

Preparation of New and Improved Products From Eastern (Dry-Type) Sweetpotatoes: Chips, Dice, Julienne Strips, and Frozen French Fries^a

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FOUR PRE-COOKED, DEHYDRATED sweetpotato products i.e. chips, julienne strips, dice and frozen French fries, have been prepared from eastern (dry-type) sweetpotatoes. Several varieties of moist-type sweetpotatoes were also used as raw material in this study. These products were produced by the French-frying process previously employed for the preparation of beet, carrot and parsnip chips, and pea and lima bean nuggets (3). Sweetpotato chips from yams, or moist type tubers, have been prepared by other investigators (2, 4, 5, 6).

This paper presents methods of preparation, yields, oil and moisture contents, stability characteristics, and potential uses of the four types of products. Novel convenience food items may provide some resistance to the decreasing consumption of sweetpotatoes which declined from an annual domestic per capita consumption of 19.4 pounds in 1939 to 8.9 pounds in 1955 (1).

EXPERIMENTAL PROCEDURES AND RESULTS

Varieties. Seven varieties of sweetpotatoes were used for the preparation of chips: Jersey Orange (Orlis), Maryland Golden, Red Jersey, Yellow Jersey as dry-types and Oklahoma Yam No. 24 (Allgold), Oklahoma Yam (strain unknown) and Louisiana Coon Yam as moist-types. Our use of the terms, dry-type, as compared to the moist-type, is based on the classification of Thompson (7). These terms refer to the texture of the cooked product which is dry and mealy for the dry-types and moist, soft and usually sweet for the moist-types. The original moisture content of the dry-types may actually be higher than that of the moist-types. The first 5 varieties were grown in New Jersey or Maryland and the latter two varieties were southern grown. Julienne strips and diced sweets were made only from the Maryland Golden variety and frozen French fries were prepared from Jersey Orange, Maryland Golden, Yellow Jersey and Oklahoma No. 24.

Equipment. Sweetpotatoes were sliced to dimensions specified below with a standard rotary knife slicer, Model 20,^c manufactured by the Eagle Machine and Tool Company, Springfield, Ohio.^c This cutter was easily adjustable to slice at any thickness but the adjustment had to be checked with a micrometer gauging of the cut slice.

The deep fat fryer used in this study was a Hotpoint Fry

Kettle Model HK3^e having a capacity of 15 pounds of frying oil. This model is available with either one large or two small baskets for holding the food product. Both sizes were useful for different size batches. In most of this work one-half to one-pound lots were fried in the large one. The Calrod^e heater of this fryer quickly brought the temperature of the hot oil to the thermostat setting required for each experiment even with the larger quantity of vegetable.

Frying medium. Evaluation tests with different types of frying media have not been made to date. As in previous studies on vegetable chips (3), a commercially available modified coconut oil was used because of its high stability and its failure to harden at room temperature on the surface of the sweetpotato products. Other oils which approximate these characteristics should be equally satisfactory.

Preparation of sweetpotato products. Sweetpotatoes were carefully washed and pared by hand without any pretreatment. Pared roots were trimmed slightly to even them for better slicing or cutting for chips, dice, or julienne pieces. Peeling losses amounted to about 18% of the original weight for good quality field run roots of the Jersey Orange or Maryland Golden varieties.

The Oklahoma No. 24 yam was often so large it was cut in half and handled as two roots. The sweetpotatoes of 2-3 inch diameter, such as found in the 3 varieties named immediately above, gave the best pared yields and the most uniform pieces for dice, julienne and French fries. Smaller diameter roots were better for chips since there was less folding of the slices during frying.

Sweetpotato chips were sliced at $\frac{1}{16}$ and $\frac{1}{32}$ inch thicknesses for experimental work with the 7 different varieties. They were fried at 275° F. for varying periods of time from 3-5 minutes. The slices were not blanched or soaked prior to frying. After cooking, the chips were drained and salted with flake salt or left unsalted. They were stored in the dark in glass bottles with tight lids.

