Table 3. Turbidity of citrus packinghouse effluents taken at various points from a packinghouse which utilizes an oil separator before and after coagulation with 140 ppm $FeCl_3$.

Sample code	Sample description	Turbidity (FTU) Before flocculation	After flocculation
A	Rinse after oil separator	55	53
B	Rinse after wash with detergent	95	54
C	Color-add rinse	180	170
D	Final discharge	320	27

The presence of separator fluid results in high COD and BOD content. It also changes its coagulation and settling characteristics. Such a change may necessitate the application of special oil removal equipment prior to its discharge into municipal wastewater treatment facilities.

Literature Cited

1. Anonymous. 1975. A process design manual for suspended solids removal. U.S. Environmental Agency Technology Transfer. Ch 4 p 7.
2. Crandall, P. G., C. C. Niementowski, and P. E. Nelson. 1977. A thermal controller for the short COD determination. *J. Food Sci.* 42:839-842.
3. Grierson, W. and F. W. Hayward. 1959. Evaluation of mechanical separators for cold damaged oranges. *Proc. Amer. Soc. Hort. Sci.* 73:278-288.
4. Ismail, M. A. and W. F. Wardowski. 1973. Phenolic contaminants in Florida citrus packinghouse effluents: Sources and regulations. *Proc. Fla. State Hort. Soc.* 86:300-302.
5. Richardson, D. K. and E. A. Taylor. January 21, 1977. An order relating to fresh citrus fruit damaged by freezing temperatures. Order No. 0-77-5. Florida Citrus Commission, Lakeland, Florida.
6. Taras, M. J., A. E. Greenberg, R. D. Hoak, and M. C. Rand. 1971. "Standard Methods for the Examination of Water and Wastewater" 13th ed. American Public Health Association, Washington, D. C. 20036.
7. Wardowski, W. F. and W. Grierson. 1972. Separation and grading of freeze damaged citrus fruits. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida Circular 372. pp 14.

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PRELIMINARY SOLAR DRYING STUDIES OF SOME FLORIDA FRUITS AND VEGETABLES

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Abstract. **In preliminary experiments Florida grown fruits (peaches and mangos) and vegetables (carrots, celery, green peppers and parsley) were dried with forced ambient air circulation in an enclosed solar dryer using direct solar energy concentrated two- to three-fold by reflectors. Dried products were compared with similar products prepared in a conventional hot-air forced-draft dryer, and with commercial products. Comparisons were based on flavor, color, moisture content, restoration, and shrinkage.**

With increasing fossil fuel costs and decreasing dependability of their supply, alternative forms of energy might become economically feasible for food drying. Flink (5) discussed energy requirements in food dehydration and suggested that conservation of fossil fuels is the first recommended step. However, conservation alone probably cannot continue to compensate for the increasing costs of fossil fuels. Alternative energy sources such as solar could become more feasible and eventually necessary. Florida, with its abundant sunshine and nearly year-round production of fruits and vegetables could be a prime location for application of solar energy for food drying.

Traditional sun drying (direct radiation in the open air) has been practiced for many years and still continues. The food crop is either dried on the plant (grains and field peas), or is harvested, sorted, washed and spread in direct sunshine for drying (raisins and prunes). Problems with open air sun drying such as rain damage and insect infestation, have been discussed by many authors including Cruess (4), VanArsdel (9), and Szulmayer (8). Applying direct radiation, both Khan (6) and Lawand (7) used enclosed chambers with natural air circulation to solar-dry foods. Although their dryers reduced contamination and duration of drying compared with traditional open-air sun drying, air temperature, flow, and humidity were not controlled.

An experimental enclosed solar dryer, using solar radiation, concentrated two- to three-fold by reflectors, and having a forced draft air circulation system, has been designed and installed at our laboratory (2, 3). In these preliminary tests Florida grown fruits (peaches and mangos) and vegetables (carrots, celery, green peppers and parsley) were solar dried. Various quality factors for these solar dried products were compared with reference samples prepared by conventional hot air drying and with commercially available products.

Experimental

Produce and pretreatments

Florida grown carrots, celery, green peppers, mangos, parsley and peaches (May to July harvest) were sorted, washed and pretreated as follows:

Carrots. 1/8 in. (3 mm) and 1/4 in. (6 mm) thick slices were blanched for 5 min with steam at 214°F (101°C).

Celery. Celery leaf (leaves that are currently wasted in the packing of fresh celery) were pretreated the same as carrots. Celery stalk was also pretreated the same as carrots, except only 1/4 in. (6 mm) slices were used.

Green peppers. These were halved with core and seeds removed, then sliced into approximate 1/4 in. (6 mm) cubes. Half the green pepper cubes were soaked in 1.5% sodium metabisulfite for 5 min, and the other half were soaked in water.

