Available online at www.ijpab.com

ISSN: 2320 – 7051
Int. J. Pure App. Biosci. **3 (4):** 132-141 (2015)

INTERNATIONAL JOURNAL OF PURE & APPLIED BIOSCIENCE

Research Article

OPEN ACCESS

Study on Effect of Different Packaging Materials on Shelf Life of Banana (*Musa paradisiaca* L.) cv. Harichal Under Different Conditions

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ABSTRACT

This study was conducted to evaluate the effect of different packaging materials on shelf life of banana (Musa sp. L.) cv. Harichal under different conditions. A laboratory experiment was laid out at Babasaheb Bhimrao Ambedkar University, School for Bioscience and Biotechnology, Department of Applied Plant Science (Horticulture), Vidya-Vihar, Rae-bareli Road, Lucknow, Uttar Pradesh from the period 2008-2009. The packaging materials were wooden box, plastic bag, polysheet and open air as a control. Packaging maintained the peel and the pulp thickness, firmness, dry matter and pulp to peel ratio was kept lower. On the basis of above findings it is concluded that the quality grade of banana fruits with nutritional and storage properties, Cool chamber+Brown paper and Cool chamber+Tissue paper were found good for improving significantly. The fruit length, fruit width, cumulative physiological loss in weight and ascorbic acid of banana fruits. The treatment T_2 (CC+Brown paper), T_5 (AT+Brown paper) are well for TSS. Treatment T_2 (CC+Brown paper) is good for ascorbic acid. Treatment T_4 (AT+Tissue paper) is useful for reducing sugars and treatment Ts (AT+Brown paper) is good for total sugars. These treatments were found to be good for 3 days of storage both at ambient and cool chamber conditions respectively. Fruits are edible at 7 days of storage under ZECC conditions and after 7 days they become pulpy and are infected by fungus. Thus, it can be concluded that packaging of banana fruits in high density and low density polyethylene bags resulted in longer shelf life and improved quality of the produce followed by packaging in dried banana leaf and teff straw. A randomized block design was employed with three treatments and replicated four times to arrange the experimental units in the lab. Harichal variety were harvested by hand in the month of March and obtained from village Itaunja (Bakshi Ka Talab) of District Lucknow. Healthy and uniform fruits were washed to remove adhering dirt and dust and dried in air and kept in plastic crates for packaging and storage to be used in the experiment. On the other hand, wooden box combined with straw was the best storage material to ripen banana fruit faster. Producers, traders or consumers may use the technology in order to get quicker ripening of banana fruits.

Key words: *Effect, different packaging, shelf life, banana fruit, Musa sp., cv. Harichal, polythene bags, wooden boxes and ZECC*

