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Effect of Honey and Sugar Solution on the Shelf Life and Quality of Dried Banana (*Musa paradisiaca)* Slices

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Abstract The main purpose of the study was to investigate the effect of solution on the shelf life and quality of banana slices and development of high quality dehydrated banana products. Ripe banana collected from local market cut into 3, 5 and 7 mm slices. Solution effect was assessed using honey, sugar and mixed (honey plus sugar, 1:1) solution. The osmosis samples were dried in a mechanical drier at 65°C for 24 hour up to moisture content 14.6%. Fresh and dehydrated banana were analyzed for their chemical composition. The effect of pre-treatment (4 min steam blanching plus 20 min sulphyting) and nutrient content also evaluate. Percent solid gain was assumed as indicator of solution of solution effect. Percent solid gain slightly decreased (per unit weight) with increasing thickness of banana slices at constant immersion time (3 hour) and concentration (72% TSS). This gain was higher in honey solution followed by sugar solution. The response of taste panel revealed that banana slices prepared by 4 min steaming plus 20 min sulphyting (0.5% KMS) and subsequently dipping in honey solution gave better colour and flavor. It has been also revealed that pre-treatment by 4 min steaming plus 20 min sulphyting (0.3% KMS) and subsequently dripping in honey was gave better colour and flavour of banana slices. So these pre-treated dehydrated products showed highest degree of acceptability. Studies on the effect of various packaging materials showed that the single layer polythene plus keep in tin can gave the best result for storing the dried banana slices. Among the different storage condition of dried banana slices (75% RH, 80%RH and 90% RH), the 75% RH was found most effective for storing the processed slices. However, in all packaging systems and storage conditions, the slices absorbed moisture over the storage period and lost its quality. To maintain better quality of slices for longer shelf-life, the low relative humidity and moisture proof packaging system (polythene plus kept in tin can or laminated aluminum foil) may be required.

Keywords: *banana, pretreatments, processing, sugar & honey solution, shelf life, quality*

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1. Introduction

Ripe bananas have been considered as a part of human diets for many years. Many people are involved with production and consumption of ripe banana around the world. The moisture content in ripe banana is about 80% and therefore very susceptible to post-harvest losses and considerable weight loss during transportation and storage [1]. Post-harvest losses are a major challenge for tropical products such as mango, pineapple, banana etc. Generally, Deterioration occurs in a fully ripened banana within 4-7days [1].

Banana (*Musa paradisiaca)* is one of the cheapest, most plentiful and nourishing of all fruits [2]. This is one of the superior fruits of Bangladesh with respect to popularity, availability, production and consumption [3]. It is also delicious and seedless. It is the most delicious fruit in the world. As a matter of fact, in Bangladesh, banana is a popular and economic fruit which constitutes 42% of fruit consumption [3]. The importance of this fruit is due to its calorific and nutritive value and of its versatile use to the consumer. It contains appreciable amount of vitamin B and certain amount of vitamin A and C.

Banana contains a considerable amount of minerals such as K, P, Ca and Fe [4]. Various products like banana chips, banana figs, flour, powder, jam, confectionary, dehydrated slice etc. could be prepared from banana [2]. Banana is not seasonal in nature like many other fruit crop and is available in large quantity throughout the year. But banana is highly perishable food item and could not be

preserved for long time after harvesting. Most of the world's bananas are eaten either raw, in the ripe state, or as a cooked and proportion are processed in order to obtain a storable product. At present few varieties of banana (e. g. Sagar) has been cultivating commercially could be encouraged for more production and spoilage could be prevented by proper preservation.

Drying is one of the oldest methods for the preservation of food products. Heated air drying method has been developed as a newer technique of drying food and also considered as more hygienic and economic [5,6]. Dried products could be used directly or treated as secondary raw material [7]. The hot air drying of food material has advantages s such as control product quality achievement of hygienic conditions and on reduction of production loss [8]. Shrinkage of the cells browning loss of redrying ability, wettability and case hardening are some common problems associated with drying of tropical fruits, which reduce their market value and general acceptability [9,10].

