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Improving the sensory quality and shelf life of dehydrated sliced banana (*Musa spp.* saba variety) using different pretreatments

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Abstract

This study aimed to determine the effects of different pretreatments on the sensory quality and shelf life of dehydrated sliced banana. Treatments designated as follows: T_1- Control, no pretreatment applied; T_2- 100g sliced banana: 4166 mg (8.33 tablets of 500mg) ascorbic acid; T_3- 100g sliced banana: 5.0 g of salt; T_4- 100g sliced banana : 100 ml lemon juice. Fresh ripe bananas were washed, cleaned and peeled. These were sliced approximately 3-5 mm thick with a sharp knife manually prior to pretreatment. Blanching of one hundred (100) grams sliced banana with lukewarm water about 60 seconds were employed and cooling will follow. This was thoroughly mixed with the pretreatments. Then oven drying followed at 70ºC for 5 hours. All treatments were evaluated for sensory attributes (right after oven drying and 3-week storage). Results showed that dehydrated sliced banana added with salt solution (T_2) obtained the highest acceptability ratings in terms of texture, sweetness, taste, appearance and general acceptability. Likewise, 3 weeks after storage, dehydrated banana under (T_1 control and T_2 salt solution) showed a comparable higher rate of acceptability in terms of texture, sweetness, taste, appearance and general acceptability after 3 weeks of storage. Thus, shelf life of dehydrated sliced banana was reached up to 3 weeks and still acceptable for human consumption.

Key words: Dehydrated banana, pretreatments, storage time, sensory qualities, shelf life and acceptability

Introduction

Saba banana (*Musa spp*) is a triploid hybrid (ABB) banana cultivar originating from the Philippines. It is primarily a cooking banana though it can also be eaten raw. It is one of the most important banana varieties in Philippine cuisine (Arias et al. 2013). It is also sometimes known as the Cardaba banana, though the latter name may be more correctly applied to a very similar cultivar also classified within the Saba subgroup. Ripe bananas have been part of humans' diets for many years. The Philippines is one of the major producers of banana in the world. In fact, it ranked fifth in global production in the year 2018 with India, Brazil, China and Ecuador on top of the list. Banana also accounted for 3.3% (P6.6 B at constant price) of the total value of production in agriculture in the year 2019 (Icier et al. 2010). However, ripe bananas contain 80% moisture and therefore very susceptible to post-harvest losses and considerable weight loss during transport and storage. In effect, it causes serious economic losses as a result of reduction in weight and quality. Post-harvest losses are a major challenge for tropical products such as mango, pineapple, and banana. Usually, a fully ripened banana takes about 4-7days to deteriorate. In the Philippines, tropical fruits produced in the peak periods are either consumed fresh, sold at relatively cheap prices, or are allowed to go waste due to inadequate processing facilities (Abano, 2017).

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One of the oldest methods in food preservation is through drying. However, little attention is given to drying of tropical fruits for consumption and improving their shelf life. Dried food could be consumed directly or treated as secondary raw material (Menges and Ertekin, 2016). The hot-air drying of food materials has advantages such as control of product quality, achievement of hygienic conditions, and on reduction of product loss (Corzo *et* al. 2018). Food scientists have found that by reducing the moisture content of food to between 10 and 20%, bacteria, yeast, mold and enzymes are all prevented from spoiling it. The flavor and most of the nutritional value is preserved and concentrated (Dennis, 2019). When drying foods, the key activity is to remove moisture as quickly as possible at a temperature that does not seriously affect the flavor texture and color of the food. If the temperature is too low in the beginning, micro-organisms may grow before the food is adequately dried. If the temperature is too high and the humidity is too low, the food may harden on the surface. Temperature ranges between 37°C and 71ºC will effectively kill bacteria and inactivate enzymes, although temperatures around 43ºC are recommended for solar dryers (Kendall and Allen, 2018). Shrinkage of the cells, browning, loss of re-drying ability, wettability and case hardening are some common problems associated with drying of tropical fruits, which reduce their market value and general acceptability.

