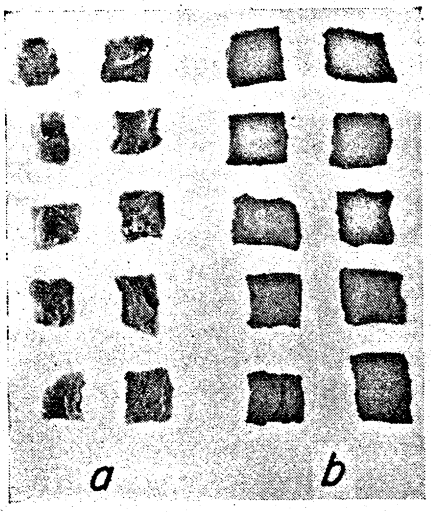

FIG. 1—After 3-min boiling, there is marked contrast between reconstituted exploded product "b" and conventionally hot-air dried dice "a" similarly reconstituted.

► Reduced total drying time
► Rehydration in 5 min or less
► Freshly-cooked flavor and color
—These are the benefits of explosion puffing in producing . . .

Quick-Cooking Dehydrated Sweet Potatoes

DEHYDRATED fruit and vegetable pieces can be reconstituted in one-fifth to one-tenth the time normally required. A process for the preparation of such products has been developed at the Eastern Utilization Research and Development Division of USDA (Ref. 1, 2, 3, 4, 5, 6).

Pilot plant research has established the operating conditions for apples, blueberries, cranberries, carrots, beets, turnips, potatoes and, most recently, sweet potatoes. Sweet potato flakes, made by a process analagous to the white potato flake process, have recently attracted attention (7). But flakes only yield a mashed product on reconstitution. A particulate product, for example dice or slices, would be more versatile.

A process for preparing ⅜-in. sweet potato dice was recently reported as a result of work at the Department's Southern Utilization Research and Development Division (8). This product, like most ⅜-in. vegetable dice conventionally dried in hot air, requires approximately 40 min to rehydrate. The value of a sweet potato product which can be prepared in 2-5 min to yield either pieces or mash is obvious.

JOHN F. SULLIVAN,
JAMES CORDING, JR.,
and RODERICK K. ESKEW
Eastern Regional Research Laboratory, USDA, Philadelphia, Pa.

About the Process

The "explosion puffing" process as it is called (not to be confused with puff-drying) is readily applicable to sweet potatoes of both the dry and moist types. And from ⅜-in. dice, it yields a product of excellent color, flavor and texture when reconstituted by 2-5 min boiling. As with other vegetables, larger pieces can be employed if desired.

Raw material which had been cured in the conventional way was obtained from a local dealer. Two varieties were used, Maryland Golden grown in North Carolina and Unit #1 Puerto Rico grown in New Jersey. The processing steps were the same for both varieties.

Washing, Peeling and Trimming

After preheating the potatoes for 30 min at 135F, skins were loosened by immersion in a 20% lye solution at 150F for 7¾ min. High pressure sprays removed the skins in a rod-reel washer. After trimming, ⅜-in. dice were cut in an Urschel Model B dicer. Between trimming and dicing the potatoes were dipped in a dilute sulfite solution to prevent discoloration.

The dice were sized using a Day-Roball screener equipped with a slotted screen having 5/16-in. wide openings. For purposes of this work, undersized pieces were discarded. In practice they would be either dried and puffed separately or converted to flakes by cooking and drum drying.

Blanching and Sulfiting

The dice were blanched in atmospheric steam for 6 min and then dipped for 30 sec in a ½% sulfite solution at room temperature. This gives about 350 ppm SO_2 in the product. The time of dip and concentration of sulfite can be varied to obtain the desired sulfite in the final product.

For example, a 6-min dip under the conditions used above gave 1100 ppm of SO_2 in the product. A concentration of between 200

and 500 ppm has been recommended (8) for conventionally dried dice from Unit #1 Puerto Rico variety.

Initial Drying

Partial drying is required in explosion puffing of all fruits and vegetables. In order to obtain data enabling extrapolation to conventional practices with continuous belt-type hot air driers, through-circulation of air was employed.

Dice were loaded 3 in. deep in 28 x 28-in. perforated trays. And air at 175F was blown through the bed at a velocity of 200 ft per min. Direction of air flow was reversed half-way through the initial drying cycle which required 1½ hr to reduce the moisture to approximately 32%.

Explosion Puffing

The equivalent of approximately 10 lb of partially dried dice per cu ft of gun volume was charged into a puffing gun. The lid was tightly closed, rotation was started and the pressure brought to 40-45 psig in approximately 6 min by external gas heating.

The latch on the gun was thereupon tripped and the dice exploded from the chamber. A small percentage of the superheated moisture is thus instantly vaporized creating a capillary structure. The partially dried pieces, previously having concave faces, regain their cubical form on puffing.

The gun employed in these tests had a volume of approximately 0.1 cu ft. It was designed for cereal puffing at high pressure. Optimum conditions in this gun may not correspond exactly to those suited for larger units. In general lower pressures can be used with larger guns. Detailed construction drawings for an experimental gun holding approximately a 14-pound charge are available.

Final Drying

To obtain a product stable at room temperature it is necessary to dry the puffed dice to 4% moisture or lower. This requires 3½ hr using air at 150F and circulating through a bed 5 in. deep.

This corresponds to a total drying time of only 5 hr in contrast to 21 hr required for unpuffed pieces under the same conditions or in shallow beds with cross circulation. These values were obtained for Unit #1 Puerto Rico and Maryland Golden varieties.