Among processed products, dried ripe banana slices contribute significantly, since it can be stored and used easily. To decrease the drying cost and increase the product quality several pre-treatment before drying are conducted. Among these immersion in high concentrated aqueous or sweet (honey) solution has potential to give a higher quality products. Before drying immersion in sugar solution prior to drying reduced drying time upto 1.6 times [11]. One of the main constrains of the dried banana products is flavour deterioration and discoloration which resulted in less marking demand. To overcome these constrains, besides steam blanching, immersion of the slices in different solution before drying might give improved colour and flavour. Keeping the above views in consideration, the present investigation were undertaken to fulfill the following objectives: To assess the solution effect on qualitative and nutritive changes in ripe banana slices. To develop high quality dehydrated banana slices. To assess the overall acceptability of the processed slices. Packaging study of the processed slices. And storage study of the processed slices.

2. Materials and Method

2.1. Sample Collection and Banana slice Preparation

The banana samples were collected from local markets and cut into slices of 3 mm, 5 mm and 7 mm thickness using stainless knives and the peels were removed manually.

2.2. Preparation of Sugar and Sugar Honey Mixed Solution

The natural honey was collected from local market of Dinajpur, Bangladesh. The total soluble solid (TSS) of honey examined by refractometer was found 72%. The sugar solution was prepared by mixing by water with heating and TSS was adjusted until it reached to the same TSS of honey (72%). The mixed solution was made by mixing (ratio is 1:1) sugar solution and honey and TSS was adjusted to that of honey (72%).

2.3. Pre-treatments and Processing of Banana Slices

Table 1. List of the pretreatments

Pre-treatments	Time
Hot Water Blanching	4 min
Steam Blanching	2 min
	3 min
	4 min
Steam Blanching + Sulphyting (0.3% KMS Solution)	4+20 min
Steam Blanching + Sulphyting (0.5% KMS Solution)	4+20 min

The banana slices were blanched in steam (100°C and atmospheric pressure) for 4 minutes to prevent the enzymatic activity which may causes undesirable changes during processing. The blanched banana slices were dipped in 0.3% and 0.5% KMS solution for 20 minutes to avoid non-enzymatic browning which act as ant browning chemicals. Then the sliced banana was immerged in sugar solution, honey solution and mixed solution (sugar + honey; 1:1) for 3 hours. The solution concentration was 72% (W/W) and the solution to product ratio was 7:1.

