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SOLAR DRYING MANGO SLICES AND MECHANICALLY DESEEDED MUSCADINE GRAPES

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Abstract. **Two cultivars of Florida grown mangos** (Magnifera indica **L.) and muscadine grapes** (Vitis rotundifolia **Michx.) were dried in two small scale solar dryers, one using natural convection, and the other forced air circulation. The drying rate was increased when forced air circulation was used. Flavor characteristics of solar dried mangos were determined. Mangos were manually peeled and sliced, and grapes were mechanically deseeded. A new prototype grape deseeding machine was designed, built and tested to determine optimum cutter diameters for seed removal while minimizing losses of peel, meat and juice.**

Both mangos and muscadine grapes could become significant agricultural commodities in the southern United States, if certain problems can be overcome. Although both grow prolifically in warm, humid climates, they tend to ripen over a very short period and are thus over-abundant for a short period and unavailable at other times. Processed products with reasonable storage stability could broaden the existing market and create new markets for these commodities and thus stabilize and/or increase their value.

Wagner (5, 6) reported that solar dried mango slices had excellent flavor, color and texture characteristics. Samples of these dried mango slices continued to show good flavor, color and texture even after storage at 10°C for over 3 yrs. Similar mango products were dried on a simple, inexpensive solar dryer. Further studies are needed to determine whether forced air circulation within such solar dryers can increase drying rates and provide further advantage in producing solar dried mango slices.

The seeds in muscadines have prevented widespread use of this tasty fruit, which is sold on the fresh market and used for juice, wine, jellies and desserts to a limited extent. Deseeding equipment used by raisin packers in California for bunch grapes was inadequate for muscadine grapes (4). Current commercial deseeders have difficulty with the thick skin of the muscadine grape. In previous experiments, we tested a grape centering and coring device, modified from a laboratory cork borer for preliminary deseeding and dried both whole and halved muscadine grapes ('Fry' and 'Higgins'). We found excellent aroma and flavor characteristics in the solar dried muscadine raisins (2).

Solar drying offers advantages for both these commodities if relatively low-cost dryers are used. We developed a low-cost dryer for home and small farm use (3) that appears suitable for preparation of solar dried mangos and muscadine grapes and has the potential for larger scale operations. Thus, we studied deseeding mechanisms on the 'Fry' and 'Higgins' varieties of Florida muscadine grapes, and solar dried muscadine grapes and mango slices to further determine optimum conditions for producing a satisfactory product.

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Materials and Methods

Produce

Two cultivars ('Fry' and 'Higgins') of muscadine grapes were obtained from Hall's Vineyard in Lake Wales. Two varieties of mango were studied: 'Saigon Seedling' from the Horticultural Research Station, Miami, and 'Tommy Atkins' from Mitchell Groves, Homestead. All fruit were washed before using.

Drying Equipment

Solar dryers. For natural convection drying, a laminated wooden frame dryer described by Coleman, et al. (1, 3, 6) was used. For forced convection drying, a dryer comparable to the natural convection dryer was equipped with a small electric fan (Type 3-15-3450 Howard Industries, Milford, Ill.) to provide 100 cfm of air to the dryer air inlet slot.

Grape deseeding machines. Single and multiple cutter deseeders were tested. The single cutter deseeder is a cork borer (Type S-23207 Sargent-Welch Scientific Company, Skokie, Ill) fitted with a centering cone made from aluminum rod stock (1.4 cm long x 2.4 cm diameter), countersunk with a 2.2-cm drill. The multiple cutter was designed and built at this laboratory. It has 4 coring cutters (each 9.5 mm dia) that are held and centered by ball bearings and driven by 0.33-hp electric motor at 900 to 1000 rpm. This assembly is attached to a steel plate above the steel frame for the deseeder (Fig. 1). Below the cutters is an aluminum head with 4 milled centering cones mounted on a cylindrical ram. The ram is held rigid during its travel upward (9.2 cm) to engage 4 grapes (1.3 to 3.3 cm dia) with 4 matched cutters. Fittings on the aluminum cutting head assure that each grape remains in the centering cone during loading and cutting. Deseeded grapes are pushed out of the cones by spring-loaded fingers activated by the returning ram, allowing the machine to automatically seat 4 more grapes. Air pressure is used to force the core plug (seeds and pulp) from the hollow revolving cutters.