Mangos. Fully ripened mangos (Tommy Atkins variety) were manually peeled, and the seed removed by making two slices from stem to stylar end. The two resulting sections of fruit were cut to produce 1/4 in. (6 mm) thick

[1]One of the laboratories of the Southern Region, U.S. Department of Agriculture, Agricultural Research Service.

Mention of a brand name or trademark is for identification only and does not constitute endorsement by the U.S. Department of Agriculture over others which may also be suitable.

slices. These were immediately soaked in 1.5% sodium metabisulfite for 5 min.

Parsley. The top one-third of the plant was removed for drying studies, representative of parsley leaves.

Peaches. These were exposed to steam for 30 sec. at 214°F (101°C), then peeled and halved by hand and pitted. Three portions of peach halves were each separately dipped for 5 min in either: 1) water, 2) 1.5% sodium metabisulfite, or 3) 2.0% ascorbic acid.

Equipment

Solar dryer. The dryer has been described in detail by Beach (2) and Bryan *et al.* (3). It is a single unit consisting of 2 separate chambers, each with a volume of 2.1 ft^3 (0.06 m^3) with independent air circulation ducts. The chambers received both direct and reflected sunlight (beam and diffuse). Each chamber had 2 thermopane glass panels (top and bottom) to permit product irradiation by both direct radiation from the top and reflected radiation from the bottom. The 2 reflectors each had an area of 35.0 ft^2 (3.2 m^2). Food trays for the chambers were made of a six-mesh (3.3 mm) stainless steel screen framed with 0.09 in. (2 mm) thick aluminum and had an effective drying area of 3.3 ft^2 (0.30 m^2) each. A squirrel cage blower (No. 1 1/4 American Blower Corporation) was used for air circulation. Independent planar orientation of the unit and reflectors permitted adjustment to obtain maximum radiation for the geographic location.

Hot air dryer. An atmospheric forced draft, pilot scale, tray-type dryer (National Drying Machinery Company) with an air temp controller (Minneapolis-Honeywell Regulator Company) was used. It had a drying surface composed of 4 separate perforated stainless steel trays each with an area of 5.0 ft^2 (0.46 m^2).

Drying tests and conditions

In preliminary tests with the experimental solar dryer carrots, celery leaves, green peppers, mangos, and parsley tops were dried for about 6 hr, while peaches were dried for about 16 hr in separate exposures over a 3 day period. Table 1 shows test variables (slice thickness and tray loading) and average drying conditions (air temperatures and insolation). For carrots, both slice thickness and tray loading were varied, while tray loading only was varied for celery leaf, green peppers and parsley tops. Both mango slices and peach halves were solar dried at a tray load representing an almost continuous single layer.

Average air temp are listed in Table 1. Air flow to the dryer (each chamber) for all tests (except mangos) was 100 ft^3/min (2.8 m^3/min). For mangos *air flow was reduced* to 50 ft^3/min (1.4 m^3/min). Differentials between inlet and exhaust air temp ranged from 13 to 20°F (7 to 11°C). Air inlet humidities for all tests averaged 58% R.H. with a range of 52 to 61%.

Average insolation values shown in Table 1 represent the value taken for radiation during the particular drying period. These ranged from 130-250 Btu/ft^2/hr (0.59-1.1 cal/cm^2/min). Instantaneous readings varied from 50-330 Btu/ft^2/hr (0.23-1.5 cal/cm^2/min) depending on weather conditions.

Celery stalk was dried using solar drying, conventional hot-air drying, and combinations of these methods. When combinations of both drying methods were used, the intermediate product was stored overnight at 48°F (9°C) before completing drying. Drying conditions were: 1) solar drying only—13 hr, 2) solar drying—6 hr followed by conventional drying—3 hr at 165°F (74°C), 3) conventional drying—2 hr at 175°F (79°C) followed by solar—8 hr, and 4) conventional drying—2 hr at 175°F (79°C), then 4 hr at 165°F (74°C). The hot air dryer had an air velocity of 1000 ft/min (305 m/min) and 90% air recirculation. When used for other samples air temp was 165°F (74°C).

Analyses

Moisture content. A vacuum oven method was used [16 hr at 140°F (60°C) at a pressure of 10 mm Hg]. Samples were weighed before and after and % weight loss on a wet-weight basis was assumed to represent moisture content. A wet basis was used for all moistures.

Ascorbic acid. Five—10 g samples were ground in 50 ml buffer for 1 min, and titrated with standard 2,6-dichlorobenzenone indophenol to potentiometric end point [modification of the AOAC Method (1)].

Shrinkage. Volume reduction of samples of celery stalk

Table 1. Preliminary solar drying tests and conditions.