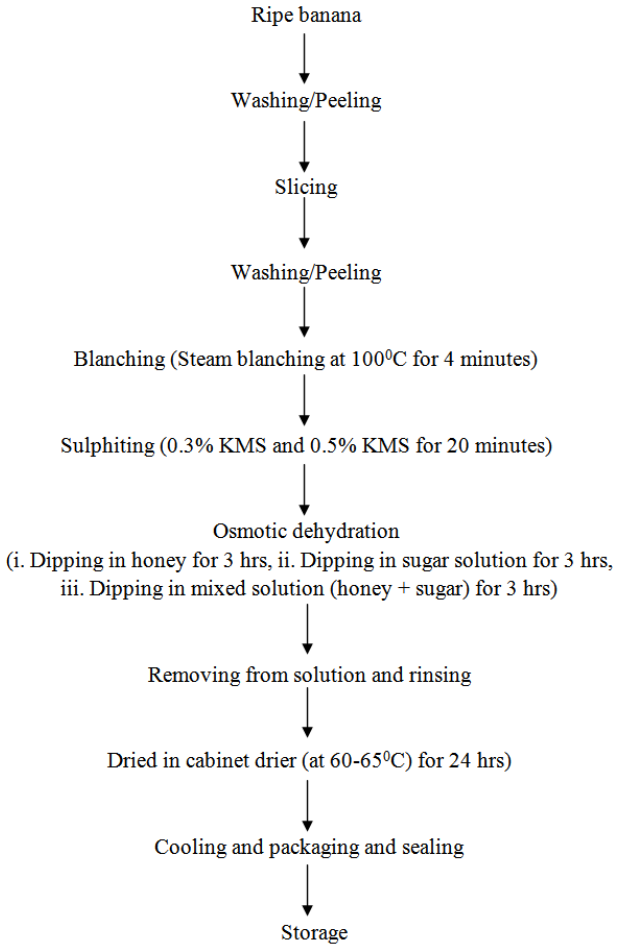

Figure 1. Flow Chart of Banana Slices Processing

Samples were removed from the solution at the end of 3 hours, quickly rinsed to remove surface sugar and moisture for the gravimetric determination of the water loss and solids uptake. The pre-treated slices were dried in mechanical drier by spreading the slices on the trays immediately. Tray loading is kept at $^1/_2$ – 1 kg/m^2 of drying area. The drying temperature was maintained at 60-

65°C. After drying the dried products was cooled, packed in polythene bas (100 g/bag) and sealed the bag by an electrical sealing machine and then stored.

2.4. Chemical Analysis

The fresh banana and the dried slice were analyzed for moisture, ash, protein, fat, ascorbic acid and acidity. The total soluble solids (TSS) were read directly from an Abbe's refractometer. All the determination was done in triplicates and the results were expressed as the average value. Moisture, Ash, Fat and protein content were determined by [12] methods.

2.5. Total Carbohydrate

Total carbohydrate content of the samples were determined as total carbohydrate by difference, that is by subtracting the measured protein, fat, ash, moisture from 100.

2.6. Quality and Sensory Evaluation of Banana Slices

The sensory and quality attributes test of banana slices was carried out according to [13,14] with some modifications. A taste- testing panel consisting of 10 experts evaluated the consumer's acceptability of developed products. The panelists (10) were requested to assign appropriate score of characteristics colour, flavour, texture and overall acceptability of various banana slices. To note the score a hedonic scale having a highest score of 9 for 'like extremely' and lowest of 1 for 'dislike extremely' was used. The hedonic scale was arranged such that: 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely.

2.7. Shelf Life of Pretreated Banana Slices

To assess the shelf-life of dried banana slices packed in various packaging system, moisture uptake was determined gravimetrically. The packaging systems used were: (a) single layer high density polythene, (b) double layer high density polythene, (c) single layer high density polythene plus kept in tin can.

Each packing unit contains 100g of samples. Moisture uptake by samples in the above packaging systems was determined at every three days interval gravimetrically from known initial moisture content of samples.

It was also essential to observe the storage behaviour of banana slices at various storage conditions. For observing shelf life of banana slices at various storage conditions each 100 g sample was packed in single layer high density polythene and stored at 75%, 80% and 90% relatively humidity at room temperature. The moisture uptake by slices at every three days interval was determined gravimetrically from known initial moisture content of samples. The above mentioned content relative humidity were maintained in dessicator by using saturated NaCl (reagent grade) solution for 75% RH, saturated $(NH_4)_2SO_4$ solution for 80% RH and saturated KNO solution for 90% RH. Samples in pre weighed Petri dishes were kept in wire-mesh support structure above the saturated salt solution at the bottom of the dessicator were airtight using grease.

2.8. Data Analysis

All means of the values and standard deviations were calculated from obtained data and analyzed statistically by the help of MSTAST-C. Meanwhile, DMRT was applied to determine differences among different samples.