INTRODUCTION

Banana (Musu sp.) and plantain are known for their antiquity and are interwoven with Indian heritage and culture. The plants are considered as the symbol of "prosperity and fertility" Owing to its greater socio-economic significance and multifaceted uses, banana is referred as 'Kalpatharu' (plant of virtues). Musa fruits play major roles in the nutrition and well being of people of the tropical and sub tropical regions of the world. They are good source of income to the farmers in their respective growing regions[3,1]. In Africa, plantains and bananas provide more than twenty-five percent of the daily energy requirements by the people[7]. Fruits of most Musa species are either taken raw or processed into various products at various stages of ripening[1]. Banana is used as a dessert with several medicinal. Recent developments in genetic engineering have opened up new avenues for developing tailored banana with several desirable traits. Banana can be utilized for the production of edible vaccine against Hepatitis- B virus (HBV).The plant based vaccine for HBV in edible banana Seems to be an economical alternative for human healthcare suggested by Uma *et al.,* 2008. The total area under banana in the world is 11.13 million ha, producing 97.38 million tonnes of banana and plantains. India is the largest producer of banana in the world, contributing 24 % to the global production with a total area of 0.565 million ha and production 19.19 million tonnes. Brazil is next largest producer of banana followed by the Philippines, Indonesia, China and Ecuador reported by Singh, 2007[20]. Banana is the most important fruit crop of India on the basis area (8.03 million ha), production (29.72 million tonnes) and productivity (37.00 million tonnes/ha). Its contribute 33.4 % of the total fruit production in India. The major banana producing states of India are Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Bihar, Assam and Madhya Pradesh[9]. India is one of the major producers of bananas cultivating in an area of 83 lakh hectare with a production over 2.9 million tonnes worth of $83,55croresas reported for the year 2011[5]. The major banana producing states of India are Tamil Nadu, Maharashtra and Gujarat. Banana is one of the important fruit crop with annual (2009-2011 average) global production of about 106 million tonnes[6]. Its fruits are perishable in nature and cannot be stored for long time. Due to short shelf life it cannot be transport to for off places and this result in glut in the local market. The shelf life of fruits can be enhanced by various methods and proper packaging is one of them. The use of paper (Brown paper and Tissue paper) for packaging is getting popular these days. It has a highly perishable fruit which results in post harvest losses as high as 30-40 % reported by Slaukne *et. al.*[18]. Banana is a rich source of starch, mineral and vitamins; banana has become a part of diet. It is useful in managing patients with high blood pressure and heart diseases. It is also useful for arthritis, kidney diseases, ulcer and gastroenteritis reported by Singh, 2007. The spoilage of banana is mainly due to harvesting at improper stage of maturity. Physical damage during transport and consequent fungal infections improper stage and fungal breakdown following senescence[17]. The banana fruits ripen quickly at high temperature and their shelf life is short. Thus, there is a need to develop inexpensive methods for delaying ripening and extending the shelf life under ambient conditions without affecting eating quality of the fruit. The losses occur on account of various factors such as lack of storage facilities, improper handling and lack of packaging and refrigerated storage facilities[12]. Reported to the in a study on efficiency of packaging material it was spoiled that the fruits not only remained firm at the early ripe stage but had prolonged shelf life with green unshielded peels having narrow pulp/peel weight ratio and perfect peeling condition till the end of shelf life when stored in polyphone bags at 15^0C and 80-90% RH respectively. The storage behaviour of Robusta and Dwarf Cavendish varieties under cold temperature conditions revealed that a temperature range of 55-60 ^{0}C has been recommended for prolonged storage of Dwarf Cavendish bananas[14]. The report on packaging of banana hands in 400 gage polythene bags with coir pith as a carrier extended the shelf life of Rasthali banana up to 22 days as against 12 days in control without loss in quality of fruits[11]. Lack of information on appropriate post harvest treatments and on farm storage the fruits not only lose their quality but also encounter a substantial post harvest loss. On farm storage play a vital role in maintaining quality soon after harvest

therefore on farm storage study was conducted with the objective to retain and extend with the shelf life of fruits using big size evaporative cool chamber developed at Indian Agricultural research Institute, New Delhi[23]. The shelf life of fruits can be enhanced by keeping them in cold storage. The cold storage facilities are not generally available near production centers. Moreover, in country like India cold storage facilitates cannot be made available in sufficient number to accommodate all perishable commodities using expensive device and due power shortage. So taking into consideration the above difficulties some cheap structure must be designed which can be easily available to farmers and can store these perishable commodities at least for short time. Zero energy cool chambers have been designed and development at IARI[2] which is reported to enhance shelf life of fruits and vegetables by lowering down temperature and maintaining high humidity inside chambers. However, high decay losses due to high humidity have been reported in these chambers[21].