Different pre-treatment methods have been developed for fruit drying, among which are lemon juice, salt solution, honey dip, ascorbic acid, sulfuring, osmotic pretreatment, and blanching (Karim, 2015). If no pre-treatment is done, the fruits will continue to darken after they are dried. For long-term storage of dried fruits, sulfuring or using a sulfite dip are the best pre-treatments. Dried fruits are a good source of energy because they contain concentrated fruit sugars. Dried foods are high in fiber and carbohydrates and low in fat, making them healthy food choices (Kingsly et al. 2007). In addition, the work was expected to provide a cost effective way of processing ripe banana for human consumption, curtail post-harvest loss of fresh ripe banana, and promote entrepreneurial opportunities through the sale of dried ripe bananas in the Philippines. There are limited studies on the use of indigenous pretreatments on the banana hence, this study was conducted to determine the effects of the different pretreatments on the sensory attributes and shelf life of sliced dehydrated banana.

Materials and Methods

Fresh ripe banana Saba variety was procured from Muñoz market in Nueva Ecija and was brought to the laboratory at Agriculture and Food Technology Business Incubator (AFTBI) in Central Luzon State University, Science City of Muños, Nueva Ecija. Primary processes such as cleaning, washing, peeling, and slicing were done. The peeled bananas were subjected to blanching before slicing was done to minimize contamination and discoloration of the samples. The peeled bananas were sliced approximately 3-5 mm thicknesses with a sharp knife manually prior to pretreatment. A ½ kilogram sliced banana samples were used in all the treatments. The following treatments were designated as follows: T_1- Control, no pretreatment applied; T_2- 100g sliced banana: 4166 mg (8.33 tablets of 500mg) ascorbic acid; T_3-100g sliced banana: 5.0 g of salt; T_4- 100g sliced banana: 100 ml lemon juice. The proportions of the treatments were based on the research of (Abano E. E. and Sam-Amoah L. K. 2017). To get the actual amounts of the pretreatments ratio and proportion was done.

Samples of the sliced bananas were soaked in 50% syrup (500 g sliced banana to 250 ml water and 250 g sugar) and 0.1 % (0.5 g:500 g sliced banana) sodium metabisulfite to the samples as preservative and let to soak overnight. In the morning the prepared pretreatments were added to the samples and boiled for 5 minutes. The samples were drained thoroughly after pretreatments were done. A 100 g samples were used in the experiment for all the treatments with three replications. The pre-treated bananas were put on trays with cheese cloth and placed on to the racks in the cabinet dryer. The 3-5 mm thick slices were dried at temperatures of 50-70 ^{0}C for 5 hours. The samples will let to cool and packed in ordinary plastic cellophane 0.003″ to 0.004″ thickness. Label, sealed using vacuum sealer and store in a cool and dry place ready for storage. The study was conducted using a completely randomized design (CRD) with four treatments including the control. All the treatments were replicated three times. The data was analyzed using SAS computer statistical program.

Sensory and Shelf-life Evaluation

Two sensory evaluations were conducted after oven drying and 3 week-storage. The samples were determined based on its acceptability in terms of the following attributes such as taste, texture, color, aroma, sweetness, appearance and general acceptability. The sensory evaluations were carried out using hedonic scale test. First and second sensory evaluations were done by the same selected panelist from IGS Dormitory, CLSU, Muños, Nueva Ecija. Shelf life of dehydrated banana was observed using the different pretreatments on a maximum duration of 3 weeks. The samples were packed in a polypropylene bag and sealed using the vacuum pack sealer. Preference test or the sensory evaluation was done for 2 times, first right after the samples are cooled from the oven. The second, was 3 weeks after storage. Observation on product`s self-life was done by conducting the second sensory evaluation (3 week-storage).

Statistical Analysis

Data gathered on sensory quality parameters was analyzed using the Statistical Tool for Agricultural Research (STAR). Treatment means were compared using Tukey’s or Honestly Significant Difference (HSD) test.

