Shelf-Life Study of Farm Lisbon Yam (*Dioscorea alata*) Chips[1]

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INTRODUCTION

Plantain and potato chips are consumed locally in appreciable amounts, chiefly as party snacks. Due to their popularity, suitable substitutes should be found for potatoes, which are not grown in Puerto Rico. Other tubers grown in Puerto Rico may prove acceptable or even preferred alternatives.

The elaboration of potato chips was extensively reviewed by Smith (11); the techniques for manufacturing sweet potato chips were described by Boggens and Woodroof (1); and the production of plantain chips (platanutres) was described by Cancel et al. (2). Martin and Ruberté (7) found varietal differences in yams processed as chips using a household deep-fat frier. Chips of all kinds change their flavor after cooking due to the oxidation of the fatty substances. Antioxidants are commonly used to control this tendency. Jain et al. (5) found it necessary to add antioxidants after the frying operation to increase shelf-life of banana chips. The high temperatures normally used in the deep-fat frying process decompose or volatilize the antioxidants, thus reducing their effects (10). González et al. (4) showed the advantages of mixing antioxidants with salt to increase shelf-life of plantain chips. They found this advantage was not dependent on the frying medium. Cancel et al. (2) found the shelf-life of plantain chips vacuum-packed in cans was about 9 months, whereas it varied from 2 weeks to 2 months when packed in plastic bags, depending on the type of packing film used. Recently, Cruz and González (3) published shelf-life studies of plantain sticks using five different packing media.

MATERIALS AND METHODS

Tubers of the yam variety Farm Lisbon (*Dioscorea alata* L.) were obtained from the Federal Experiment Station collection and stored at ambient conditions for 6 weeks prior to their elaboration.

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For the preparation of chips, tubers were hand-peeled and then submerged under tap water at room temperature to avoid browning reactions. The peeled tubers were then sliced at an appropriate thickness, using a Hobart Slicing Machine.[4] The slices were caught in a stainless steel wire basket and then fried in an electric deep-fat frier provided with a temperature control and having a capacity of 15 pounds of frying medium.

Slices were fried in three different frying media: lard, a mixture of 60-percent hydrogenated vegetable shortening and 40-percent lard (60:40 mixture), and corn oil. Frying time was 6 ± ½ minutes at a temperature ranging from 290° to 280° F. (143.3° to 137.8° C.). The slices were stirred with a stainless steel wire fork to prevent sticking and to assure even frying. The chips were then drained, placed on absorbent paper, and salted. Antioxidants such as propylene glycol, butylated hydroxyanisole, propyl gallate, and citric acid were mixed with the salt.

The fried chips were packed in three different types of containers: tin cans, nitrocellulose-coated 195-yield, double cellophane bags, and polyvinylidene chloride-coated 210-yield, double cellophane bags. Packing of samples into tin cans was under vacuum while samples in the two types of cellophane bags were packed under atmospheric conditions. All packed samples were stored at ambient conditions of temperature (70° to 90° F. or 21.1° to 32.2° C.) and relative humidity (60 to 95 percent).

Sensory evaluations of yam chips were conducted at different storage-time intervals following the method developed by Kramer and Ditman (6), which consists of a five-point scale ranging from very acceptable (+2) to not acceptable (−2). Moisture content, shear press, and fat analyses were made at the same storage-time intervals. Moisture was determined following the vacuum oven method (8). Fat content was measured as total ether extract using a Soxhlet-type extractor (9). Shear press measurements were taken on individual 15-g. samples of yam chips. The shear press system was adjusted to a 1-minute stroke. A 3,000-pound proving ring set at a range of 600 pounds (20 percent), and the standard compression cell were used. The maximum force applied to break the yam chips was read directly from the curve.

RESULTS

Preliminary trials showed that peeled tubers should be maintained in water until used to avoid browning from enzymatic action.

Irrespective of the frying medium, when slices were fried at 350° F.

[4] Trade names are used in this publication solely for the purpose of providing specific information. Mention of trade names does not constitute a guarantee or warranty of the equipment by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other equipment not mentioned.

(176.7° C.) or more, the flesh changed in color from white to brown after being fried for about 1 minute. However, this excessive darkening was not observed on yam slices fried at lower temperatures (280° to 300° F. or 137.8° to 148.9° C.). The browning condition also occurred in sprouted yams even at lower temperatures. Figure 1 shows the various shades of color in fried yam chips due to differences in frying temperatures.