Julienne strips were prepared by slicing at $\frac{1}{16}$ inch followed by cutting of the slices the long way to give strips of $\frac{1}{16}$ x $\frac{1}{16}$ inch cross section about 2 inches long. For dice pieces these 2 inch strips were again cut to give cubes $\frac{1}{16}$ inch on a side. Larger strips were prepared for preliminary trials and these were likewise cut for cubes of $\frac{1}{8}$ - $\frac{3}{16}$ inch size.

French fries were prepared by first trimming the pared roots to approximately a square cross section followed by cutting with a standard restaurant size white potato French fry cutter to about $\frac{7}{16}$ inch cross section. On frying, these gave pieces of $\frac{3}{8}$ inch cross section.

Combined paring and trimming losses for the preparation of the French fries are somewhat greater than those for the chips, dice and julienne strips due to the necessity for squaring the roots before cutting. The average loss for Jersey Orange sweetpotatoes was 38.8% of the unpared weight, for Maryland Golden, 31%, and for Oklahoma No. 24 (Allgold), 37%.

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^b Eastern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture.

^c Mention of trade names does not imply endorsement by the United States Department of Agriculture over similar products not mentioned.

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TABLE 1
Preparation of chips from dry and moist type (yam) sweetpotatoes¹
(French fried at 275° F.)

Variety	Area grown	Moisture fresh	Thickness of slice	Frying time	Oil content	Yield (based on pared and trimmed roots)
Dry-types						
Jersey Orange.....	Maryland and New Jersey	%	<i>inches</i>	<i>min.</i>	%	%
Jersey Orange.....		72.6	1/16	3 1/2	30.7	38.5
Jersey Red.....	New Jersey	78.8	1/32	3 1/2	39.8	37.0
Jersey Yellow.....		72.4	1/16	3 1/4	28.6	38.4
Maryland Golden.....	Maryland	72.2	1/32	3 1/2	50.0
Moist-types						
Oklahoma Yam.....	New Jersey	76.8	1/32	3 1/4	41.9	40.4
Oklahoma No. 24 (Allgold).....		62.8	1/16	3	26.4	49.7
Louisiana Yam.....	New Jersey South	75.6	1/32	3 1/2	35.6	39.2
		65.2	1/16	3 1/2	28.2	42.3

¹ Average data from 4-6 replicates prepared from one lot of each variety. Data are representative of values obtained in numerous preliminary experiments.

Cut pieces were cooked in the frying oil at 275° F. for varying periods from 3-7 minutes for the trial experiments. Fried pieces were drained and frozen without salting at -22° F. They were kept at this temperature until needed. For use the frozen pieces were placed in a gas oven at 350° F. for 10 or 15 minutes depending upon the frying time.

Since the French fries as they come from the hot oil are only partially cooked before freezing, the oven warming serves not only to thaw the frozen pieces and bring them to temperature, it also cooks and browns the pieces for better taste and appearance. For example, satisfactory products could be made at 4 minutes frying time with 15 minutes warming of the frozen pieces and 6 minutes frying time with 10 minutes warming.

RESULTS AND DISCUSSION

Table 1 provides data on the sweetpotato chips. The moisture content of the raw material varies with the conditions at the time of harvesting and the curing and storage conditions. No attempt has been made to follow the exact history of each batch of potatoes since it was necessary to obtain certain varieties through a wholesale produce house. In general, in this area, newly harvested potatoes are cured for wound healing for about 10 days at 80°-90° F. and stored in houses kept as close as possible to 55° F. We have found that the quality of the stored sweetpotatoes remains high during the winter and early spring months but becomes lower in those purchased in late April and early May.

Chips made from 1/16 inch slices were better from a structural standpoint but with most varieties they tended to be a little tough and chewy. Chips sliced at 1/32 inch were generally preferred by most tasters for ease of eating and general appearance. Many of these thinner chips were wrinkled and folded, and might present problems for use with dips. On the other hand, their greater bulkiness would make a better-filled and more attractive package.

Chips prepared from Jersey Orange and Maryland Golden sweetpotatoes were rated highest in color and texture by the consumer-type taste panels to whom they were submitted. The deep orange color was preferred when compared with the lighter colored chips resulting from the frying of the Jersey Red and Jersey Yellow varieties. The color of chips prepared from the yam types was satisfactory but the crunchy nature of the dry-types was preferred to the harder, horny texture resulting from the frying of the yams under the conditions used in our studies.

