Elaboration, Sensory and Microbiological Evaluation of Mofongo.[1]

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ABSTRACT

A formula was developed for preparing mofongo (a ball of ground fried pork rind and fried green plantains seasoned with chicken stock and condiments). The mofongo was packed in boilable pouches, frozen and stored at −23.3° C. An organoleptic evaluation of the product indicated good acceptability for up to 7 months of frozen storage, thus evidencing a favorable potential market for frozen mofongo. Microbiological studies showed that sanitation and personal hygiene are important in the elaboration of frozen mofongo, since a common pathogen like *S. aureus* survived well for 6 months of frozen storage. If temperatures are not monitored and this pathogen is present, growth of the organism could grow to dangerous levels.

INTRODUCTION

Plantains are widely cultivated in Puerto Rico and constitute one of the most widely studied of our agricultural products (2, 5, 6). Industrialization and alternative methods of utilization of green plantains are always in great demand because of the rapid ripening of the fruits after harvest.

Studying the storage of plantains, Hernández (2) found that at temperatures of 7° C and 13° C green plantains suffer little change in chemical composition. Tostones (fried plantain slices) that compared favorably with those prepared from fresh green plantains, were obtained from stored plantains. Sánchez-Nieva et al. (6) reported no significant difference in quality and acceptance of tostones stored for 20 days at 13° C. The physical and chemical changes that occur during storage did not have enough adverse effect on flavor and texture for a taste panel to reject the tostones.

A typical Puerto Rican dish, "mofongo," which is prepared with mashed fried green plantain, fried pork rind and condiments, is well liked (7). The dish must be eaten as soon as prepared and while hot because hardening occurs with cooling. Industrial production of mofongo would provide an additional method for the utilization of green plantains. However, the difficulty in commercially developing mofongo of organoleptic quality has retarded its industrialization.

Since the elaboration of mofongo involves a great amount of manipu-

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lation, the potential health hazard that it could represent must be determined microbiologically. Not only the initial microbial content but also the behavior of the microbial flora upon storage ought to be determined.

Of particular interest would be the coliform population of fecal origin (*Escherichia coli*) and the *Staphylococcus aureus* microflora. The former group of microorganisms are sanitation indexes that measure the amount of fecal contamination while the latter organism is a personal hygiene indicator since it is found in hair, nose, mouth, skin, fingernails, abscesses, etc. In addition, *S. aureus* is a pathogen that produces a heat resistant enterotoxin.

With this need in mind, we have researched the feasibility of developing a formula for mofongo to be preserved by freezing.

MATERIALS AND METHODS

Green plantains were purchased at a local market. They were peeled, sliced diagonally in 2 in. pieces and soaked in salt water for 10 min. The pieces were then deep fried in hot pork lard for 7 min at medium heat without browning.

Twenty five grams of fresh crushed garlic were fried in 55 g of lard and added to 850 ml of hot water, to which one cube of chicken concentrate had been added. This mixture was boiled for 10 min for broth.

We mashed in a mortar three slices of the pre-fried green plantain pieces (approx. 75 g); 20 g of crushed fried pork rind, supplied by a local vendor; and 50 ml of the hot garlic-chicken broth. Mofongo balls weighing approximately 98 g each were shaped with a 8.9 cm diameter cup.

The mofongo balls thus prepared were placed individually into cellophane boilable pouches, heat sealed and quick frozen in a plate freezer at −43° C. The frozen product was stored at −23° C. At various time intervals, up to 203 days of frozen storage, samples were tested. For the organoleptic tests, pouches with the frozen mofongo were placed in boiling water for 25 min (or 3 min in microwave oven). The cooked, hot mofongo was then submitted to a trained taste panel. A 6-point hedonic scale was used to measure the quality of the product (4).

For the microbiological study, a series of mofongo balls was prepared as before. Each mofongo ball was inoculated prior to freezing with 1.7×10^7 *E. coli* cells and with 8.5×10^6 *S. aureus* cells.

At various time intervals up to 176 days of frozen storage, duplicate samples were withdrawn from the freezer and each blended for 2 min with 450 ml of 0.1% peptone water. Subsequent dilutions were made with 0.1% peptone water and inoculated into Violet Red Bile Agar-Tryptic Soy Agar (VRBA/TSA) for *E. coli*, and into Tryptic Soy Broth (TSB) with 10% NaCl and 1% pyruvate for *S. aureus*. These media were chosen since

they had been superior in the detection and enumeration of stressed cells (1). VRBA/TSA plates were incubated at 37° C for 24 h, while the TSB with 10% NaCl-1% pyruvate tubes were incubated at 37° C for 48 h.