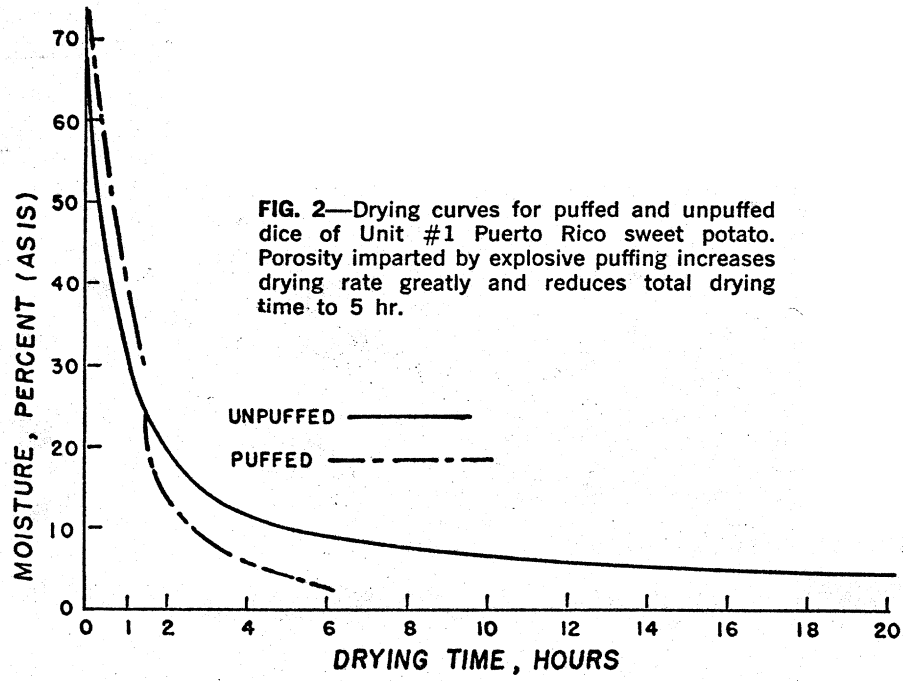

FIG. 2—Drying curves for puffed and unpuffed dice of Unit #1 Puerto Rico sweet potato. Porosity imparted by explosive puffing increases drying rate greatly and reduces total drying time to 5 hr.

Fig. 2 shows drying curves for puffed and unpuffed dice from the same lot of Unit #1 Puerto Rico variety. The drying rates are about the same down to 30% moisture. The break in the curve for the puffed product, 30% to 24%, is a result of water loss as vapor in the actual explosion of the pieces from the gun.

As shown in the lower portion of the curve, the drying rate is increased greatly by the porosity imparted by the explosive-puffing step. Further, the total drying time for the puffed dice is reduced to 5 hr as compared with 21 hr for unpuffed dice.

The Product Itself

When 50 g of the product are boiled from 2-5 min in 1¼ cup of water, the pieces fully regain their original shape. They possess the characteristic color and flavor of the freshly cooked sweet potatoes.

When water is poured off, the reconstituted dice may be seasoned and eaten in this form or they may be mashed. In large pieces they would be suited to making the popular candied sweet potatoes.

Fig. 1 shows the appearance of the product "b" reconstituted in 3 min boiling, in contrast to conventionally hot-air dried dice "a" similarly reconstituted.

Storage tests on the product have not yet been completed. But different keeping properties from unpuffed dice are not anticipated.

Cost Factors

Preliminary estimates indicate that in a plant processing several commodities with 300 days-per-year operation, the cost should be (a) only slightly higher than for conventional hot dried dice, and (b) far below that for a freeze-dried product.

Inquiries for samples and further information may be addressed to R. K. Eskew, Chief, Engineering and Development Laboratory, Eastern Utilization Division, 600 East Mermaid Lane, Philadelphia 18, Pa. (End)

NOTE: Reference to certain products or companies does not imply endorsement by the Department over others not mentioned.

REFERENCES

1. Eskew, R. K., Cording, J., Jr., and Eisenhardt, N. H. "Dehydrated Fruit and Vegetable Products Capable of Rapid Rehydration." USDA, ARS, ERRL Correspondence Aid-E-27, (Revised May 1961).
2. Roberts, Norman E. "USDA Process Produces 'Quick-Cook' Dehydrated Foods." FOOD Engineering, 33, (9), p. 45 (1961).
3. Eisenhardt, N. H., Cording, J., Jr., Eskew, R. K. and Sullivan, J. R. "Quick-Cooking Dehydrated Vegetable Pieces. I. Properties of Potato and Carrot Products." Food Technology, 16, (5), 143-146 (1962).
4. Eskew, R. K., Cording, J., Jr., and Sullivan, J. F. "A Gun for the Explosive Puffing of Dehydrated Fruits and Vegetables." FOOD Engineering, 35, (4), p. 91 (1963).
5. Eskew, R. K., Cording, J., Jr., Sullivan, J. F., and Eisenhardt, N. H. "Quick-Cooking Dehydrated Vegetable Pieces. II. Process for Carrots and Beets." Talk given by R. K. Eskew at the First International Congress of Food Science and Technology, London, Sept. 18-21, 1962.
6. Cording, J., Jr., Eskew, R. K., Sullivan, J. F., and Eisenhardt, N. H. "Quick-Cooking Dehydrated Vegetable Pieces. II. Process for Carrots and Beets." FOOD Engineering, 35, (6), p. 52 (1963).
7. Deobald, H. J., et al. "Precooked Dehydrated Sweetpotato Flakes." USDA, Agricultural Research Service, ARS-73-23.
8. Molaison, L. J., Spadaro, J. J., Roby, M. T., and Lee, Frances H. "Dehydrated Diced Sweetpotatoes—A Pilot-Plant Process and Product Evaluation." Food Technology, 16, (11), 101-104 (1962).