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EFFECT OF DIFFERENT PACKING MATERIALS AND STORAGE CONDITIONS ON THE SHELF LIFE OF BANANA (AMRITSAGAR)

Khan, S.A.K.U.*, A.H.M.H. Chowdhury and D.K. Chakravarty

Agrotechnology Discipline, Khulna University, Khulna 9208, Bangladesh

Abstract: A study was conducted on the storage performance of banana cv. Amritsagar, using different packing materials and maintaining different storage conditions. The two storage conditions differed significantly in case of days required to reach 7th stage of ripening, % weight loss, % of brix and softness of peel. However, the banana stored in refrigerated condition performed better in most of the cases. The banana stored in perforated polybag showed better performance for days required to reach 7th stage (9.67 days), percent of brix (2.48 %) and sweetness (8.33). Minimum weight loss (1.86 %), maximum softness (7.07) and maximum moisture content (77.00 %) were found in bananas kept in unperforated polybag with silica gel. In case of interaction between packing materials and storage conditions, maximum days (13) were required to reach at 7th stage for the bananas kept in perforated polybags in refrigerated condition, minimum weight loss (1.74%) was in unperforated polybag with silica gel kept in refrigerated condition and maximum sweetness (8.74) was in perforated polybag kept in refrigerated condition.

Key words: Banana, packing, storage, shelf life, amritsagar

Introduction

Banana is one of the cheapest, most plentiful and nourishing of all fruits (Khader *et al.*, 1995). It is most important fruit which is available throughout the year in Bangladesh. The consumption rate is also higher than any other fruits. From the nutritional point of view it has high calorific and nutritional value. Its carbohydrate content in the pulp can be as high as 36.4% (Bajpai *et al.*, 1985).

The per capita availability of fruits in Bangladesh is 30-40 g day^{-1} whereas nutritionist recommended every person should have 85 g of fruits in his daily diet (Chandha, 1981), therefore the availability is far below than recommended level. The per capita of fruits is further reduced due to high level of post harvest losses. In Bangladesh a huge amount of banana is spoiled due to prevailing high temperature, humidity and inappropriate post harvest technology. This spoilage of fruit is attributed to adverse physiological changes, namely loss of weight due to respiration and transpiration, loss of flesh hardness and loss of resistance to microbial attack. Such spoilage can occur either during transportation and/or in the market resulting considerable economic loss to both importer and retailer. So it is necessary to find out the suitable preserving methods of banana. Therefore this study was conducted by preserving banana under different post harvest treatments such as storage in unperforated and perforated polythene bags, unperforated polythene bags with silica gel, unperforated polythene bags with potassium permanganate ($KMnO_4$) and brown papers under normal and refrigerated conditions, to mitigate the post harvest losses.

* Corresponding author: Ph. 88041-720171/322, < sakuk@bttb.net.bd>

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Materials and Methods

Materials used: Amritsagar, one of the most important and commercial banana variety of Bangladesh.

Packing materials: Different packing materials used are- newspaper, unperforated polybag, perforated polybag, unperforated polybag with $KMnO_4$, unperforated polybag with silica gel and brown paper. Only 0.5 g of $KMnO_4$ and silica gel were used by encapsulating them in papers of normal texture. The packing materials were tied with banana using rubber band.

Collection of data: Changes in the different parameters were observed in the laboratory. The following physical and chemical parameters were studied. Data were collected on every alternative days.

***a. Days required for reaching different stages of ripening*:** Days required to reach in different stages of ripening was determined on the basis of the characteristics of fruit as shown in the Table 1.

Table 1. Description of different stages of banana (Amritasagar) ripening especially in physical appearance and color change (Momen *et al*., 1993).

Stages of ripening	Physical appearance and color changes
Stage-1	Freshly harvested and green
Stage-2	Greenish yellow
Stage-3	Yellowish green
Stage-4	Light yellow but in edible condition*
Stage-5	Dark yellow, in edible condition
Stage-6	Dark yellow, stalk start rotting
Stage-7	Dark yellow, still in edible conditions
Stage-8	Skin blackened, non edible conditions**
Stage-9	Rotted completely

* Edible conditions mean the texture of flesh is soft and no unpalatable latex. ** Non edible conditions mean texture blackened, bad smell and bitter taste.