MATERIALS AND METHODS

The present study entitled "Studies on Effect of Different Packaging Materials on Shelf life of Banana (*Musa paradisiaca* L.) cv. Harichal Under Different Conditions" was carried out at Horticultural Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae-Bareli Road, Lucknow during 2008-2009 in well levelled field having proper drainage. Geographically, BBA University, Lucknow is situated at an elevation of 129 meters above the mean sea level in the subtropical tract of central Uttar Pradesh at $26^0$46' North latitude and $80^0$55' East longitude. The selection of packaging material was ready according to quantity of fruits to be packed for certain storage period at a particular storage temperature and relative humidity as per procedure given for the selection of packaging material reported by Ranganna 1986[15]. One *Musa* cultivar (Harichal) used for this study were collected from the village Itaunja (Bakshi Ka Talab) of District Lucknow. This experiment was carried out in Randomized Block Design with three treatments and replicated four times. The observations were recorded on the basis of Physical parameters i.e. Length of the fruits (cm), width of fruits (cm), cumulative physiological loss in weight (CPLW) (%) and specific gravity (%) as well as Chemical Parameters i.e. total soluble solids (^{0}Brix), acidity (%), ascorbic acid (mg) and sugars (%). The data recorded during observation was used for analysis to test the level of significance as per method given by Chandel, 1984[4]. The significance between any two means was judged by calculating critical difference (C.D.) at 5 % level of significance, according to the ANOVA Table.

RESULTS AND DISCUSSION

The results of Physico-chemical analysis of fruits packed in Different packaging materials under cool chamber and ambient conditions have been presented in the present chapter in detailed manner. Under the present study it was observed that the fruits stored under cool chamber conditions retained their appearance, flavors and quality for a longer duration (7 days) as compared to those stored under ambient condition (3 days).

All the physical parameters i.e. Fruit length, width specific gravity, physiological loss in weight as well as bio chemical parameters i.e. Total soluble solid (TSS), acidity, ascorbic acid and sugars of the fruit were recorded to be better under cool chamber conditions among the different packaging treatments used for prolonging the shelf life of fruits.

Physical parameters:

Fruit length- It was observed that the fruit length recorded to be significantly superior under cool chamber storage condition even after three days storage treatment T_1 (13.45 cm), T_2 (12.52 cm), T_3 (12.89 cm) as compared to ambient storage T_4 (12.02 cm), T_5 (11.55 cm) and T_6 (11.89 cm). Thus, it is clear that cool storage is superior over ambient storage till 3 days of storage among the packaging treatment applied

for prolonging self Iife, brown paper performed significantly better both under cool chamber storage T_2 (Cool chamber+Brown paper) (12.52 cm.) and under ambient storage T_5 (AT+Brown paper) (11.55 cm) as compared to other treatments viz . T_1 (CC+Tissue paper) (13.45 cm), T_3 (CC+Open control) (12.89 cm), T_4 (AT+Tissue paper) (12.02 cm) and T_6 (AT+Open control) (11.89 cm) at 3 days of storage (Table 1).

Fruit width- lt was observed that the fruit width was recorded to be significantly superior under cool storage even after 3 days of storage viz., treatment T_1 (2.62 cm), T_2 (2.59 cm), T_3 (2.46 cm), T_4 (2.80 cm), T_5 (2.55cm) and T_6 (2.42 cm). Thus, it is clear that cool storage is significantly superior over ambient condition. The changes in width were found to be statistically significant with respect to packaging treatment (Table 2).

Specific gravity- It was observed that significant variation among all packaging treatments under both cool chamber and ambient conditions. However it was obvious that treatment T_1 (CC+Tissue paper) and T_4 (AT+Tissue paper) has maximum specific gravity at after 3 days of storage. It was found to be in treatment T_1 (1.012) and T_4 (0.989) at after 3 days of storage followed by treatment T_2 (1.101), T_4 (0.912), T_5 (0.972) and T_6 (0.998). It is obvious from the data that although there was a variation in specific gravity it was highly significant differences in all treatments. The changes in specific gravity were found to be statistically highly significant with respect to packaging treatments (Table 3).

Cumulative physiological loss in weight- CPLW was found to be increased in all treatments and in both storage conditions. However, it was observed that there was no change in weight loss at harvest i.e. on 0 day of storage. It was observed that the physiological loss in weight was recorded to be 5ignificantly superior under storage conditions even after 3 days of storage. It was found to be in treatment T_1 (Cool chamber+Tissue paper) 16.21%, T_2 (Cool chamber +Brown paper) 12.32%, T_3 (Cool chamber +Open control) 17.15% as compared to physiological loss in weight under ambient conditions after 3 days of storage T_4 (Ambient +Tissue paper) 16.38%, T_5 (Ambient +Brown paper) 13.31% and T_6 (Ambient+Open control) 18.75%. Among the packaging treatments applied for prolonging shelf life tissue paper T_4 as compared to other treatments viz. T_2 (Cool chamber+Brown paper), T_3 (Cool chamber+Open control) , T_5 (Ambient+Brown paper) and T_6 (Ambient+Open control) was found to be best. The changes in physiological loss in weight were found to be statistically significant with respect to packaging treatments (Table 4).

