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Studies on Freezing Green Plantains (*Musa paradisiaca*)

I. Effect of Blanching Treatments on the Quality and Storage Life of Raw and Pre-fried Slices¹

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ABSTRACT

A blanching treatment was found necessary in the preparation of high quality frozen plantain slices to provide adequate storage life. Blanching in steam for 2 to 4 minutes, in water at 87.7° C (190° F) for 4 minutes, or in water for 2 minutes at 93.3° C (200° F), proved the most effective blanching treatments. Increasing the length of the blanching treatment time or increasing the temperature of the water resulted in higher fat absorption during frying. When the slices were pre-fried before freezing, the blanching treatment had no effect on either quality or storage life, and no effect in reducing discoloration resulting from browning.

INTRODUCTION

Plantains (*Musa paradisiaca*) are very popular in Puerto Rico, and used in both the green or ripe stage to prepare numerous dishes. One of the most popular products prepared from green plantains is known as "tostones". These are prepared by frying of plantain cut crosswise into slices for several minutes until partially cooked. The slices are then pressed to a thickness of about one half of an inch and deep-fat fried for a second time until crisp. The tostones are served sprinkled with salt along with meat and fish as a substitute for French fried potatoes.

Procedures have been under development at the Food Technology Laboratory for several years for freezing plantains and plantain products for use by consumers to prepare plantain dishes. One of the extensively studied products is frozen green slices used for preparing tostones in either raw or

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pre-fried forms. The results of these investigations were furnished to the local food processing industry as the work progressed, and frozen plantain products thus have been on the market for several years.

The results of the studies conducted on freezing of plantains are presented in a series of papers each discussing the different factors which must be controlled to obtain a high quality product.

Blanching or scalding of vegetables is one of the essential procedures in freezing vegetables. Proper blanching inactivates oxidizing enzymes reducing development of off-flavors, and prevents change in color and loss of vitamin C during cold storage. Blanching also seems to enhance the keeping quality of frozen vegetables.

In processing frozen French fried potatoes, the strips are blanched prior to frying. Several advantages have been claimed for the blanching treatment (2) namely: more uniform color of the fried product, reduction of fat adsorption through gelatinization of the surface layer of starch, reduction of frying time and improved texture of the final product.

Although the plantain is a fruit, it resembles the potato in green stage, mostly because of its high starch content (6). Tostones also are somewhat similar to French fried potatoes. Consequently, the effect of blanching on product quality and storage life was investigated as a first step in developing a frozen product from plantains similar to French fried potatoes.

MATERIALS AND METHODS

The fruit used in these studies was harvested at a pulp content of about 60 percent. The fingers were separated from the stem and steam peeled at 80 lb/in²g for 30 seconds then cooled with water sprays. Loose peel was removed by hand and the fruit then sliced crosswise into sections about 1 inch thick. The slices were either processed without blanching or blanched by water or steam as follows:

Water blanching: The slices were blanched by dipping in hot water at the desired temperature for a specified length of time as required by the experiment in progress. Following blanching, the slices were cooled in water sprays to near room temperature (29.4°–32.2° C) (85°–90° F).

Steam blanching: The slices were steam blanched in a drapper conveyor type steam blancher. The steam pressure was adjusted to maintain a dense steam atmosphere inside the tunnel. The length of the blanching treatment was controlled by adjusting the speed of the conveyor and was varied within the limits required by the experimental procedure. Following the steam blanching treatments, the slices were cooled under water sprays as previously indicated.

The blanched slices were sulfited by dipping for 4 minutes in 0.6 percent K₂S₂O₅ solution and drained. Unfried slices were packed without previous

blanching treatment. When prefried slices were prepared, the slices were sulfited and then fried for 4 minutes at 176.6° C (350° F) in a mixture of 60 percent hydrogenated vegetable shortening and 40 percent lard. Both unfried and pre-fried slices were packed in waxed, lined, cardboard boxes overwrapped with vapor moisture-proof paper and frozen in a plate freezer at -42.7° C (-45° F). All freezer samples were stored at -23.3° C (-10° F).