***b. Changes in weight*:** Immediately after collection, the four fingers were cut off. Then initial weight was taken by using balance. Changes in weight during ripening were monitored by weighing the fingers at one day interval. Weight loss was calculated by deducting the final weight from the initial weight.

***c. Pulp to peel ratio*:** The pulp and skin tissues were separated by means of stainless steel knife and weighted separately. The ratio between pulp weight and skin weight was calculated by dividing the fresh weight of pulp with weight of skin of single fruit. The data were collected at the beginning and at the end of the experiment.

***d. Dry weight*:** On the final day of data collection, 5 g of the pulp was taken in petridish and oven dried at 80^0C for 72 hours and dry weight was taken with the help of electric balance.

***e. Moisture content*:** Moisture percentage was calculated from the obtained data of dry weight using the following formula.

$$\% \text{ moisture} = \frac{I - F}{I} X 100$$

Where, I = Initial weight of pulp, and F = Final weight of pulp

***f. Brix percentage*:** The brix percentage was determined by using a refrectometer. A drop of banana extract squeezed from the banana pulp was placed on the prism of the refrectometer and percent brix value was obtained from direct reading.

***g. pH of the banana pulp*:** Only 15gm banana samples were homogenized in distilled and de-ionized water and the pH of homogenate was measured with a pH meter.

***h. Organoleptic evaluation*:** Organoleptic test of banana were done for determining the sweetness and softness of banana. For this purpose banana were cut into small pieces and were tested. Ten members participated in the test panel and they indicated the condition of the banana by grading points from 1-10.

***i. Surface diseased area*:** Surface diseased area of the banana fruits were calculated at different stages of ripening.

Design of experiment and treatments of the study: The study was conducted following Completely Randomized Design (CRD) with three replications for each treatment. All possible combinations of two storage conditions and seven packing materials were considered as the treatments of the study.

Statistical analysis: The means for all the treatments were calculated and analysis of variance for all the characters was performed by F-test. Means were compared by the least significant difference (LSD) test (Gomez and Gomez, 1984).

Results

Effect of storage conditions on performance of banana: The storage conditions studied showed significant differences for days required to reach 7th stage (Fig. 1), weight loss at final day of data collection (Fig. 2 and Fig. 3), brix percentage and softness of the pulp (Table 2). Similar moisture content, pulp-peel ratio, dry weight, pH and sweetness in stored bananas were observed in both storage conditions. There was no disease infection on the surface of the bananas stored in refrigerated storage condition. In normal condition the bananas were infected and surface diseased area ranged from 23.33% in control and newspaper wrapped bananas to 86.67% in unperforated polybag with $KMnO_4$ (Fig. 4).

Effect of packing materials on performance of banana: The packing materials studied showed significant differences for most of the parameters considered in this study. The banana kept in perforated polybag showed better performance for days required to reach 7th stage (9.67 days), percent of brix (2.48 %) and sweetness (8.33). Maximum softness (7.07) was also found in this treatment. However, maximum pulp to peel ratio was observed in the control treatment. There was no significant difference among the packing materials regarding moisture content (%), dry weight and pH (Table 3).

Effect of interactions between packing materials and storage conditions on stored banana: The interaction between packing materials and storage conditions showed statistically significant difference for days required to reach 7th stage, loss of weight (%) and organoleptic parameters (Table 4). Maximum days (13) were required to reach at 7th stage for the bananas kept in perforated polybags whereas minimum weight loss (1.74%) occured in unperforated polybag with silica gel. On the other hand, maximum sweetness (8.47) was found in perforated polybag kept in refrigerated condition. Similar result was obtained by Chen *et al.* (1998).

Table 2. Effect of storage conditions on storage performance of banana cv. Amritsagar

Storage condition	Days to reach 7th stage	Weight loss of banana (%)	Moisture content (%)	Pulp-peel ratio	Dry weight (gm)	Brix (%)	pH	Organoleptic test	
								Sweetness	Softness
Normal condition	6.86	11.37	74.67	2.35	1.27	1.83	6.32	5.08	7.88

Refrigerated condition	10.43	9.66	74.00	2.51	1.30	1.26	6.29	4.73	5.09
Level of significance	*	*	NS	NS	NS	*	NS	NS	* *

*p<0.05, **p<0.01, NS = Non significant

Table 3. Effect of packing materials on storage performance of banana cv. Amritsagar.