Bio-chemical parameters:

Total soluble solids (TSS) - It was observed that TSS fruit was recorded to be significantly decreases both under cool storage condition and ambient storage conditions i.e. treatment T_1 (Cool chamber+Tissue paper) 27.26 ^{0}B, T_2 (CC+Brown paper) 24.25 ^{0}B, T_3 (CC+Open control) 28.30 ^{0}B and TSS of fruit under ambient conditions after 3 days of storage i.e. treatment T_4 (AT+Tissue paper) 30.25 ^{0}B, T_5 (AT+Brown paper) 26.70 ^{0}B & T_6 (AT+Open control) 31.75 ^{0}B. Thus, it is obvious that cool storage significantly superior compared to under ambient storage. Among the packaging treatment applied for prolonging shelf life of white polythene performed better both cool storage treatment T_2 (CC+Brown paper) 24.45 ^{0}B and under ambient storage treatment T_5 (AT+Brown paper) 26.70 ^{0}B as compared to other treatments viz. T_6 (CC+Tissue paper) 27.26 ^{0}B, T_3 (CC+ Open control) 28.30 ^{0}B, T_4 (AT+Tissue paper) 30.25 ^{0}B and T_6 (AT+Open control) 31.75 ^{0}B at after 3 days of storage (Table 5).

Acidity- The acidity of fruit was recorded to be significantly superior both under cool chamber and ambient conditions at after 3 days of storage i.e. treatment T_1 (Cool chamber+Tissue paper) 0.291%, T_2 (CC+Brown paper) 0.243%, T_3 (CC+Control) 0.263% as compared to acidity of fruit under ambient conditions after 3 days of storage T_4 (AT+Tissue paper) 0.335%, T_5 (AT+ Brown paper) 0.256% and T_6 (AT + Control) 0.293%. Thus it is evident from the data that cool storage is significantly superior over ambient conditions. Among the packaging treatments applied for prolonging shelf life tissue paper

performed better both under cool storage T_2 (CC+Tissue paper) and ambient condition T_6 (AT+Tissue paper) as compared to other treatments. The acidity of fruit was maximum in T_1 (0.391%), T_2 (0.243%), T_3 (0.263%), T_4 (0.335%), T_5 (0.256%) and T_6 (0.293%) at 3 days of storage (Table 6).

Ascorbic acid- It was observed that ascorbic acid of fruit was recorded to be significantly affected by the treatment. It was shown that treatment T_1 (CC+Tissue paper) 18.88 mg/100 gm at retained maximum ascorbic acid at 3 days of storage followed by T_2 (CC+Brown paper) 20.48 mg/100 gm, T_3 (CC+Open control) 2l.55 mg/100 gm, T_4 (AT+Tissue paper) 22.40 mg/100 gm, T_5 (AT+Brown paper) 23.15 mg/100 gm and T_6 (AT+Open control) 19.21 mg/100 gm. It was observed that there was significant variation among all packaging treatments under both conditions cool chamber and ambient temperature condition. It was found that there were no clear cut effects in all packaging materials. The value of ascorbic acid of fruit was found to vary statistically significant among all packaging treatments (Table 7).

Sugars:

a. Reducing sugar- It was observed that reducing sugar of fruit was recorded to be significantly superior under cool storage conditions even after 3 days of storage because reducing sugar gradually increased under cool storage conditions compared to ambient conditions. It was found to be in treatment T_1 (CC+Tissue paper) 4.45%, T_2 (CC+Brown paper) 3.72%, T_3 (CC+Open control) 5.52% as compared to reducing sugar of fruit under ambient condition after 3 days of storage i.e. treatment. T4 (AT+Tissue paper) 4.38% (AT+Brown paper) 3.88% and T6 (AT+Open control) 6.02% respectively.