For organoleptic tests, the unfried frozen slices were fried without thawing in shortening at 176.6° C (350° F) for 8 minutes. The slices were then pressed and fried a second time at 190.5° C (375° F) for 5 minutes. The pre-fried slices were fried only for 6 minutes in shortening at 176.6° C (350° F) before serving. The fat content was determined by extracting with hexane as described by Bueso (1). Two methods of organoleptic evaluation

TABLE 1.—*Effect of steam blanching on texture of plantain slices and on fat content and quality of fried tostones*

Blanching treatment	Average temperature of slices after blanching	Texture shear press force	Fat content	Rank sums	Results of preference test by ranking
Minutes	°C	Kg	Percent		
0		1474.1	12.42	52	Rejected at 1 percent No significant difference among samples
2	58.3° (137° F)	1088.6	14.13	44	
4	55.5° (132° F)	1406.1	10.53	42	
6	62.7° (145° F)	861.8	22.41	29	
8	67.2° (153° F)	816.4	26.74	32	
10	71.1° (160° F)	476.2	—	32	

were employed; rating in a ± 2 scale (4) or ranking (3) depending on the purpose of the test. When the ranking method was used, several samples were presented at each setting and the judges ranked the samples independently for eating quality and appearance. The results of the test were statistically analyzed by the rank sum method described by Kramer (3).

RESULTS AND DISCUSSION

The results of the steam blanching tests are given in table 1. Increasing the length of time in the steam blanching treatment softened the plantains as evidenced by lower shear press values for treatment exposures longer than 4 minutes. The partial cooking taking place during longer blanching treatments resulted in a higher fat content in the fried tostones. Probably due to the fact that cracks occur in the surface of the slices during pressing before the second frying which expose inner tissue, blanching does not have the same effect in reducing fat absorption as reported for French fried potatoes (2).

TABLE 2.—*Effect of temperature and the length of time in the water blanching treatment on the texture of plantain slices and on fat content of fried tostones*

Blanching temperature	Length of treatment	Average temperature of slice after blanching	Texture shear press force	Fat content	
°C	Minutes	°C	Kg	Percent	
71.1° (160° F)	0	—	1315.4 2900 lbs	14.7	
	2	44.4 (112° F)	1542.2 3400 lbs	11.7	
		47.5 (117.5° F)	1610.2 3550 lbs	12.3	
	4	49.9 (122.0° F)	1406.1 3100 lbs	14.7	
		51.9 (125.5° F)	1723.6 3800 lbs	19.7	
	76.6° (170° F)	0	—	1315.4 2900 lbs	14.7
		2	48.9 (120° F)	1292.1 2850 lbs	10.9
			50.3 (122.5° F)	1723.6 3800 lbs	11.6
4		54.4 (130.0° F)	1451.5 3200 lbs	13.5	
		54.4 (130.0° F)	1360.7 3000 lbs	15.3	
82.2° (180° F)		0	—	1315.4 2900 lbs	14.7
		2	46.6 (116° F)	1610.2 3550 lbs	13.3
			57.2 (135° F)	1179.3 2600 lbs	17.5
	4	58.0 (136.5° F)	1270.0 2800 lbs	18.3	
		59.9 (140° F)	997.9 2200 lbs	21.6	
	87.7° (190° F)	0	—	1179.3 2600 lbs	14.2
		2	51.6 (125° F)	1383.4 3050 lbs	17.8
			57.2 (135° F)	1158.9 2555 lbs	21.9
4		59.9 (140° F)	476.2 1050 lbs	21.6	
		65.5 (150° F)	396.8 875 lbs	27.6	
93.3° (200° F)		0	—	1315.4 2900 lbs	14.7
		2	48.9 (120° F)	907.2 2000 lbs	15.6
			59.9 (140° F)	879.7 1800 lbs	27.7
	4	65.5 (150° F)	566.9 1250 lbs	29.1	
		66.9 (152.5° F)	430.9 950 lbs	30.9	