Data on the 4 types of products are given in Table 2. Only one variety, the Maryland Golden, was prepared in these forms but it is probable that the Jersey Orange variety would have been equally satisfactory. The completely fried chips, julienne strips and dice have very low moistures whereas the French fries still contain about 46% moisture. In the diced products the 1/16-3/32 inch cubes contained 2.7% moisture with 5 minutes cooking, whereas the 1/8-3/16 inch cubes had 2.1% higher moisture with 6 minutes cooking. This slight difference in moisture content was actually reflected in the crispness of the pieces with the larger cubes being slightly chewy.

The oil absorption of the larger cubes was also somewhat lower than that of the thinner cubes, chips or strips and, as a result, the yield was lower.

Moisture, oil content, and yield relationships are quite different in the French fries than in the chips, julienne and diced products. With the higher moisture content, due to slower removal of water from the large pieces, less oil is taken up but the yield of the partially cooked product is greater. Oven heating of the frozen French fried pieces of 47% moisture content brings about a further reduction of moisture to a value of 37%. The yield of the finished product, after oven-warming, with its lower moisture content would amount to 48% instead of 55% for the Maryland Golden sweetpotato listed in Tables 2 and 3.

Data for two additional varieties of sweetpotatoes used for the preparation of French fries are given in

TABLE 2
Data on sweetpotato products deep-fat fried at 275° F.¹
(Maryland Golden Variety)

Products	Moisture		Frying time	Oil content	Yield (based on pared and trimmed roots)
	Fresh	After cooking			
Chips (1/32" slice)	%	%	<i>min.</i>	%	%
Julienne strips (1/16" x 1/16")*	76.4	3.3	3 1/4	41.9	40.4
Dice (1/8"-3/16" cube)	76.4	2.7	5	37.3	38.4
Dice (1/16"-3/32" cube)	76.4	4.8	6	34.8	32.3
Frozen French Fries (3/8" x 3/8")*	76.4	2.7	5	41.9	41.6
	76.4	47.2	4	11.8	55.4

* Length variable (2-3 1/2").
¹ Average data from a minimum of 3 frying experiments from one 50 pound lot. Data are representative of values obtained in numerous preliminary experiments.

Table 3. The data on the Maryland Golden variety as shown in Table 2 are included for comparison as are the data for sweetpotato chips of all 3 varieties. The moisture contents of the 3 varieties of French fries after frying are within 2% and the yields are within the same limits. The oil content of the Oklahoma No. 24 (Allgold) yam variety is lower than that of the other two varieties.

Yields of sweetpotato products. One bushel of sweetpotatoes has an average weight of 55 pounds (1a) but after curing and storage this weight may be lower. Based on the 55 pounds weight, a bushel of sweetpotatoes would yield 45.1 pounds of pared roots when the average paring and trimming loss for chips, dice, and julienne strips is 18%.

The average yield of fried chips, dice, or julienne for the 3 varieties, Jersey Orange, Maryland Golden, and Oklahoma No. 24 (Allgold), based on the pared and trimmed weights is 38.9% or 17.5 pounds of chips from one bushel.

The average yield of chips on the 7 varieties shown in Table 1 was 41.9% or 18.9 pounds from a bushel.

Yields of pared and trimmed pieces for French frying are somewhat less because of the greater trimming losses. A 55-pound bushel of sweetpotatoes of the 3 varieties listed in Table 3 would yield an average of 35.4 pounds of pared and trimmed roots. The overall yield of the fried product is a little higher because of the higher moisture content. This was an average of 56.4% for the three varieties which would give an average of 20 pounds of French fries/bushel.

Evaluation of deep-fat fried sweetpotato products.