Thus, it is obvious that cool storage is significantly superior over ambient storage conditions. Among the packaging treatments at applied for prolonging the shelf life brown paper and Tissue paper performed better both under cool storage T_2 (CC+Brown paper) and under ambient storage T_5 (AT+Brown paper) as compared to other treatments i.e. T_1 (CC+Tissue paper), T_3 (CC+Open control), T_4 (AT+Tissue paper) and T_6 (AT+Open control). Under cool chamber banana was edible at 7 days but under ambient conditions banana was become pulpy and fungal infected at 7 days (Table 8).

(b) Total sugars- It was observed that total sugar of fruit was recorded to be significantly superior under cool storage conditions even 3 days of storage because total sugar increased gradually compared to ambient storage conditions. It was found to be under cool chamber conditions in treatment T_1 (CC+Tissue paper) 6.32%, T_2 (CC+Brown paper) 8.61%, T_3 (CC+Open control) 6.94% as compared to total sugars of fruit under ambient condition in treatment T_4 (AT+Tissue paper) 6.15% T_5 (AT+brown paper) 6.15% and T_6 (AT+Open control) 6.02%.Thus it is clear that cool storage is significantly superior over ambient condition of storage. Among the packaging treatments applied for prolonging the shelf life, in cool chamber brown paper performed better and tissue paper is performed better under ambient conditions. After 7 days under cool chamber fruits were treatments with T_1 (CC+Tissue paper) 13.78%, followed by T_2 (CC+Brown paper) 11.23% and T_3 (CC+Open control) l5.24% was edible at 7 days but under ambient conditions banana was become pulpy and fungal infected by fungus at 7 days. The changes in total sugars were found to be statistically significant with respect to packaging treatments (Table 9).

A. Physical Parameters

Table 1. Effect of different packaging treatments on the fruit length (cm) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	13.81	13.45	13.59
T_2	12.59	12.52	12.48
T_3	13.16	12.89	12.65
T_4	12.36	12.02	12.85
T_5	11.56	11.55	11.95
T_6	12.05	11.89	12.50
SE (d)	0.07371	0.07710	0.06433
CD at 5%	0.15486	0.16198	0.13516

Table 2. Effect of different packaging treatments on the fruit width (cm) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	2.52	2.62	2.48
T_2	2.57	2.59	2.52
T_3	2.39	2.46	2.33
T_4	2.70	2.80	2.45
T_5	2.52	2.55	2.65
T_6	2.35	2.42	2.50
SE (d)	0.03902	0.03037	0.02461
CD at 5%	0.08197	0.06380	0.05170

Table 3. Effect of different packaging treatments on the specific gravity (%) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	1.245	1.012	1.112
T_2	1.113	1.101	1.110
T_3	0.959	0.912	0.938
T_4	1.047	0.989	1.105
T_5	0.980	0.972	0.995
T_6	1.053	0.998	1.115
SE (d)	0.00514	0.00401	0.00580
CD at 5%	0.01079	0.00842	0.01218

Table 4. Effect of different packaging treatments on the physiological loss in weight (%) of banana cv. Harichal in different conditions

Treatments	Number of Days	
	3.00	**7.00**
T_1	16.21	20.15
T_2	12.32	14.21
T_3	17.15	20.46
T_4	16.38	18.22
T_5	13.31	16.25
T_6	18.75	19.46
SE (d)	0.25011	0.28696
CD at 5%	0.52546	0.60287

B. Bio-chemical Parameters

Table 1. Effect of different packaging treatments on the total soluble solid (^{0}Brix) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	23.75	27.26	25.75
T_2	23.50	24.25	23.70
T_3	23.75	28.30	21.75
T_4	25.00	30.25	23.45
T_5	24.00	26.70	24.65
T_6	23.50	31.75	22.36
SE (d)	0.32275	0.66260	0.60162
CD at 5%	0.67807	1.39206	1.26395