The results of moisture analyses after frying and after storage are given in table 1. The frying medium and the type of storage container affected the moisture content. In vacuum-packed tin cans the moisture content of the chips was generally even, although samples fried in lard and in the 60:40 mixture showed a slight tendency to lose moisture. This tendency is

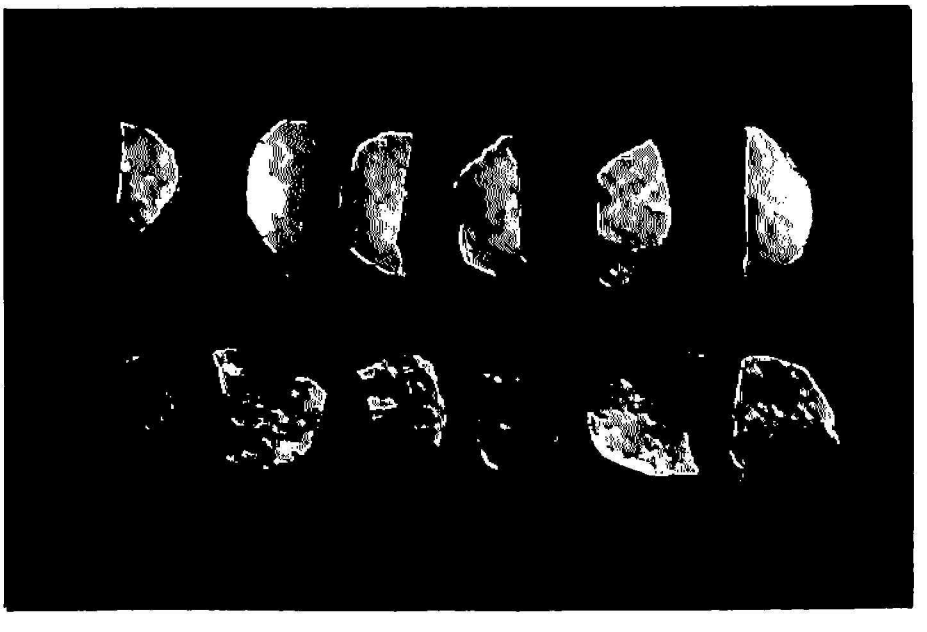

FIG. 1.—Frying temperature effects on the color of yam chips. Upper row: frying temperature range 280°–300° F. Lower row: frying temperature, 359° F. or higher.

not evident in chips fried in corn oil. The reduction in moisture content is probably due to reactions brought about by hydrolysis. Chips packed in cellophane bags accumulated moisture and thus became soggy, especially those in polyvinylidene chloride-coated 210-yield, double cellophane bags. Chips fried in corn oil absorbed and held excessive moisture as compared with those fried in other media.

Shear press results are shown in table 2. Chips packed in tin cans were crisper than the others. They also showed less change in texture than those packed in nitrocellulose-coated, 195-yield, double cellophane bags. Except in the case of vacuum-packed tin cans, moisture content increased with the length of storage and, as a result, the samples became soggy. Yam chips packed in polyvinylidene chloride-coated 210-yield, double cellophane bags

have a tendency to become even soggier than those chips packed in nitrocellulose-coated 195-yield, double cellophane bags.

The average fat content for the samples was highest in chips fried in lard (33.31 percent). When fried in the 60:40 mixture and in corn oil the chips had about the same fat content (31.57 and 31.22 percent, respectively). The fat content results approximately match those obtained by González et al. (4) for "platanutres" (about 32 percent), and are lower than the fat content for plantain sticks (44.4 percent), as reported by Cruz and González (3).

TABLE 1.—*Percent moisture in yam chips as affected by frying medium, packing technique, and length of storage*

Frying medium	Type of package	Percent moisture			
		Storage time (weeks)			
		0	3	6	9
Lard	Vacuum-packed tin can	1.99	1.98	1.76	1.43
	Nitrocellulose-coated 195-yield, double cellophane bags	2.93	3.98	4.08	4.62
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	2.42	3.45	3.90	3.92
A mixture of 60-percent hydrogenated vegetable shortening and 40-percent lard	Vacuum-packed tin can	1.78	1.77	1.67	1.59
	Nitrocellulose-coated 195-yield, double-cellophane bag	2.43	3.28	4.36	4.26
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	2.39	3.81	4.38	6.03
Corn oil	Vacuum-packed tin can	2.04	—	2.05	—
	Nitrocellulose-coated 195-yield, double cellophane bag	3.04	—	4.52	*
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	3.02	—	5.01	*

* Asterisk indicates samples no longer acceptable.

The results of the taste evaluations are presented in table 3. Taste was affected by the frying medium, the method of packing, and the length of storage. All the chips were crisp, good-flavored, and highly acceptable immediately after preparation. With time, however, their quality decreased progressively. Quality decreased least rapidly in chips packed in tin cans and most rapidly in those packed in polyvinylidene chloride-coated bags. Among the three frying media, lard proved best in terms of its effects on sensory qualities. Chips fried in corn oil deteriorated rapidly under all conditions.