The effect on the texture of the slices and on the fat content of the tostones by water blanching at different temperatures and for different lengths of time is given in table 2, which shows that blanching at 71.1° C (160° F) and 76.6° C (170° F) from 0 to 8 minutes had little effect on texture or fat content. When the temperature was increased from 82.2° C (160° F) to 87.7° C (190° F) softening of the slices and an increase in the fat content of the tostones resulted. Increasing the length of treatment time from 0 to 8 minutes at these higher temperatures likewise resulted in softening the slice and a high absorption of fat. It is preferable from the dietary point of view to

TABLE 3.—*Effect of steam and water blanching treatments on quality of tostones prepared from frozen green plantain slices stored at -23° C (-10° F) for 32, 120 and 180 days*

Item	Rank sums after storage period in days indicated					
	32		120		180	
Length of blanching treatment in minutes	2	4	2	4	2	4
Blanching treatment						
Steam	45	37	44	56	56	40
Water at						
71.1° C (160° F)	46	39	30	49	33	27
76.6° C (170° F)	43	51	37	40	44	34
82.2° C (180° F)	44	50	50	41	56	19
87.7° C (190° F)	42	27	28	24	33	28
93.3° C (200° F)	32	48	19	32	30	41
Rank sum for significant difference at:						
1 percent	28-56	28-56	22-48	28-56	28-56	20-42
5 percent	31-53	31-53	25-45	31-53	31-53	23-40

reduce the fat content as much as possible, thus only those blanching treatments were considered in which further tests gave a fat content at a level similar to that of the controls.

Table 3 gives the results of organoleptic comparisons of tostones prepared from plantains blanched in steam and in water at 71.1, 76.8, 82.2, 87.7, 93.3° C (160, 170, 180, 190 and 200° F) for 2 and 4 minutes for 3 storage intervals. The results show that of 36 samples submitted to organoleptic evaluation, 5 were selected as superior with the results significant at the 5 percent level of probability. Of these, two samples were blanched at 87.7° C (190° F), two at 93.3° C (200° F) and one at 82.2° C (150° F). All samples with the lowest rank sums were blanched at 180° F or higher.

Based on texture measurements, fat content of the tostones and product quality as judged by tasters, the following blanching treatments seem to be

similarly effective: 1) Blanching in steam for 2 to 4 minutes, 2) blanching in water for 4 minutes at 190° F, and 3) blanching in water for 2 minutes at 200° F. These treatments resulted in good quality tostones with a fat content ranging from 10 to 17 percent, and a storage life of no less than 6 months.

The effect of several blanching treatments on the quality and storage life of pre-fried frozen plantains was also studied. The results of the organoleptic tests conducted at 4 different intervals during storage for 364

TABLE 4.—*Effect of blanching treatments on product quality after storage at -23.3° C (-10° F) for 13, 55, 145 and 364 days*

Blanching treatments	Rank sums at ages in days indicated			
	13	55	145	364
No blanching	34	33	37	45
Steam blanching for 2 minutes	31	34	41	26
Steam blanching for 4 minutes	33	43	32	26
Water blanching at 190° F for 4 minutes	38	21	34	42
Water blanching at 200° F for 4 minutes	29	39	47	26
Rank Sums for Significant difference at 5 percent	24-48	24-48	28-49	24-42

TABLE 5.—*Rating given to samples blanched in water and steam after storage at -23.3° C (-10° F) for 57 and 364 days*

Blanching treatment	Score at storage period of	
	57 days	364 days
No blanching	0.6	0.9
Blanching in steam for 2 minutes	-0.045	.27
Blanching in steam for 4 minutes	.45	.27
Blanching in water at 170° F for 4 minutes	.87	.86
Blanching in water at 200° F for 4 minutes	.90	.95

days are given in table 4. When the samples were ranked for quality at each of the four storage periods, tasters could not detect any difference among the samples which could be attributed to any of the blanching treatments. When the samples were rated in ± 2 scale after 57 and 364 days after storage, it was found that the blanching treatments had no effect on product quality during a year of storage at -10° F (table 5).