3. Results and Discussion

3.1. Composition of Fresh Banana

The fresh banana pulp was analyzed for moisture, sugar, protein, fat, ash and total carbohydrate. The results are presented in Table 2. The fresh banana pulp contained moisture 71%, ash 0.99%, sugar 5.20%, fat 0.2%, protein 1.3%. The composition of fresh ripe banana under study was more or less similar to these reported by [15]. Anon [15] reported that the composition (per 100 g) of fresh ripe banana is as follows: moisture 70.0%, carbohydrate 22.0%, crude fat 0.5%, protein 1.2%, far 0.3%, ash 0.9%, phosphorus 290 ppm, calcium 80.0 ppm, iron 6.0 ppm, β-carotene 0.5 ppm, riboflavin 0.5 ppm, niacin 7.0 ppm, ascorbic acid 120 ppm. The variation in composition of banana pulp might be due to varietal difference, variation in stage of maturity, time elapsed between harvesting and analysis and growing condition of banana.

Table 2. Composition of fresh ripe banana

Components	Quantity (%)
Moisture	71.00
Total carbohydrate	26.54
Ash	0.96
Sugar	5.20
Fat	0.20
Protein	1.30

3.2. Effect of Pretreatments on the Colour of Banana Slices

Immediately after slicing, banana slice became dark (core colour) due to enzymatic reaction. To eliminate this problem, banana slices were subjected various pretreatment just after slicing. The treatment was hot water blanching, steam blanching plus 20 minutes sulphyting (0.3% KMS) and 4 minutes steam blanching plus 20 minutes sulphyting (0.5% KMS). The samples evaluated visually and the result shown in Table 3.

Table 3. Effect on pretreatment in colour

Pretreatments	Time	Colour (considered only core colour of banana)
Hot Water Blanching	4 min	Dark
Steam Blanching	2 min	Slightly dark
	3 min	Almost natural
	4 min	Almost natural
(a) Steam Blanching + Sulphyting (0.3 % KMS Solution)	4 + 20 min	Attractive
(b) Steam Blanching + Sulphyting (0.5 % KMS solution)	4 + 20 min	More attractive

It is observed from Table 3 that hot water blanching and short time steam blanching yielded banana slices of unattractive. Treatment of 4 minutes steam blanching plus 20 minutes sulphyting (0.5% KMS) resulted in attractive colour of banana slices and they used for further studies.

3.3. Effects of Sugar and Honey Solution on the Pre-Treated Banana Slices

The samples of three different thicknesses were dipped in natural honey solution, sugar solution and mixed (honey plus sugar, 1:1) solution. The concentration of sugar and mixed solution was maintained equal to that of natural honey solution (72%). After three hours of immersion the weight loss of the banana slices was measured. The weight loss and the solid grain were considered as indicator of solution effect. The results showed that the weight loss increased with increasing thickness. After recording weight loss, the samples immediately dried in a mechanical drier. The solid grain and sugar content of the samples is shown in Table 4 and Table 5. Since rapid water loss took place during first 3-4 hours. Hope and Vitalthe [16] immersion time was selected for 3 hours.

Table 4. Effect of solution on the pretreated banana slices

Thickness of banana slices (mm)	Solution Effect as % Solid Gain		
	Honey	Sugar	Mixed
3	12.11	11.21	11.42
5	11.25	10.75	10.95
7	10.08	9.98	10.20

Table 5. Effect of solution as percentage (%) of total sugar on the pre-treated banana slices

Thickness of slice (mm)	Solution effect as % total sugar (sugar grain per unit weight		
	honey	sugar	mixed
3	52.49	54.22	53.78
5	50.29	52	50.97
7	49.19	51.29	50.25

It is observed from Table 4 that the percent solid grain per unit weight slightly decreased with increasing thickness slices. Since the solution concentration was remained the same, the solid grain and the sugar content showed slight variation. The higher solid and sugar content is due to infusion of sucrose during immersion in different solution. The solid grain is higher in honey solution than other solution. It can also be seen from Table 5 that sugar content of banana slices also increase with increasing thickness. During experiment it is seen that 3 mm thickness slices could not retain its shape in the solution rather they broke into small pieces while removing from it and also they become hard after drying. On the other hand, 7 mm thick slices took more time during drying and their quality also not acceptable. In this regard 5 mm thick banana slices was found better during pre testing, dipping in solution and drying. So 5 mm thick slices gave good products.