Results and Discussion

Sensory evaluations were conducted 2 times (after oven drying and 3 week- storage) using a hedonic scale from 1 to 5 and 1 is dislike very much and 5 like very much using 20 selected panelists from Dormitory in Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines. Data for the 1st sensory evaluation is presented in Table 1 and 1a. Results showed that in terms of texture (T_2) salt solution and (T_4) kalamansi juice had a significantly comparable higher preference by the panelist as compared to T_1 control and T_3 ascorbic acid. This suggests that T_2 and T_4 had an acceptable texture above average (3.80). This result might be due to the effect of salts and kalamansi that improved the texture of the sliced banana during soaking and dehydration. In terms of sweetness and taste/flavor T_1 and T_2 had a significantly higher acceptability preference from the panelists as compared to T_3 and T_4. These results might be due to the effects of kalamansi and ascorbic acid that might change the sweetness of the sliced banana upon treatment thus, lessen the acceptability of the flavor. On the other hand, T_1 and T_2 had a higher in terms of the sweetness due to the pretreatments used in the study thus, resulted to higher acceptability rating in flavor. Moreover, in terms of color and aroma, there were no significant differences among the treatments. These implied that there was no effect of the pretreatments applied to the sliced dehydrated banana in terms of color and aroma to the 10 panelists who are undergoing the sensory evaluation of the product (Kendall and Allen, 2018). However, in terms of general appearance and general acceptability of the product (Table 1 and 1a) there was a highly significant difference among the treatments. Sliced banana treated with salt and kalamansi juice (T_2 and T_3) were significantly comparable ratings the control treatment (T_1) in terms of product appearance and general acceptability. On the other hand, sliced banana treated with ascorbic acid (T_3) had the lowest acceptability ratings in terms of appearance and general acceptability among the treatments. These data implied that sliced banana did not change its appearance even added with salt and kalamansi juice thus showing a comparable appearance to the control. However, ascorbic acid greatly affects the appearance of the sliced banana hence, got the lowest ratings from the panelists. Santiago (2012) mentioned that when salt was added to the sliced banana and rambutan it showed a significant improvement on its appearance thereby, resulted in a significant general acceptability of the product.

Table 1. Sensory evaluation of dehydrated sliced banana after dehydration as influenced by different pretreatments.

Treatment	Texture	Sweetness	Taste	Color	Aroma	Appearance	Gen. Acceptability
T_1- Control	3.20b	4.00a	4.10a	3.20	3.80	4.30a	4.00a
T_2- Salt Solution	3.80a	3.70a	4.10a	3.80	4.00	4.00a	3.80a
T_3- Ascorbic Acid	2.60b	2.90c	2.60b	2.90	3.40	2.70c	2.60c
T_4- Kalamansi Juice	3.50a	2.70c	3.00b	3.80	3.80	3.70ba	3.50ba
% CV	21.88	1.32	18.32	23.86	16.70	16.64	14.34

Means within the same column and without letter designations are not significantly different at 0.05, HSD.
Hedonic Scale: 1- dislike very much, 2- dislike, 3- neither like nor dislike, 4-like and 5- like very much

Table 1a. Analysis of variance on the sensory quality of dehydrated sliced banana after dehydration as influenced by different pretreatments.

		Sum of Squares	df	Mean Square	F	Sig.
Texture	**Between Groups**	1.357	4	0.194	0.164*	0.992
	Within Groups	274.805	232	1.185		
	Total	276.163	236			
Sweetness	**Between Groups**	3.705	4	0.529	0.846^{*}	0.550
	Within Groups	145.091	232	0.625		
	Total	148.796	236			
Taste	**Between Groups**	3.705	4	0.529	0.846^{*}	0.550
	Within Groups	145.091	232	0.625		
	Total	148.796	236			
Color	**Between Groups**	1.673	4	0.239	0.187^{ns}	0.988
	Within Groups	296.327	232	1.277		
	Total	298.00	236			
Aroma	**Between Groups**	0.702	4	0.100	0.105^{ns}	0.998
	Within Groups	222.481	232	0.959		
	Total	223.183	236			
Appearance	**Between Groups**	3.705	4	0.529	0.846^{*}	0.550
	Within Groups	145.091	232	0.625		
	Total	148.796	236			
General Acceptability	**Between Groups**	2.557	4	0.365	0.425^{*}	0.886
	Within Groups	199.443	232	0.860		
	Total	202.000	236			

^{ns} – not significant *significant

Table 2 and 2a present the results of sensory evaluation at 3 week-storage of the sliced dehydrated banana. Treatment 4 (ascorbic acid) were not included in the second sensory evaluation because it had already signs for the presence of molds. This result showed that ascorbic acid has a low effect in terms of storage or shelf life of the product when used as pretreatment.