Table 2. Effect of different packaging treatments on the acidity (%) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	0.2500	0.291	0.452
T_2	0.2320	0.243	0.376
T_3	0.2240	0.263	0.656
T_4	0.2650	0.335	0.563
T_5	0.2241	0.256	0.485
T_6	0.2331	0.293	0.753
SE (d)	0.00246	0.00453	0.00506
CD at 5%	0.00517	0.00951	0.01063

Table 3. Effect of different packaging treatments on the ascorbic acid (mg/100 gm) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	18.94	18.88	14.29
T_2	20.51	20.48	15.75
T_3	21.95	21.55	16.48
T_4	22.54	22.40	13.55
T_5	23.21	23.15	14.62
T_6	19.56	19.21	12.85
SE (d)	0.05773	0.05657	0.05715
CD at 5%	0.12130	0.11885	0.12008

Table 4. Effect of different packaging treatments on the reducing sugar (%) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	0.98	4.45	6.62
T_2	0.96	3.72	4.53
T_3	0.93	5.52	7.78
T_4	0.89	4.38	6.56
T_5	0.92	3.88	8.45
T_6	0.94	6.02	5.65
SE (d)	0.01810	0.04714	0.08165
CD at 5%	0.03804	0.09904	0.17154

Table 5. Effect of different packaging treatments on the non reducing sugar (%) of banana cv. Harichal in different conditions

Treatments	Number of Days		
	0.00	**3.00**	**7.00**
T_1	6.22	6.32	13.78
T_2	6.25	6.28	11.23
T_3	6.75	6.94	15.24
T_4	5.89	6.15	12.35
T_5	6.12	6.15	14.55
T_6	5.92	6.02	11.85
SE (d)	0.05497	0.06532	0.09144
CD at 5%	0.11550	0.13723	0.19211

DISCUSSION

The result obtained regarding physical chemical changes during storage period and packaging treatments are discussed below.

Fruit size- Treatment with brown paper packaging viz., treatment T_2 (Cool chamber+Brown paper) proved to be the best treatments compared to other treatments. The maximum decrease in fruit size was recorded in treatment to T_3 (Cool chamber conditions) and T_6 (Controlled conditions) both cool chamber conditions as well as ambient conditions. The results are in accordance with a similar study in guava by Nath and Singh,2000[13] where it was found that treatment of polythene recorded minimum decrease in fruit size as compared to paper packaging. Similar results have been obtained even in kinnow.

Specific gravity- Statistically significant differences was recorded in specific gravity was observed in fruits packed in different packaging materials irrespective of storage temperature minimum specific gravity was recorded in treatment T_2 (Cool chamber+Brown paper) 1.101 and treatment T_6 (Ambient+Open control) 0.998, it is not highest retention value of specific gravity after 3 days of storage. Maximum specific gravity was recorded in treatment T_2 (CC+Brown paper) 1.101 and ambient conditions treatment T_6 (AT+Open control) 0.998 proved to be the best having higher retention value for specific gravity after 3 days of storage.

Cumulative physiological loss in weight- It has been observed that packaging treatments T_2 (cool chamber+brown paper) 16.21% and T_4 (AT+Tissue paper) 16.38% at after 3 days of storage proved to be the best giving higher retention value for CPLW.

Singh *et al.*,1987[21] reported that physiological loss in weight increased with increasing period of storage the fruits treatment with diphenyl and under ZECC having maximum loss 37.67% compared to room temperature 25.67%, this process is obtained the fruits is stored up to 4 days. These results are in conformity with findings of Ravi, 2007[16] and Wasker, *et al.* 1999[23].

Total soluble solids (TSS) - The TSS was much faster at room temperature compared than ZECC temperature. However, minimum TSS was recorded in treatment T_2 (CC+Brown paper) 24.25^0B and maximum TSS was recorded in treatment T_3 (Cool chamber+Open control) 28.30^0B at after 3 days of storage. The rate of TSS was increased much faster at room temperature than in cool chamber. These results are support the findings of Singh, *et al.*,1987[21] and Garg, *et al.*,1973.

