Fried chips from staple-type sweet potatoes[1]

Franklin W. Martin[2]

ABSTRACT

Five sweet potato selections with medium to very low sweetness and low in polyphenolic oxidation were tested as fried chips by a standardized method. Chips were evaluated by panelists on the basis of appearance, crispness, flavor, and sweetness. Quality scores were calculated. Whereas all of the selections produced very good chips, one, SPV 65 (Mojave), was superior in all tests. Most panelists found that the flavor was not improved by salt, nor were there definite benefits from the use of an antioxidant, ascorbic acid, except for an increase in the crispness of stored fried chips.

INTRODUCTION

Staple-type sweet potatoes are those cultivars selected for low sugar content (even after cooking), and for mild or neutral flavors, sweet potatoes that are suitable for everyday use as a principal staple food. Staple type sweet potatoes are especially recommended in dishes where sweetness is not desired. As a group they are good boiled, mashed, and fried. They also seem to be well suited for making flour.

For fried chips similar to potato chips, not all sweet potatoes are equally useful.[3] In some sweet potatoes the chips lack quality with respect to appearance, crispness, or flavor. Sweet sweet potatoes yield a cookie-like chip. During frying, reducing sugars in the chip can combine with amino acids to form a dark color (Maillard reaction). Previous experience with sweet potato has not included evaluation of the staple-types, because these have only recently been developed.

The sweet potato selections in the present study were developed at the Tropical Agriculture Research Station as either staple-type or sub-staple (slightly sweet after cooking). They have been tested here for their potential in the production of fried chips.

MATERIALS AND METHODS

Table 1 lists the sweet potatoes used for this study and their characteristics. They were all white or cream in uncooked color and all have mild or neutral flavors suitable in a staple. They differed, however, in the amount of total sugar present both before and after cooking. The

[1]Manuscript submitted to Editorial Board 6 March 1987.

[2]Research Horticulturist, Tropical Agriculture Research Station, South Atlantic Region, Agricultural Research Service, USDA, Mayagüez, Puerto Rico.

[3]Martin, F. W. and A. M. Rhodes, 1984. Sweet potato variability in boiled slices and fried chips. *J. Agric. Univ. P. R.* 68: 223–33.

TABLE 1.—*Sweet potato selections used and their characteristics.*

Selection	Latex production	Polyphenolic oxidation	Density more than	Color		After cooking	% Total sugars[1]	
				External	Internal		Before cooking	After cooking
SPV 55 (Toquecita)	Very little	Light oxidation	1.02–1.03	White	White	White	14.8	32.4
SPV 60 (Limonette)	Very little	Light oxidation	1.00–1.01	White	Cream	Cream	5.1	11.4
SPV 52 (Ninety-nine)	Very little	Light oxidation	1.06–1.07	White	Light cream	Light cream	6.2	6.1
SPV 65 (Mojave)	Very little	Intermediate	1.05–1.06	Dark purple	White	White	8.3	11.1
SPV 69 (Nutty)	Very little	Light oxidation	1.03–1.04	Dark purple	Yellow	Yellow	13.8	23.2

[1]Dry weight basis.

storage roots used were harvested at maturity, washed, and held at ambient temperature (24–29° C) for 2 weeks before frying. The roots were peeled and sliced (1 mm) immediately before use. Type of cooking oil and appropriate temperatures were determined by simple trials with SPV 65. As a variation of the technique, some samples were salted before frying by being immersed 5 minutes before cooking in a 1% solution of NaCl. For storage, some samples were treated by a brief dip in either water or 1% ascorbic acid before frying. The slices were fried in a household deep fryer in a standard cooking oil (maize) at 177° C for 3 minutes. The fried samples were cooled and drained on paper towel before taste tests or storage. Chips were stored in sealed polyethylene freezer bags at room temperatures (24–29° C).

Chips were evaluated for appearance, crispness and flavor by a panel of 8 or 9 persons familiar with the sweet potato project and with sensory evaluations. All characteristics were judged on a scale of 1 (low) to 5 (high quality) and the sum was calculated as a quality score. They were also evaluated for sweetness, not considered here as a quality attribute. Selections and treatments were compared by analysis of variance.