Chips were tested for texture, color and flavor by consumer-type taste panels. Texture was rated as either crisp or crunchy, or tough and chewy. Flavor was to a great extent a matter of sweetness and similarity to that of a baked sweetpotato. Good texture ratings were assigned to Jersey Orange and Maryland Golden Chips with Oklahoma No. 24 (Allgold) chips a close second. These chips were satisfactory from the color standpoint having an attractive bright orange appearance. Chips made from Jersey Red and Jersey Yellow varieties were not as crisp and they were a pale yellow, less attractive color. Chips made from Oklahoma (red root) yams, and Louisiana Coon yams were likewise tougher and more chewy. They had a deeper

orange color and a duller finish. Taste preference for the different chips was greatly influenced by their relative sweetness. As in the tasting of other vegetable chips, some panel members felt that all except the bland Jersey Red and Jersey Yellow chips were too sweet. When asked to rate the flavor, other than sweetness, the Jersey Orange and Maryland Golden were preferred.

Julienne strips and sweetpotato dice were acceptable to all who liked sweetpotato chips.

French fried sweetpotatoes were rated for preference of the 15-minute oven-warmed product after 3, 4, 5, 6, and 7 minutes of deep-fat frying and freezing. The 4-minute product was considered most satisfactory. Six-minute frying with 10-minute warming was also well liked, particularly if a more crisp toasted product was preferred by the taster.

The laboratory taste panel also rated the 4-minute French fries made from Maryland Golden, Jersey Orange and Oklahoma No. 24 (Allgold) varieties after a storage period of 5 months at -22° F. A sample of Maryland Golden frozen French fries, freshly prepared from stored roots was also included in this test. All three varieties were rated satisfactory from the taste and appearance standpoint. Maryland Golden was rated highest in taste preference with Jersey Orange next. Oklahoma No. 24 (Allgold) was rated highest in color and general appearance.

When the two samples of Maryland Golden were evaluated, definite preference was shown by the panel for the French fries prepared in November and held in frozen storage compared with those prepared in April from sweetpotatoes that had been stored in commercial storage houses from harvest time in October to early April. Both texture and taste in the latter sample were considered inferior to the frozen product prepared in late fall. It is probable that certain varieties might remain in better condition in storage houses and that the original might influence the quality of the final product. Apparently it would be necessary in the commercial scale preparation of frozen French fried sweetpotatoes to obtain these either in the late fall and early winter months or test each lot for quality in the early spring months.

In April and May over 130 visitors to the laboratory

TABLE 3
Preparation of chips and frozen french fries from three sweetpotato varieties for storage studies¹
(Fried at 275° F.)

Variety and product	Moisture		Thickness	Frying time	Oil content	Yield (based on pared and trimmed roots)
	Fresh	After frying				
Jersey Orange						
Chips.....	78.8	45.2	1/2 slice 3/8 x 3/8 *	3 1/2	39.8	37.0
French Fries.....	78.8	45.2		4	14.4	57.4
Maryland Golden						
Chips.....	76.8	47.2	1/2 slice 3/8 x 3/8 *	3 1/4	41.9	40.4
French Fries.....	76.8	47.2		4	11.8	55.4
Oklahoma No. 24 (Allgold)						
Chips.....	75.6	45.8	1/2 slice 3/8 x 3/8 *	3 1/2	35.6	39.2
French Fries.....	75.6	45.8		4	10.03	56.4

* Length variable (2-3 1/2").

¹ Average data of numerous replicates prepared from 50 pound lots of each variety.

were served frozen French fries made from the Jersey Orange and Maryland Golden sweetpotatoes prepared in November. About 70% of the tasters indicated they would purchase this product if it were commercially available.

SUMMARY

Four sweetpotato products have been successfully prepared from dry-type sweetpotatoes grown in the northeast section of the country. These are deep-fat fried chips, dice, julienne strips and French fries.

Chips, dice and julienne strips prepared from Jersey Orange (Orlis) and Maryland Golden varieties gave crisp, well-colored tasty products without prior blanching or soaking. These varieties likewise made excellent French fries for the preparation of frozen packs for home consumption. One yam variety, Oklahoma No. 24 (Allgold) grown in the Northeast was also used for the preparation of acceptable French fries.

Data on conditions of cooking, moisture and oil contents of the finished products, and yields based on

the pared and trimmed roots and one the original sweetpotato were obtained.

A discussion of taste panel evaluation of the four products is also included.

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