Tests

Drying. Trays were loaded with 0.5 g/cm² of fruit and placed in the solar dryers. Mangos were sliced (6-12 mm) and pretreated with a 5-min dip in 2% aqueous sodium bisulfite solution. Grapes were deseeded but not pretreated. Tray weight was measured to determine drying rates.

Deseeding. To determine optimum deseeding operation, grapes were manually loaded on a centering cone and deseeded by a cork borer with 4 cutters (6.5, 8, 9, and 10 mm ID). Weights were determined on the grapes before and after deseeding and on the core and seeds.

Analyses

For measuring the solids content a vacuum oven method was used (6). For the H_2O/solids ratio, the weight of H_2O in the fruit was divided by the weight of its solids (6). For flavor evaluations, 12 trained panelists were presented random pieces of partially reconstituted (10 min in 10°C H_2O) mango slices that had been dried in the forced or natural convection dryers. Tasters were asked to indicate their preferences. All tests were replicated.

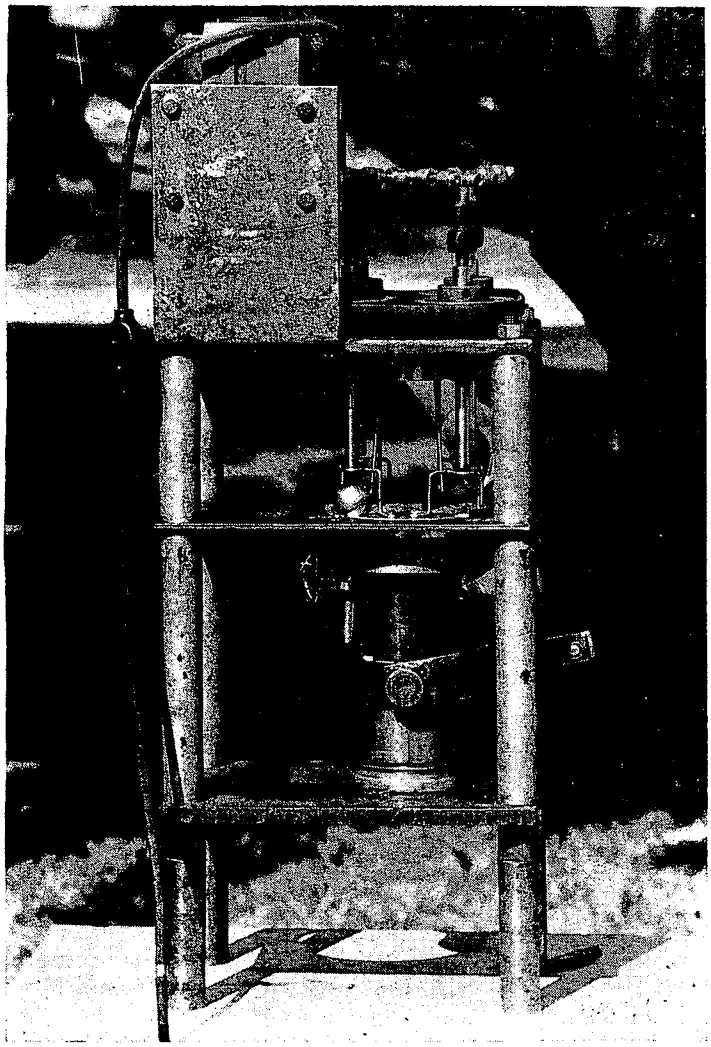

Fig. 1. A multiple cutter machine designed for deseeding muscadine grapes.