Packing materials	Days to reach 7th stage	Weight loss of banana (%)	Moisture content (%)	Pulp-peel ratio	Dry weight (gm)	Brix (%)	pH	Organoleptic test	
								Sweetness	Softness
Control	7.50	23.53	73.00	3.80	1.35	1.78	6.26	7.17	7.03
Newspaper	7.00	16.95	75.33	3.23	1.23	1.82	6.25	7.03	6.80
Unperforated polybag	5.00	3.26	76.67	1.82	1.17	1.16	6.35	1.00	4.50
Perforated polybag	9.67	6.93	75.67	2.28	2.22	2.48	6.25	8.33	7.50
Unperforated polybag with $KMnO_4$	4.67	2.27	70.67	1.54	1.46	1.06	6.25	1.33	6.53
Unperforated polybag with silica gel	5.00	1.86	77.00	1.44	1.15	1.12	6.42	2.67	7.07
Brown paper	5.33	18.78	72.00	2.95	1.40	1.42	6.34	6.77	5.93
Level of significance	* *	* *	NS	* *	NS	*	NS	* *	* *

*p<0.05, **p<0.01, NS = Non significant

Table 4. Combined effect of storage conditions and packing materials on storage performance of banana cv. Amritsagar.

Storage condition × Packing materials	Days required to reach 7th stage	Weight loss of banana (%)	Moisture content (%)	Pulp -peel ratio	Dry weight (gm)	Brix (%)	PH	Organoleptic test	
								Sweetness	Softness
Normal condition × Control	6.33	23.08	74.00	3.44	1.30	1.73	6.31	7.40	6.73
Normal condition ×Newspaper	6.00	18.28	76.00	3.01	1.20	2.17	6.32	7.73	7.13
Normal condition × Unperforated polybag	8.00	2.87	78.00	2.07	1.10	1.43	6.37	1.00	8.00
Normal condition × Perforated polybag	6.33	11.59	74.00	2.20	1.30	2.97	6.33	8.20	7.93
Normal condition × Unperforated polybag with $KMnO_4$	7.33	2.29	72.00	1.56	1.40	1.13	6.23	1.00	10.00
Normal condition × Unperforated polybag with silica gel	8.00	1.98	74.67	1.50	1.27	1.57	6.38	2.00	8.00
Normal condition × Brown paper	6.00	19.46	74.00	2.70	1.30	1.83	6.29	8.13	7.33
Refrigerated condition × control	8.67	23.98	72.00	4.17	1.40	1.83	6.22	6.93	7.33
Refrigerated condition × Newspaper	8.00	15.61	74.67	3.45	1.27	1.47	6.17	6.33	6.47
Refrigerated condition × Unperforated polybag	2.00	3.65	75.33	1.57	1.23	1.88	6.33	1.00	1.00
Refrigerated condition × Perforated polybag	13.00	2.28	77.33	2.36	1.13	2.00	6.16	8.47	7.07

Refrigerated condition × Unperforated polybag with $KMnO_4$	2.00	2.26	69.33	1.51	1.53	0.98	6.27	1.67	3.07
Refrigerated condition × Unperforated polybag with silica gel	2.00	1.74	79.33	1.38	1.03	0.67	6.47	3.33	6.13
Refrigerated condition × Brown paper	4.67	18.09	70.33	3.19	1.50	1.00	6.39	5.40	4.53
Level of significance	* *	*	NS	NS	NS	NS	NS	*	* *

*p<0.05, **p<0.01, NS = Non significant

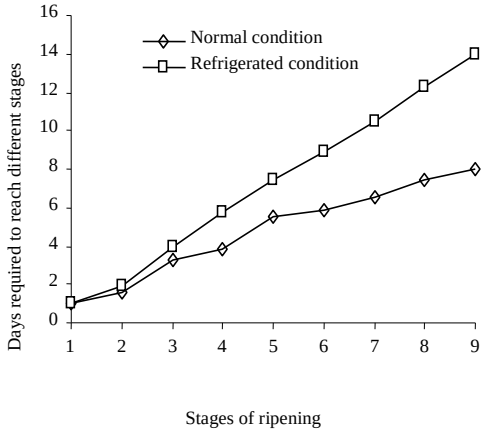

Fig. 1. Days required to reach different stages of ripening by bananas stored in normal and refrigerated condition

