.62	2.45	3.30	3.75	7.11	8.17	9.05
T_3	Storage at 14^{0}C and 95 % RH.	0.96	1.17	2.23	3.23	3.45	3.71	3.95	1.62	2.20	2.64	2.72	2.80	2.99	4.09
T_4	Dipping in Ethrel 500 ppm for 10 seconds and storage at ice placed condition for seven day	0.96	3.59	6.14	7.73	8.80	8.83	8.53	1.62	3.10	5.57	6.74	7.30	7.27	7.26
T_5	Dipping in Ethrel 1000 ppm for 10 seconds and storage at ice placed condition for seven day	0.96	3.60	6.16	7.74	8.83	8.77	8.54	1.62	3.13	5.58	6.78	7.33	7.23	7.24
T_6	Dipping in Ethrel 1500 ppm for 10 seconds and storage at ice placed condition for seven day	0.96	3.61	6.17	7.69	8.77	8.74	8.53	1.62	3.14	5.61	6.76	7.28	7.21	7.22
	S. Em±	0.01	0.02	0.03	0.04	0.07	0.07	0.09	0.01	0.03	0.07	0.09	0.10	0.13	0.13
	C. D. at 5 %	NS	0.05	0.09	0.12	0.20	0.22	0.28	NS	0.10	0.21	0.27	0.30	0.37	0.39
	CV %	1.79	1.24	1.36	1.25	1.69	1.83	2.32	1.15	2.43	3.21	3.59	3.10	3.68	3.63

Table 3. Effect of post-harvest treatments on acidity (%) and moisture (%) of banana cv. Grand Nain (*Musa AAA*) during ripening under different storage condition

Treatments	Acidity (%)(No. of storage day)						
	1st	3rd	5th	7th	9th	11th	13th
ge at ambient temperature (control)	0.235	0.260	0.280	.302	0.312	0.382	0.390
ooling at 13^{0}C and 95 % RH. for 30 min. and then storage at ambient temperature	0.235	0.245	0.254	.267	0.275	0.332	0.335
ge at 14^{0}C and 95 % RH.	0.235	0.235	0.240	.257	0.272	0.290	0.307
ng in Ethrel 500 ppm for 10 seconds and storage at ice placed condition for seven day	0.235	0.255	0.275	.310	0.345	0.320	0.330
ng in Ethrel 1000 ppm for 10 seconds and storage at ice placed condition for seven day	0.235	0.260	0.270	.307	0.340	0.315	0.320
ng in Ethrel 1500 ppm for 10 seconds and storage at ice placed condition for seven day	0.235	0.267	0.280	.295	0.340	0.315	0.310
. Em±	0.004	0.003	0.004	.005	0.021	0.007	0.008
'. D. at 5 %	NS	0.011	0.014	.016	0.007	0.022	0.024
'V %	3.43	2.90	3.50	3.81	4.40	4.40	4.90

Table 4. Effect of post harvest treatment on storage at 14^0 and 95% RH (T_3) of chemical changes during ripening of banana cv. Grand Nain (*Musa* AAA).

Chemical parameters	Number of storage day											
	15th	17th	19th	21th	23th	25th	27th	29th	31th	33th	35th	37th
Total soluble solids (%)	8.73	9.48	10.43	12.30	15.03	16.65	18.68	19.62	21.56	21.60	21.94	23.05
Total sugar (%)	8.63	8.89	9.39	9.79	10.27	10.55	10.73	11.16	11.74	13.76	16.29	18.59
Reducing sugar (%)	4.0	4.22	4.75	5.00	5.30	5.53	5.64	5.72	5.80	6.14	7.04	7.67
Non reducing sugar (%)	4.63	4.67	4.70	4.78	4.97	5.02	5.09	5.44	5.94	7.61	9.20	10.92
Titrable acidity (%)	0.320	0.322	0.332	0.342	0.347	0.355	0.362	0.365	0.375	0.382	0.385	0.385