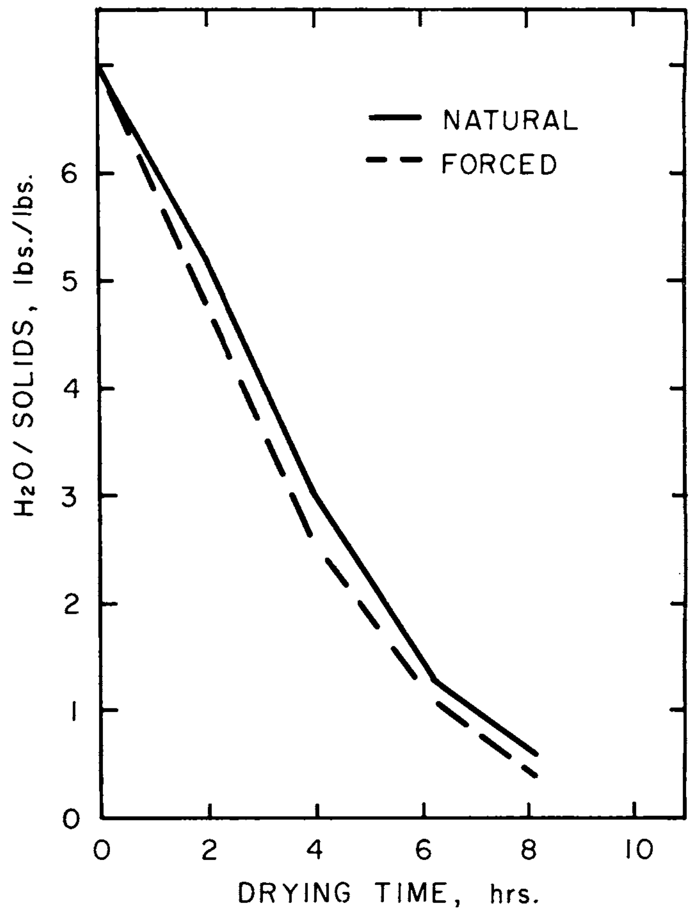

Fig. 2. Drying rate curves for two varieties of mangos each dried in solar dryers with and without forced air circulation.

Table 1. Weight composition of 2 varieties of muscadine grapes deseeded with different size cutters.

	ID cutter mm	% Original weight		
		Deseeded	Seeds	Removed skin & flesh
	6.5[z]	87.9	2.2	9.9
	8[z]	87.8	4.2	8.0
Higgins	9	82.0	3.4	14.5
	10	73.4	4.3	22.2
	6.5	90.4	2.3	7.3
Fry	9	83.8	3.1	13.1
	10	73.0	2.9	21.7

[z]This size cutter did not remove every seed.

Results and Discussion

Drying rates in these experiments and others were slightly increased in the forced convection solar dryer. Drying rate curves for mangos ('Tommy Atkins' and 'Saigon Seedling') are shown in Fig. 2. Drying times were reduced 1/2 to 1 hr (7 to 14%). Data for the 'Saigon Seedling' were collected during two different solar periods. The greater initial drying rate reported with the second test can be attributed to small differences in both insolation and initial solids content.

Flavor evaluations (using replicated 12-man panels) of the solar dried mango slices indicated no significant difference between those dried in the forced convection dryer and those from the natural convection dryer. Significant changes in both flavor and nutrient retention may be caused by adjustments of air flow to effect drying temperatures and drying times (7).

In our preliminary deseeding experiments with muscadine grapes, we found that the seeds of both varieties were in the geometrical center of the fruit. 'Higgins' grapes (21.6 mm average dia, 7.0 g weight) tended to be smaller than the 'Fry' grapes (25.6 mm dia, 10.6 g weight) and had greater seed dispersion. Cutters of less than 9 mm ID did not remove all seeds from 'Higgins' grapes. Cutters with a 9 mm ID removed less than 15% of the edible grape (Table 1).

Drying rate curves for 2 varieties ('Fry' and 'Higgins') of muscadine grapes are shown in Fig. 3. Each drying curve represents an accumulation of 4 solar drying periods (about 6 hrs each) in the natural convection solar dryer. Because both varieties were not dried during the same solar periods, differences in drying rates may be due in part to variations in insolation as well as solids content and cultivar.

In conclusion, solar drying rates for 2 varieties of mangos were determined and slightly increased drying rates but no significant flavor advantages could be attributed to forced air circulation. Less energy consuming natural convection, therefore seems advantageous at least in a small scale solar dryer unless shortened drying time is required.