3.4. Effects of Sugar and Honey Solution on the Nutrients Status Banana Slices

The development products were analyzed for their nutrients content and the result are compared to those of fresh banana as shown in Table 6. It is seen that there is noticeable difference in ascorbic acid content between fresh bananas and processed as development banana slices. But the development products contained more total sugar and protein than fresh banana when processed products are comparing to fresh sample. It is shown that all the nutrients accept vitamin C apparently shown higher value in processed products. It should be noted that the nutrients content presented are based on wet weight basis and that (in solution) sample contained additional sucrose due to infusion during osmosis.

Due to this additional sucrose, the dried products showed higher total sugar a lower fat content. Here should be describing that the 3 type of solution treatment when applied to observed effect on the nutritional quality of processed product. The solution one is honey two is sugar solution and other is mixed solution. The nutrient content of processed production is shown in Table 6.

Table 6. Nutrients content of fresh and processed banana slices

Components	Fresh	Processed (dried)		
		Honey	Sugar	Mixed
Sugar (%)	5.2	50.29	52	50.97
Fat (%)	0.2	0.005	0.002	0.0035
Protein (%)	1.3	3.08	2.10	2.96
Ascorbic acid (%)	6.93	4.27	2.31	3.95

3.5. Sensory Quality Evaluation of Dried Banana Slices

The samples of processed banana slices produced from banana slices with pretreatment were subjected to the sensory evaluation. The colour, flavour, texture and overall acceptability of 6 samples of processed slices were evaluated by a panel of 10 judges. Samples no. 1 was prepared by 4 min. steam blanching and subsequently dipped in 0.5% KMS for 4 min. and then dipped in honey solution for 3 hrs. Sample 2 was prepared by 4 min. steam blanching and dipped 0.5% KMS for 20 min. and subsequently dipped in sugar solution. Sample 3 was prepared by steam blanching then dipped in 0.5% KMS solution for 20 min. and subsequently dipped in mixed solution (sugar and honey) for 3 hours. Sample 4, 5 and 6 prepared by same above procedure but different in percent of KMS which percent was 0.3%. Then mean scores for colour, flavour, texture and overall acceptability of different sample are present in Table 7.

A two way analysis for variance (ANOVA) was carried out for colour preference and result revealed that there were ($p<0.01$) difference in colour acceptability among the chips. The calculated value F (16.0164) was greater than the tabulated value F (4.8692). Then indicates that colour of different samples of banana slices were not equally acceptable.

As shown in Table 7, the sample 5 is secured the lowest score for the colour preference than other five samples. However sample 1 and 2 were equally acceptable at 1% level of statistical significant. Similar sample 1, 2, 4, 5 and 6 were equally acceptable at 1% level of statistical significant in colour preference and significant different from sample 3 which secured the highest score (6.90 out of 9).

Table 7. Mean score for colour, flavour, texture and overall acceptability of various pretreated banana slices

Sample type	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
A	5.40± 0.100^{b}	5.20±0.992^{b}	5.40±0.132^{b}	6.20±0.164^{b}
B	5.30± 0.082^{b}	5.10±0.962^{b}	5.30±0.097^{b}	5.90±0.078^{b}
C	6.90± 0.131^{b}	7.00±0.154^{b}	7.00±0.085^{b}	7.10±0.142^{b}
D	4.80±0.062^{b}	4.80±0.062^{b}	5.30±0.090^{b}	5.20±0.040^{b}
E	4.00±0.054^{b}	3.90±0.035^{b}	5.10±0.082^{b}	5.10±0.043^{b}
F	4.50±0.058^{b}	4.20±0.046^{b}	4.90±0.075^{b}	4.40±0.053^{b}
LSD P<1.01	0.3486	0.7312	0.8358	0.7290

All values are expressed as mean ±SD
Mean followed by different superscript letter in each column are significantly different (p<1.01).