Water blanched samples were rated higher than the steam blanched, but the rating given to all blanched samples are not significantly different from the ratings given controls. Pre-frying seems to substitute for blanching, thus the latter treatment can be omitted without affecting product quality.

During these investigations it was found that blanching did not reduce the brown discoloration which appeared on the surface and around the placenta of the frozen raw or pre-fried slices. This discoloration can be controlled only by sulfiting.

RESUMEN

Se estudió el efecto de escaldar sobre la calidad y la vida en almacén del plátano verde congelado y sobre la calidad de los tostones preparados de las rodajas congeladas.

Cuando se escaldaron al vapor rebanadas de aproximadamente una pulgada de espesor, al aumentar el tiempo de exposición al vapor se ablandó el tejido y aumentó el contenido de grasa en los tostones. Un tratamiento de escaldar a vapor de una duración de 2 a 4 minutos, resultó ser adecuado, obteniéndose un producto congelado de buena calidad, del cual pudieron prepararse tostones de un contenido de grasa relativamente bajo.

Cuando las rodajas fueron escaldadas en agua, variando el tratamiento de 0 a 8 minutos y la temperatura de 71.1°C (160°F) a 93.3°C (200°F), se observó que el contenido de grasa de los tostones aumentó proporcionalmente con el largo del tratamiento y con la temperatura.

El resultado de pruebas organolépticas con productos almacenados a -23.3°C (-10°F) por un año indicaron que es necesario escaldar el plátano a ser congelado para obtener un producto de buena calidad que se conserve bien en almacenamiento. Escaldar al vapor por 2 a 4 minutos, en agua a 87.7°C (190°F) por 4 minutos o a 93.3°C (200°F) por 2 minutos resultaron ser tratamientos de escaldar igualmente efectivos.

Cuando las rodajas de plátano verde fueron fritas antes de la congelación, no fue necesario escaldar las mismas, ya que el freir sustituye como tratamiento de calor al de escaldar.

Ninguno de los tratamientos de escaldar ensayados evitaron el obscurecimiento de la superficie de la rodaja que tiene lugar durante el proceso de elaboración para la congelación. Este obscurecimiento solo pudo evitarse por medio de la sulfitación.

LITERATURE CITED

1. Bueso, C. E., A Pre-fried Fat Test for Fried Plantain Products, *J. Agr. Univ. P.R.* 53(2): 273-5, 1974.
2. Feustel, I. C. and Kueneman, R. W., Frozen French Fries and Other Frozen Products. Chap. 11 in *Potato Processing 2nd Ed*, edited by Talburt W. F. and Smith O., AVI Publishing Co., Westport Conn., pp. 340-373, 1967.
3. Kramer, A., A rapid method for determining significance of differences from rank sums, *Food Technol.* 14: 576, 1960.
4. Kramer, A. and Ditman, L. P., A Simplified Variable Taste Panel Method for Detecting Flavor Changes in Vegetables Treated with Pesticides, *Food Tech.* 10(3): 155-9, 1956.
5. Sánchez Nieva, F., Colom Covas, G., Hernández, I., Guadalupe, R., Díaz, N., Viñas, C. B., Preharvest changes in the physical and chemical properties of plantains, *J. Agr. Univ. P.R.* 52(3): 241-255, 1968.
6. Tsven Leung, Woot and Flores, María, Food composition tables for use in Latin America. INCAP and N.I.H., Guatemala and Bethesda, Md., pp. 37, 61, 1961.