RESULTS

Tests for the standardization of technique of making chips were made with one selection, SPV 65 (Mojave) and were not subjected to analysis of variance (table 2). Of three types of cooking oil, little difference was

TABLE 2.—*Effects of frying variables on chip quality of one sweet potato selection, SPV 65 (Mojave)*[1]

Treatment	Appearance	Crispness	Flavor	Quality score	Absence of sweetness
Type of oil					
Soybean	4	5	4	13	5
Maize	4	4	5	13	5
Lard/veg. shortening	4	5	5	14	5
Temperature (°C) in corn oil					
149	4	3	2.5	9.5	4.5
163	5	4.5	4	13.5	5
177	4	4.5	4	12.5	5
191	3	4.5	3	10.5	5
204	2.5	4.5	3	10.5	5
Time of frying in corn oil at 350° F					
2 min	3	4	4	11	4.5
2 1/2 min	4	4.5	4	12.5	5
3 min	4	5	4	13	5
3 1/2 min	3	5	4	12	5
4 min	2	5	3.5	10.5	5

[1]All variables evaluated on a scale of 1 = least to 5 = highest expression of the variable.

found in appearance, flavor or crispness due to type of oil. Maize oil was arbitrarily selected as a standard.

The appropriate temperature for frying was selected among 5 tried, 149, 163, 177, 191, and 204° C, in a thermostatically controlled household deep fryer. The lowest of these temperatures resulted in inadequate color and excess frying time. The highest temperature was too critical and overcooking (browning) occurred. The ideal temperature appeared to be between 163 and 177° C. The time for frying was standardized at 3 minutes on the basis of overall quality of the fried chip.

All 5 sweet potato selections were satisfactory for making fried chips. Table 3 shows the quality ratings of unsalted and salted chips. The selections were significantly different in most ratings and in quality scores (an average rating derived from ratings of appearance, crispness, and flavor). The analysis shows that all chips were rated slightly sweet. Examination of the data, however, showed that sweetness was not perceived by all the panelists. Two selections, SPV 55 and SPV 60, were slightly sweeter than the other three, SPV 52, SPV 65 and SPV 69.

The trials for chips with and without salt were made on separate days. In terms of total quality score, one cultivar, SPV 65, was superior whether salted or not; one cultivar was superior unsalted, SPV 52, and one was superior salted, SPV 60. Panelists reported that they liked the chips just as well without salt.

The appearance of the chips was rated fair–2 to excellent–5 by all panelists. The cultivar SPV 65 ranked highest in appearance with or without salt. Crispness of the chips varied even within a sample, perhaps because of slight differences in thickness of the slices. There were signficant differences in crispness; nevertheless, all were sufficiently crispy.

TABLE 3.—*Quality ratings and summary scores given to chips of 5 sweet potato selections, with and without pre-fry salting, by 9 panelists*

Quality characteristics	Selections				
	SPV 55	SPV 60	SPV 52	SPV 65	SPV 69
A. Without salt					
Appearance	31.0 ab[1]	29.5 b	25.0 b	40.0 a	30.5 ab
Crispness	29.5 b	35.0 ab	42.0 a	35.0 ab	38.0 a
Flavor	34.0 a	30.5 a	34.0 a	35.5 a	34.0 a
Sweetness	24.0 a	23.0 a	18.0 b	18.5 b	17.0 b
Quality score[1]	31.5 b	31.7 b	33.6 ab	36.8 a	34.2 ab
B. With salt					
Appearance	22.5 bc	37.0 a	22.5 bc	39.0 a	28.5 ab
Crispness	35.0 b	42.0 a	33.0 b	40.0 a	34.0 b
Flavor	34.0 b	39.5 a	33.5 b	40.5 a	33.0 b
Sweetness	18.5 b	18.5 b	15.0 a	15.0 a	14.0 a
Quality score[1]	29.8 b	38.1 a	29.7 b	39.8 a	31.8 b

[1]Scores represent sums of ratings by 9 panelists. Figures in rows followed by the same letters do not differ significantly at (P=0.05).

After 2 weeks of storage, the sweet potato chips were still of edible quality whether or not an antioxidant, ascorbic acid, had been used. Table 4 gives the effects of 2 weeks of aging on quality characteristic ratings and quality score. Aging accentuated differences among selections. Selections differed significantly in all quality characteristics. The selection SPV 65 was outstanding in retaining quality, whereas selections, SPV 69 and SPV 55 decreased most in quality.