DISCUSSION

Yam chips appear to be an acceptable substitute for fried potato chips. As shown by Martin and Ruberté, their quality is markedly affected by the variety. Although yam chips prepared from the Farm Lisbon variety are of good quality, the irregular shape of the tuber makes it difficult to peel with lye (12) and, thus, to process. The Puerto Rican variety Forastero, while not well known at present, yields a chip of similar quality. Its tubers are more uniform in shape and probably will prove easier to peel.

TABLE 2.—*Crispness of yam chips measured by shear press, as affected by frying medium, packing technique, and length of storage*

Frying medium	Type of package	Shear press maximum peak (pounds)[1]			
		Storage time (weeks)			
		0	3	6	9
Lard	Vacuum-packed tin can	114	131	123	112
	Nitrocellulose-coated 195-yield, double cellophane bag	134	195	132	169
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	127	156	188	198
A mixture of 60-percent hydrogenated vegetable shortening and 40-percent lard	Vacuum-packed tin can	98	85	111	98
	Nitrocellulose-coated 195-yield, double cellophane bag	155	126	180	249
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	158	158	269	242
Corn oil	Vacuum-packed tin can	132	154	134	—
	Nitrocellulose-coated 195-yield, double cellophane bag	151	143	161	*
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	197	182	228	*

[1] Higher shear press values indicate less crisp chips.
* Asterisk indicates samples no longer acceptable.

Of the three frying media tested, lard proved to be the best especially because of its tendency to resist the accumulation of moisture, and its flavor retaining capacity.

Among packing media, vacuum-packed tin cans proved best of the three studied. Nitrocellulose-coated 195-yield, double cellophane bags rank second and polyvinylidene chloride-coated 210-yield, double cellophane bag a poor third. Yam chips became gummier as moisture was absorbed through the cellophane bags, and as a consequence, more strength was required to break them. Gummier chips were the least accepted by the panelists.

SUMMARY

Yam chips of good quality were prepared from the Farm Lisbon variety (*D. alata*). Samples were packed using three different types of storage containers, i.e., vacuum-packed tin cans, nitrocellulose-coated 195-yield, double cellophane bags, and polyvinylidene chloride-coated 210-yield, double cellophane bags. Yam chips packed in vacuum-packed tin cans had a longer shelf-life than those packed in the two other types of containers.

TABLE 3.—*Sensory scores of yam chips given by a taste panel, as affected by frying medium, packing technique, and length of storage*

Frying medium	Type of package	Sensory scores[1]			
		Storage time (weeks)			
		0	3	6	9
Lard	Vacuum-packed tin can	1.1	1.1	1.2	1.0
	Nitrocellulose-coated 195-yield, double cellophane bag	1.0	1.2	0.5	0.4
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	1.1	1.4	0.2	−0.5
A mixture of 60-percent hydrogenated vegetable shortening and 40-percent lard	Vacuum-packed tin can	1.0	0.9	1.2	0.6
	Nitrocellulose-coated 195-yield, double cellophane bag	0.8	0.2	0.4	−0.5
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	0.9	0.4	0.1	−0.4
Corn oil	Vacuum-packed tin can	1.1	1.1	0.4	—
	Nitrocellulose-coated 195-yield, double cellophane bag	0.9	0.8	−0.4	*
	Polyvinylidene chloride-coated 210-yield, double cellophane bag	1.0	0.6	−0.9	*

[1] Five-point scale ranging from +2 (very acceptable) to −2 (not acceptable).
* Asterisk indicates samples no longer acceptable.

Of the three types of frying media, lard proved best in terms of its effect on sensory qualities.

RESUMEN

Se prepararon hojuelas fritas de ñame de buena calidad usando la variedad Farm Lisbon (*D. alata*). Las muestras preparadas se empacaron en tres distintas clases de envases, i.e., latas estañadas (al vacío), bolsas de celofán de un rendimiento de 19,500 pulgadas cuadradas por libra, revestidas con una capa de nitrocelulosa y bolsas de celofán de un rendimiento de 21,000 pulgadas cuadradas por libra, revestidas con una capa de cloruro de polivinilideno. Las hojuelas fritas envasadas al vacío en latas estañadas se conservaron en buen estado por más tiempo que las envasadas en los

dos tipos de bolsas de celofán. De las tres grasas usadas para freírlas, la manteca de cerdo fue la mejor por sus efectos deseables en cuanto a las características sensoriales del producto.

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