RESULTS AND DISCUSSIONS

Table 1 shows the results of the organoleptic tests for appearance, flavor, texture, and overall acceptability. Tasters could not detect significant differences among the samples that could be related to the frozen storage time. Characteristics such as flavor, texture and general acceptability did not suffer noticeable changes during the 7 months of the experiment. Frozen mofongo thus prepared, packaged, stored and reheated compared with the fresh samples.

The initial microbial content of the prepared mofongo averaged 9.9×10^3 bacteria per gram of sample and <10 *S. aureus* and total coliforms

TABLE 1.—*Organoleptic evaluation and bacterial counts of frozen mofongos*[1]

Storage time (days)	Appearance	Mean values		General acceptability	Aerobic plate counts
		Flavor	Texture		
Fresh	5.0	5.4	5.1	5.3	6.6×10^3
29	5.0	5.1	4.8	4.8	1.8×10^3
59	5.1	5.1	4.6	5.1	8.0×10^2
89	—	—	—	—	—
119	5.3	5.3	5.1	5.3	6.7×10^2
149	5.0	5.3	5.1	5.3	4.5×10^2
179	4.9	5.1	4.7	5.0	3.8×10^2
203	5.3	5.5	5.3	5.5	1.9×10^1

[1] 6-point hedonic scale.

per gram of sample. These low microbial counts evidenced the high quality of the mofongo prepared.

Since the samples did not have sufficient bacteria, they had to be inoculated in order to be studied for sanitation and personal hygiene indexes upon storage. Table 2 shows these results. The coliform (*E. coli*) population exhibited the greatest decrease during storage, thus supporting previous findings (3). The *S. aureus* population demonstrated greater tolerance to freezing, an observation that has been reported before (8). In general terms, the coliform population exhibited a reduction in number of slightly over 2 logarithmic cycles at the end of the 5th and 6th month of frozen storage, whereas the *S. aureus* population exhibited a reduction of only slightly under 1 logarithmic cycle during the same period. The first 2 months of frozen storage evidenced the greatest drop in numbers for the coliform population, whereas the *S. aureus* population remained essentially unaltered.

These results demonstrate the importance of proper sanitation in producing frozen mofongo. A pathogen like *S. aureus* survives extremely well during frozen storage, so a high initial input into the product could present health problems if storage temperatures are not monitored. The size of the coliform and the *S. aureus* population at any given frozen storage time could give a good idea of the number of cells present just before freezing, since we have an idea of how much the bacterial populations decrease, provided there are no temperature failures that could allow microbial growth.

The organoleptic and microbiological data obtained in this study demonstrate that frozen mofongo can be produced on a commercial scale. Care must be observed regarding the sanitary conditions during processing.

TABLE 2.—*Log number of cells per gram of "mofongo" at various storage times*

Storage time (days)	*E. coli*	*S. aureus*
0	5.53	5.23
8	4.89	5.38
14	4.68	5.43
28	4.53	4.52
37	4.34	5.66
51	4.08	4.77
66	3.85	5.44
78	3.90	5.34
85	4.15	5.28
103	3.46	5.08
125	4.04	4.52
145	3.40	5.11
176	3.08	4.85

RESUMEN

Se desarrolló una fórmula para preparar mofongo envasado en bolsas hervibles y congelado a −23.3° C. Luego dè fritos los trozos de plátano verde, se majaron junto con condimentos, chicharrón[3] y un caldo de ajo cor concentrado de pollo. Bolas de mofongo se colocaron en sendas bolsas de celofán, las cuales se sellaron y se congelaron. Las evaluaciones organoléticas indicaron que el producto tenía buena aceptafción hasta los 7 meses de almacenamiento en frigorifico que duró el experimento. La apreciación de los catadores demuestra que el mofongo congelado tiene un potencial favorable para su elaboración. Los estudios microbiológicos del producto inoculado con *Escherichia coli* y *Staphylococcus aureus* demostraron la importancia de observar buenas con-

[3] Cuero de cerdo frito.

diciones sanitarias en su elaboración. Patógenos comunes como *S. aureus* sobreviven extremadamente bien durante el almacenamiento en frío. Si este patógeno estuviera presente y la temperatura del frigorifico no se vigila, el crecimiento del organismo pudiera llegar hasta niveles peligrosos para la salud pública.

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