The effects of aging seemed to include a reduction in appearance, crispness, and flavor in selections SPV 69 and SPV 55. An antioxidant, ascorbic acid, appeared to improve crispness, with little or variable effect on other characteristics. The total effect can be seen from the distribution of judgements of quality among 3 categories: quality decrease, no change, or quality increase (table 5).

TABLE 4.—*Quality ratings and summary scores given to chips of 5 sweet potato selections, after 2 weeks of storage, with or without prefry ascorbic acid treatments*

Quality characteristics	Selections				
	SPV 55	SPV 60	SPV 52	SPV 65	SPV 69
A. Without ascorbic acid					
Appearance	15.0 c	29.0 ab	29.0 ab	34.0 a	18.5 bc
Crispness	18.0 b	29.0 a	29.5 a	32.5 a	11.0 b
Flavor	20.0 ab	24.0 a	22.5 ab	29.0 a	14.5 b
Sweetness	18.0 a	17.0 a	14.5 b	14.0 b	11.0 b
Quality score	17.7 b	27.3 a	27.0 a	31.8 a	14.7 b
B. With ascorbic acid					
Appearance	15.0 c	22.0 bc	29.5 ab	36.0 a	23.5 bc
Crispness	27.0 a	33.0 a	32.0 a	32.5 a	15.5 b
Flavor	22.0 a	23.0 a	23.0 a	25.0 a	16.0 b
Sweetness	17.5 a	17.0 a	13.5 b	13.0 b	12.5 b
Quality score	21.3 bc	26.0 ab	28.2 a	31.2 a	18.3 c

[1]Sum of panelists ratings, can range from 8 to 40.

[2]Average of point scores for appearance, crispness, and flavor (does not include sweetness).

[3]Scores in rows followed by the same letters are not statistically different (P=0.05).

TABLE 5.—*Judgements of panel members on the effects of ascorbic acid on quality characteristics of stored chips*

Characteristics	Effects of ascorbic acid		
	Decreases quality characteristic	No change	Increases quality characteristic
Appearance	15.0[1]	72.5	12.5
Crispness	7.5	45.0	47.5
Flavor	25.0	52.5	22.5
Sweetness	15.0	75.7	10.0

[1]Percent of 40 judgements.

DISCUSSION

The production of superior fried chips from the sweet potato depended on the development of new kinds, low in sugars (especially reducing sugars), with neutral or mild flavors, and with a low level of phenolic substances. Such selections are now available and are tested here as chips for the first time. However, the selections are not alike with respect to many other characteristics. Quality characteristics in a chip can be determined only through production and testing of the chip itself.

The standard techniques for chip production are very closely related to those used for Irish potatoes or recommended for sweet potatoes.[4] No special treatment such as osmotic processing[5] seems to be necessary. The keeping quality of these chips appears to be good, even without the use of an antioxidant. The best selections merit pilot-scale trials.

The selection SPV 65 (Mojave), named for its dry mouthfeel, appears to be of exceptional quality for the making of chips. This selection is low in sugar content before and after cooking. It has a desirable appearance and produces an excellent chip. SPV 52 also appears very good. All selections tested were satisfactory sources of chips; thus this class of sweet potatoes is ideal for this product.

The findings here contrast with those of Martin and Rhodes,[3] who found excellent sweet potato cultivars for sweet cookie-like chips, but could not recommend a suitable white-fleshed cultivar for non-sweet chips.

RESUMEN

Rodajas fritas de batatas de poca dulzura

Cinco selecciones de batatas de mediana o muy baja dulzura y de baja oxidación polifenólica se probaron como rodajas fritas usando una técnica corriente. Las rodajas se probaron por catadares a base de la apariencia, tostadura, sabor y dulzura, y se calculó la calidad media. Aunque en todas las selecciones las rodajas resultaron muy buenas, una, SPV 65 (Mojave), sobresalió en todas las pruebas. La mayoría de los catadores encontraron que la sal no mejoró el sabor. Tampoco hubo mejorías definitivas con un antioxidante, ácido ascórbico, excepto que mejoró la tostadura de las rodajas fritas y almacenadas.

[4]Boggens, T. S., Jr. and J. G. Woodroof, 1964. Sweet Potato Chips, Ga. Agric. Exp. Stn. Leaflet 6, Experiment, Ga.

[5]Hanningan, K., 1979. Sweet potato chips. Chelton's Food Engineering International 45 (5): 28.