Acidity- Minimum acidity was recorded in treatment T_2 (CC+Brown paper) 0.243% and T_5 (AT+Brown paper) 0.256% at after 3 days of storage. Maximum acidity was recorded treatments T_1(CC+Tissue paper) 0.291% proved to be the best having highest retention values for acidity under ZECC after 3 days of storage. The rate of increase in acidity was cool chamber than ambient condition after 7 days in cool chamber acidity was increase in treatment T_1 (CC+Tissue paper) 0.452% and T3 (CC+Open control) 0.656% under ambient conditions fruit was pulpy and fungal infected by fungus.

Ascorbic acid- Treatment T_3 (Cool chamber+Open control) 21.55 mg/100 gm proved to be the best having high retention values for ascorbic acid and treatment Ts (AT+Brown paper) 23.15 mg/100gm at after 3 days of storage. Ascorbic acid was decreased maximum in T_2 (CC+Brown paper) 20.48 mg/100 gm in cool chamber and T_6 (AT+Open control) 19.21 under ambient conditions at after 3 days of storage. Treatment T_3 (CC +Open control) 16.48 proved to be the having highest retention values for ascorbic acid followed by treatments T_1 (14.29) and T_2 (15.75) at 7 days of storage.

Gautam *et al.*,[8] reported that the similar trend in mango the fruits dipped in 6% emulsion and stored under ZECC conditions recorded higher ascorbic acid compared then ambient conditions.

Sugars

(a) Reducing sugar- The reducing sugar showed on increase during the storage in all treatments and both storage conditions increase the reducing sugar much faster at room temperature and cool chamber temperature. Maximum reducing sugar was recorded in treatment T_6 (AT+Open control) 6.02% at after 3 days of storage. The rate of reducing sugar was increased much faster at room temperature compared to

cool chamber. During storage the reducing sugars increased significantly. Similar finding were also reported by Tiwari and Dwivedi, 2007[22] in mango.

(b) Total sugars- The total sugars showed on increase during the storage in all treatments and both storage conditions than cool chamber conditions. Maximum total sugars was recorded in treatment T_6 (AT+control) 6.02% at after 3 days of storage during storage the total sugars increased significantly. At after 7 days of storage under cool chamber it was found minimum treatments T_2 (CC+Brown paper) 11.23% and maximum T_3 (CC+Open control) 15.24% and under ambient conditions fruits was become pulpy black skin and infected by fungus therefore cool chamber storage fruits are best compared then under ambient conditions of fruits. Similar study were also reported by Singh and Singhrot, 1987[21] working on grape. During storage of total sugars increased significantly because this increase could be attributed to the conversion of starch and other in soluble carbohydrates into soluble sugars, similar observation were also reported by Selvaraj and Pal, 1984[19] and Kumbhar and Desai, 1986[10] while working with storage of sapota fruits.

CONCLUSION

On the basis of above findings it is concluded that the quality grade of banana fruits with nutritional and storage properties, Cool chamber+Brown paper and Cool chamber+Tissue paper were found good for improving significantly. The length, width, CPLW and ascorbic acid of banana fruits. The treatment T_2 (CC+Brown paper), T_5 (AT+Brown paper) are well for TSS. Treatment T_2 (CC+Brown paper) is good for ascorbic acid. Treatment T_4 (AT+Tissue paper) is useful for reducing sugars and treatment Ts (AT+Brown paper) is good for total sugars. These treatments were found to be good for 3 days of storage both at ambient and cool chamber conditions respectively. Fruits are edible at 7 days of storage under ZECC conditions and after 7 days they become pulpy and are infected by fungus. Banana (*Musa sp.*) an important tropical fruit crop in the world. It is widely grown in India with great socio-economic significance interwoven in the cultural heritage of the country. Banana is also a dessert fruit for millions apart from a staple food owing to its rich and easily digestible carbohydrates with a calorific value of 67-137mg/100 gm fruit. It is a rich source of Vitamin C and minerals. It makes healthy and salt free diet. Banana fruits contain 6l-78% of moisture and 20-25% of total carbohydrates.

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