Preliminary deseeding studies have shown that solar dried muscadine raisins can be produced with good flavor qualities, thus increasing their potential for development into a profitable food industry. The solar drying time for deseeded muscadines was found to be half or less than that

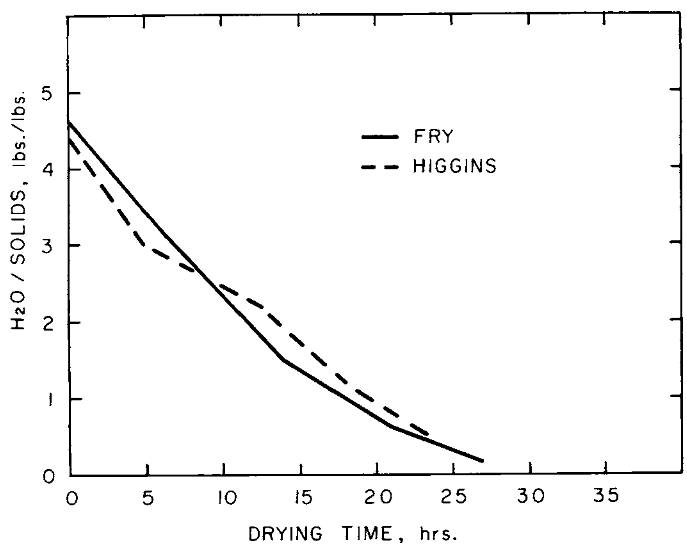

Fig. 3. Drying rate curves for two varieties of muscadine grapes dried in a natural convective solar dryer.

for whole grapes. A deseeder for muscadine grapes has been designed and built and is now undergoing further testing and modification.

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PRETREATMENT FOR SOLAR AND HOT-AIR DRIED MUSHROOMS

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Abstract. **Studies were conducted on pretreatments to reduce bacteria and preserve color of solar and hot-air dried mushrooms. Pretreatments included 1) dipping washed whole mushrooms in aqueous solutions of sodium hypochlorite, 2) slicing the dipped mushrooms, and 3) dipping the sliced mushrooms a second time in some other antimicrobial agent (methyl paraben, potassium sorbate, sodium benzoate or sorbic acid), with sodium bisulfite. Hypochlorite dips were effective in reducing bacteria in washed whole mushrooms. Additional agents were needed for reducing bacteria in solar and hot-air dried slices and varied in effectiveness. Color of dried mushrooms improved when they had been pretreated with sodium bisulfite.**

Fresh and canned mushrooms, used extensively by U. S. consumers, are produced domestically. However, all dried mushrooms except for a small quantity that are freeze-dried are imported. Compared with fresh or canned, dried foods can conserve energy through lower weight. Solar drying conserves fossil fuels in the drying process. Also, dried mushrooms require less energy for transportation and storage since they require little refrigeration.

Dried mushrooms for food use should have low bacteria count, proper color and good flavor. Blanching prior to hot-air drying at 65.6°C was suggested by Cruess and Mrak (4), but this method of reducing bacteria darkens the color. While dark mushrooms are preferred in England, the U.S. consumers prefer a very light tan or gray product. Recently Komanosky, et al. (6) studied pretreatments for hot-air dried mushrooms. Pretreatments were required and 2 stages of drying were necessary to produce products low in bacteria. The second stage for this method required temperatures of 76.7 to 82.2°C. Brunell, et al. (2) found mushrooms dried above 65.6°C had slight burned flavors.

A market presently exists for dried mushrooms incorporated with other dried foods but total bacteria plate counts must be minimal. Acceptable freeze-dried mushrooms have been reported with bacteria plate counts in the range of tens to hundreds of thousands/g (7). Our study developed pretreatments to reduce bacteria count in both conventionally hot-air and solar dried (A.D. and S.D.) mushrooms, while preserving color and flavor.

Materials and Methods

Drying Equipment

Hot-air dryer. An atmospheric pressure, forced draft, pilot scale, tray-type conventional hot-air dryer described by Wagner, et al. (10) was used.

Florida Solar Energy Center (FSEC) dryer. A solar dryer with two manually adjustable planar reflectors and forced air circulation described by Bryan, et al. (3) was used.

Mushrooms. All mushrooms used in these tests were obtained from the Ralston Purina plant at Zellwood, Florida. They had been graded and were ready for the fresh market. These mushrooms were usually stored overnight at 1.7°C before pretreatment.

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