Sample A: Pretreatment by 4 minutes steam blanching plus 20 minutes sulphyting (0.5% KMS solution) then dipping in honey for 3 hours plus 24 hours dried in cabinet drier at 60-65°C, Sample B: Pretreatment by 4 minutes steam blanching plus 20 minutes sulphyting (0.5% KMS solution) then dipping in sugar for 3 hours plus 24 hours dried in cabinet drier at 60-65°C, Sample C: Pretreatment by 4 minutes steam blanching plus 20 minutes sulphyting (0.5% KMS solution) then dipping in mixed solution (sugar + honey, 1:1) for 3 hours plus 24 hours dried in cabinet drier at 60-65°C, Sample D: Pretreatment by 4 minutes steam blanching plus 20 minutes sulphyting (0.3% KMS solution) then dipping in honey for 3 hours plus 24 hours dried in cabinet drier at 60-65°C, Sample E: Pretreatment by 4 minutes steam blanching plus 20 minutes sulphyting (0.3% KMS solution) then dipping in sugar for 3 hours plus 24 hours dried in cabinet drier at 60-65°C and Sample F: Pretreatment by 4 minutes steam blanching plus 20 minutes sulphyting (0.3% KMS solution) then dipping in mixed solution (sugar + honey, 1:1) for 3 hours plus 24 hours dried in cabinet drier at 60-65°C.

In case of flavour preference among the slice samples a two analysis of variance (ANOVA) showed that the pretreatment has significant influence on flavour acceptability (P<0.01). Since the calculated F (6.6454) was greater than the tabulated value F (4.0878). The result showed that (Table 7) sample 1, 2 and 4 were equally acceptable securing 5.2, 5.1 and 4.8 respectively. Sample 4 is significantly different from sample 5 but equally acceptable to sample 6. It is noted that sample 3 secured the highest score (7.00 out of 9) while sample 5 is the lowest score (3.90).

In case of texture of produced banana samples, the panelist's detected significant differences among the samples tasted at 1% level of statistical significance as calculated F (18.000) was higher than the tabulated value of F (4.5393). As shown in Table 7 (DMRT) the samples were not equally acceptable. The result showed that the sample 3 was the highest acceptable among the samples 1, 2, 4 and 5 securing 7 out of 9 while the sample 6 secured the lowest score (4.90).

A two way analysis of variance (ANOVA) was carried out for and result rebuild that there were 1% level of statistical significant (p<0.01) overall acceptability among the slices. The calculated value F (8.82539) was greater than the tabulated value F (1.1719). This indicates that the overall acceptability of different sample of slices were not equally acceptable. As shown in table (DMRT) the sample 6 secured the lowest score among the samples for overall acceptability preference. However sample 1, 2 and 4 were equally acceptable at 1% level of statistical significant. Sample 5 secured the second lowest score and was significantly different from other sample. The result showed that sample 3 was the highest acceptable among the samples tested in overall acceptability preference than the sample 1, 2, 4, 5 and 6 and securing the highest score (7.10).

3.6. The Shelf Life of Dried Banana Slices

3.6.1. Shelf Life of Dried Banana Slices at Various Packaging System

Studies were conducted to determine storage stability in terms of moisture grain by using different packaging materials and equilibrium relative humidity. Dried banana slices with 14.6% moisture content were packed in single layer polythene package, double layer polythene package and packed by single layer polythene plus kept in tin can and kept in the laboratory at room temperature and humidity. The moisture content by banana slices were determined gravimetrically at (from initial known moisture content) every 3 days, interval. Results are shown in Table 8.