However, 3 treatments were showed a significant difference on sweetness, taste, appearance and the general acceptability and not on texture, color and aroma. Treatments (T_1 control and T_2 salt solution) had a comparable preference in terms of sweetness, taste, appearance and general acceptability by the panelists. These values had a significantly higher acceptability rating as compared to T_3 treated with kalamansi juice. These results can be attributed to the effect of kalamansi acid flavor that might affect the sweetness, taste, and thereby affect its appearance and general acceptability of the product. This result conforms to the findings of (Awole et al., 2011) that apples dropped with kalamansi juice was affected its taste and acceptability.

Table 2. Sensory evaluation at 3 week-storage of dehydrated sliced banana as influenced by different pretreatments.

Treatment	Texture	Sweetness	Taste	Color	Aroma	Appearance	Gen. Acceptability
T_1- Control	3.40	4.20 a	4.00 a	3.60	3.60	4.00 a	4.20 a
T_2- Salt Solution	3.60	4.00 a	4.00 a	3.80	3.80	3.80 a	4.60 a
T_3- Kalamansi Juice	2.80	1.80 b	2.60 b	3.00	2.80	3.00 b	2.60 b
%CV	22.35	20.12	18.63	17.45	16.55	10.75	14.49

Means within the same column and without a letter designations are not significantly different at 0.05, HSD
Hedonic Scale for the sensory evaluation rating: 1- dislike very much, 2- dislike, 3- neither like nor dislike, 4-like and 5- like very much
T_4- (Ascorbic acid) were not included in the sensory evaluation (3 week-storage) because there was already signs of molds.

Table 2a. Analysis of variance on the sensory quality of dehydrated sliced banana after dehydration as influenced by different pretreatments.

		Sum of Squares	df	Mean Square	F	Sig.
Texture	Between Groups	1.357	4	0.194	0.164ns	0.992
	Within Groups	274.805	232	1.185		
	Total	276.163	236			
Sweetness	Between Groups	3.705	4	0.529	0.846*	0.550
	Within Groups	145.091	232	0.625		
	Total	148.796	236			
Taste	Between Groups	3.705	4	0.529	0.846*	0.550
	Within Groups	145.091	232	0.625		
	Total	148.796	236			
Color	Between Groups	1.673	4	0.239	0.187ns	0.988
	Within Groups	296.327	232	1.277		
	Total	298.00	236			
Aroma	Between Groups	0.702	4	0.100	0.105ns	0.998
	Within Groups	222.481	232	0.959		
	Total	223.183	236			
Appearance	Between Groups	3.705	4	0.529	0.846*	0.550
	Within Groups	145.091	232	0.625		
	Total	148.796	236			
General Acceptability	Between Groups	2.557	4	0.365	0.425*	0.886
	Within Groups	199.443	232	0.860		
	Total	202.000	236			

ns – not significant *significant

On the other hand, salt and sucrose are known for its effective food preservation because it reduces the water activity of foods. The water activity of a food is the amount of unbound water available for microbial growth and chemical reactions. Salt's ability to decrease water activity is thought to be due to the ability of sodium and chloride ions to associate with water molecules (Santiago, 2012). Adding salt to foods can also cause microbial cells to undergo osmotic shock, resulting in the loss of water from the cell and thereby causing cell death or retarded growth (Davidson, 2018). It has also been suggested that for some microorganisms, salt may limit oxygen solubility, interfere with cellular enzymes, or force cells to expend energy to exclude sodium ions from the cell, all of which can reduce the rate of growth thus, resulted to a higher acceptability and long shelf life of the product (Shelef and Seiter, 2017).

Conclusion

Based on the results of the study, the following conclusions can be drawn;

1. Dehydrated sliced banana added with salt solution showed the highest acceptability ratings in terms of texture, sweetness, taste, appearance and general acceptability.
2. All treatments were acceptable for human consumption after 3 weeks of storage except on the treatments added with ascorbic acid showed the presence of molds and not acceptable for human consumption after 3 weeks.
3. Treatments (T_1 control and T_2 salt solution) showed comparable higher ratings in terms of preferences in texture, sweetness, taste, appearance and general acceptability after 3 weeks of storage. However, treatment treated with ascorbic acid T_4) showed signs on the presence of molds.

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Conflict of Interest

The author would like to declare that there is no conflict of interests regarding the publication of this paper because he is the only one owned to this research paper.

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