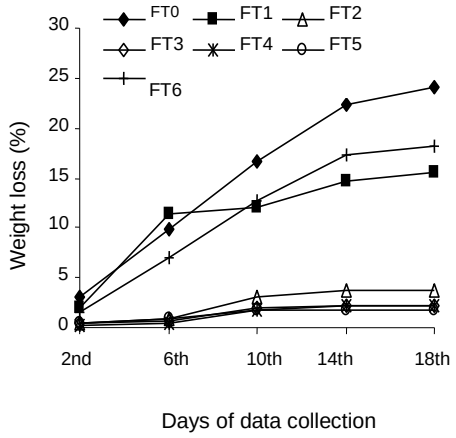

Fig. 2. Trend of weight loss (%) due to the effect of different packing materials in refrigerated condition

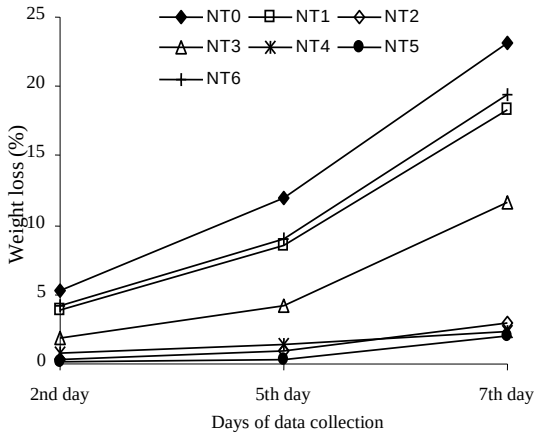

Fig. 3. Trend of weight loss (%) due to the effect of different packing materials in normal condition

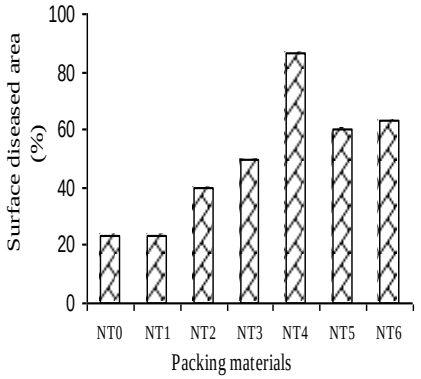

Fig 4: Effect of different packing materials in normal storage condition on surface disease area (%) of banana

Note: N=Normal storage condition, T0= Control, T1= Newspaper, T2= Unperforated polybag, T3= Perforated Polybag, T4= Unperforated polybag with $KMnO_4$, T5 = Unperforated polybag with silica gel, T6= Brown paper

Discussion

Banana stored at normal condition, the stored bananas took the longest days (6.86 days) to reach at 7th stage of ripening, showed highest brix percentage (1.83%) and maximum softness (7.88). However, the percent weight loss was minimum (9.66%) in refrigerated condition (Table 2). The findings of Muthuswamy *et al.* (1971), Krishnamurthy (1989) and Chitarra and Lajola (1985) support the results of the present study. An experiment was conducted by Zhang *et al.* (1992) on the softness of banana pulp which also supports the findings of the present study. They reported that high temperature (30° C) accelerated softening of the pulp, inhibited chlorophyll break down in the peel (than 20°C), resulting in "green ripe" condition of the banana.

Perforated polybags showed better performance in the study. Similar phenomenon was observed by Smock (1967) and Zica and Brune (1973). Minimum weight loss (1.86%) was found in bananas kept in unperforated polybag with silica gel. In an experiment, Scott *et al.* (1971) also found less reduction of weight of banana fruits packed in polythene bags.

Maximum softness (10.00) was recorded in unperforated polybag with $KMnO_4$ in normal storage condition (Table 4). In 1984, Dugay found similar results where the author observed that potassium permanganate ($KMnO_4$) prolonged the storage life of banana without any effect on the quality. Regarding moisture content in stored bananas variation was minimum between the interactions of packing materials and normal storage condition than refrigerated condition. Almost similar pulp-peel ratio, dry weight, per cent brix and pH were observed due to the interaction between storage conditions and packing materials.

Conclusion

The study on changes in various physical and chemical parameters during ripening of banana (var. Amritsagar) was carried out to find out the suitable keeping condition and packing materials. From this study, it can be concluded that shelf life of banana could be extended up to 13 days by using perforated polythene cover in refrigerated storage condition with a remarkable values of sweetness (8.47) and softness (7.07).

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