Table 8. Moisture content of dried banana slices at various packaging system

Days of storage	Moisture Content %		
	Packed in single layer polythene	Packed in double layer polythene	Packed in single layer polythene plus kept in tin can
3	18.0±0.430^{ab}	16.2±0.244^{a}	15.0±0.283^{b}
6	20.5±0.243^{b}	18.0±0.303^{d}	16.0±0.294^{c}
9	22.0±0.362^{d}	18.8±0.273^{ab}	17.0±0.374^{a}
12	23.0±0.342^{abc}	20.5±0.334^{ad}	18.0±0.523^{bc}
15	23.8±0.095^{bd}	20.8±0.560^{bc}	19.0±0.952^{b}
18	24.7±0.370^{a}	21.3±0.351^{b}	20.0±0.981^{a}
21	25.5±0.082^{d}	21.9±0.311^{a}	21.0±0.241^{cd}
24	26.0±0.221^{d}	22.5±0.233^{d}	21.5±0.490^{bc}
27	26.4±0.153^{abc}	22.7±0.241^{ab}	22.0±0.219^{abc}
30	26.8±0.263^{a}	22.9±0.129^{c}	22.2±0.649^{c}

All values are expressed as mean ±SD
Mean followed by different superscript letter in each column are significantly different (p<0.05).

The results showed that percentage of moisture content by samples, packaged in polythene package and subsequently kept in tin can was the lowest among packaging systems tested, while slices packed in the single layer polythene package percentage of water was the

highest among the systems. Slices packed in double layer polythene showed second highest moisture content. The above trend continued all throughout the investigation period up to 30 days and a linear relationship of moisture was found with storage period of 10 days for all the packaging systems, investigated. Moisture content of dried banana slices for various packaging system are illustrate in Figure 2.

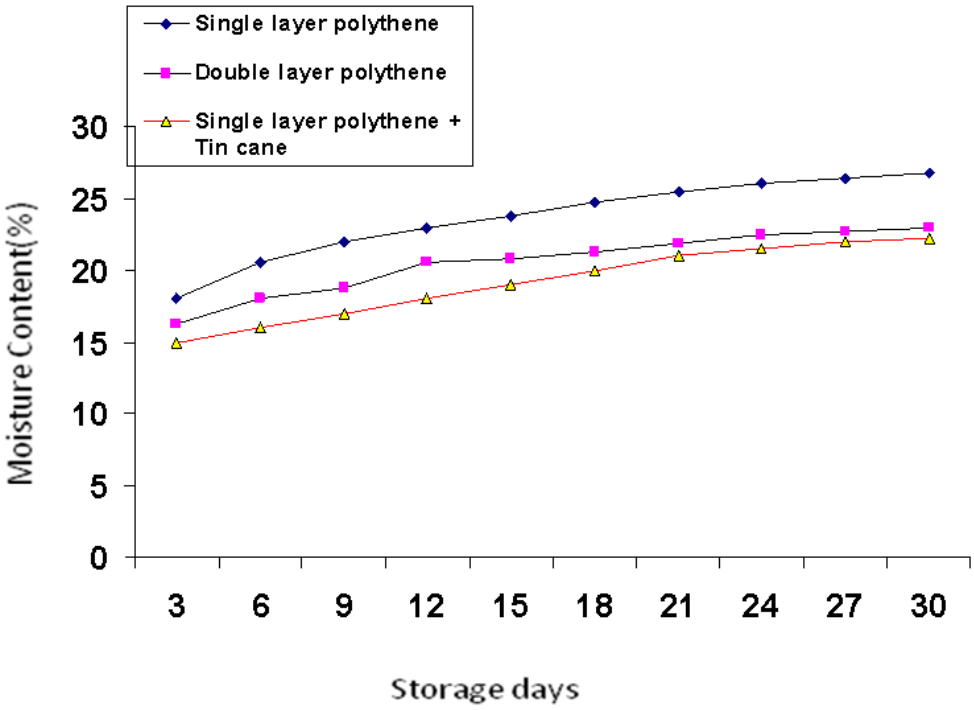

Figure 2. Moisture content of dried banana slices for various packaging systems such as single layer polythene, double layer polythene and single layer polythene plus kept in tin can

3.6.2. Shelf Life of Dried Banana Slices at Various Storage System

Studies were conducted to determine storage stability in terms of moisture grain by storing in different relative humidity. Dried banana slices with 14.6% moisture content were packed in single layer polythene packages and kept in tin can 75%, 80% and 90% relative humidity using different saturated salt solution as mentioned by Islam (1999). The moisture content of slices was measured gravimetrically at every three days interval. Results are shown in Table 9.

Table 9. Moisture uptake by dried banana slices at various storage conditions (at room temperature)

Days of storage	Moisture Content %		
	Stored in 75% RH	Stored in 80% RH	Stored in 90% RH
3	18.3±0.254^{a}	19.3±0.321^{bc}	20.3±0.549^{abc}
6	20.3±0.423^{ab}	21.2±0.450^{ab}	22.5±0.704^{bc}
9	22.3±0.287^{b}	22.8±0.196^{a}	23.8±0.327^{cd}
12	24.0±0.472^{c}	23.6±0.309^{b}	24.5±0.307^{abc}
15	24.5±0.371^{bc}	24.5±0.134^{d}	25.2±0.209^{a}
18	25.0±0.412^{abc}	25.0±0.809^{bc}	25.8±0.476^{c}
21	25.5±0.324^{bc}	25.8±0.421^{bc}	26.3±0.654^{b}
24	25.8±0.413^{a}	26.5±0.388^{d}	27.1±0.543^{ab}
27	26.3±0.542^{b}	27.2±0.623^{c}	28.3±0.342^{bc}
30	26.6±0.278^{cd}	27.9±0.554^{a}	28.9±0.432^{a}

All values are expressed as mean ±SD
Mean followed by different superscript letter in each column are significantly different ($p<0.05$).

The results showed that during first three days the increase in moisture content was high (from 14.6% to 18.3%-20.3%) for all cases and after that the rising moisture content was quite slow. The dried banana slices stored at 90% RH, the product moisture content continued to increase up to 30th days of storage. The dried banana slices stored at 90% RH reached moisture content 28.9% on 30th days of storage. Similarly the product stored at 80% RH reached moisture content 27.9% on 30th days of storage, while the product stored at 75% RH attained 26.6% moisture content on 30th days of storage period. Up to 30th days of storage, the higher the RH, the higher was the moisture content of banana slices. The above results indicated that the initial rate of moisture uptake was very high for all cases. The equilibrium moisture content of banana slices corresponding to 75% RH, 80% RH and 90% RH was not attained at 30th days of storage like banana slices. The behavior may attribute low percentage of fat contained in dried banana slices.

The above study clearly indicated that moisture content of dried banana slices during storage was dependent on relative humidity of the storage structure. Storage at low relative humidity and for short period would be helpful to preserve the dried banana slices. Banana slices packed in single layer high density polythene can be kept for longer period. While packed in single layer polythene plus kept in tin can could be kept for 15 days if 15% moisture content could be allowed without much loss is crispness. In case of dried slices packed in single layer polythene plus kept in tin can could be kept for 15 days if 20% moisture content could be allowed. Therefore, packaging of both slices in double layer high density polythene and

single layer polythene plus kept in tin can of in laminated aluminum foil is recommended.

4. Conclusion

The study on storage of processed or dried banana slices showed that the moisture uptake by single layer polythene plus kept in tin can was the lowest. Moisture uptake was highest in polythene and was lowest in polythene and kept in tin cane. Moisture uptake was highest in the slices stored in only single layer polythene. Therefore, single layer polythene plus kept in tin cans are considered is better packaging aids. In case of dried banana slices single layer polythene plus kept in tin can or laminated aluminum foil is recommended. The finding of this study may help in developing commercial processing techniques of banana to reduce post harvest losses of banana in Bangladesh.

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