Sample	Test	Form	Loading Kg/m²	Average air Temperature Inlet °C	Average air Temperature Exhaust °C	Average Insolation Cal/cm²/min	Final Moisture %
		Slice, mm					
Carrots	1	3	1.9	29	39	1.0	9
	2	3	3.8				10
	3	6	3.8				27
	4	6	7.6				40
Celery leaf	1	6	2.4	29	38	0.6	12
	2	6	4.8				35
	3	6	7.2				44
		Cubes, mm					
Green peppers	1	6	4.5	29	36	0.9	11
	2	6	9.1				42
		Tops					
Parsley	1	1/3	1.2	30	42	1.0	9
	2	1/3	2.4				14
		Slice, mm					
Mangos		6	5.7	33	43	1.1	41
Peaches		Halves	10.8	30	40	1.0	19

and mango slices were estimated from average measurements of product dimensions before and after drying.

Rehydration ratio and percent restoration. Dried samples were boiled for 10 min using 10 g sample/300 ml deionized water, drained on a stainless steel screen for 10 min, and weighed. Calculations were made as described by Wilson (10).

Flavor. Eight trained panelists were asked to evaluate the flavor of samples on a hedonic scale of 1-5 (1 = good flavor, 5 = poor). Samples for taste evaluations were prepared as follows:

Dried celery stalk slices were rehydrated in 3% salt (NaCl) solution. Three samples, solar dried, solar plus conventionally dried, and conventional plus solar dried, were presented to each panelist and a conventionally dried sample was used as reference.

Three solar dried peach samples, without preservative, with SO_2, and with ascorbic acid, were presented in random order to each panelist, as were quarters of commercially dried peaches (California peaches preserved with SO_2). The commercial sample was identified and used as reference.

Half slices of solar dried and conventionally dried mango were randomly selected for each panelist and the conventionally dried mango half slice was identified as reference.

Results and Discussion

Preliminary studies have been made on an experimental approach for solar drying of fruits and vegetables. This technique uses both direct and reflected radiation to increase solar energy by two- to three-fold and forced air circulation to remove moisture. Just as Khan (6) and Lawand (7) found with direct radiation and natural air circulation, drying duration can be greatly reduced compared to traditional sun drying. In initial comparisons, quality (flavor, rehydration and restoration) of solar dried samples was, in most cases, comparable or better than conventionally dried samples. The solar dried fruits and vegetables in this preliminary study all showed potential of excellent dehydrated products.

Final moisture contents for the fruits and vegetables are shown in Table 1. Results from carrots of the same thickness in tests 1 and 2 indicate little difference in final moisture, thus neither loading had reached maximum capacity. Comparing tests 2 and 3 for carrots at the same loading with different slice thickness, a substantial difference was noted between final moisture contents, (10% and 27% respectively). In the last comparison with carrots a large difference was also observed between final moisture contents of different tray loadings. Influences of material thickness and loading on final moisture were similar to those expected in conventional hot air drying.

The influence of tray loading was also shown for celery leaf, green peppers, and parsley tops. In all of these the lower moisture content corresponded to the lower tray loading. Final moistures (9-12%) shown in test 1 for each of the vegetables are high in comparison with the standard 5% moisture of commercial products, but the 19% moisture of peaches was lower than that of the commercial product (25% moisture). Mangos, with their high sugar content, should probably have a moisture content the same as peaches but had a higher moisture in these preliminary tests.

Table 2 shows effects of combinations of solar drying (S) and conventional hot air drying (C) on moisture content of sliced celery stalk. All combinations of S and C resulted in products with acceptable moisture content while the sample dried by S alone did not. These results confirm the possibilities of combining solar with fossil energy sources to produce acceptable products. In addition an auxiliary source of energy would assure continuous energy supply on days with low insolation.

Table 2. Influence of combinations of solar drying (S) and conventional hot air drying (C) on moisture content of celery slices.

Method and Duration	% Moisture		
	Initial	Intermediate	Final
6 hr C	93.9		2.7
6 hr S + 3 hr C	93.9	74.7	4.3
2 hr C + 7.7 hr S	93.2	76.5	3.7
12.8 hr S	93.2		8.4

Physical properties such as rehydration ratio, coefficient of restoration, and shrinkage (size reduction), and the chemical property of ascorbic acid content are shown in Table 3. Drying method combination or sequence for celery stalk had no significant effect on rehydration ratio, restoration coefficient or shrinkage; but ascorbic acid content was highest in the C sample and extremely low in the S sample. Differences in ascorbic acid retention may be due to drying time required. The C sample had highest ascorbic acid and shortest drying time, while the S sample had the lowest ascorbic acid and the longest drying time.

Table 3. Physical properties, moisture and ascorbic acid content of dried products.

Product[z]	Rehydration ratio	Restoration coefficient	Shrinkage %	Moist %	Ascorbic acid mg 100 gm
Celery stalk					
C and S	4.0	28	95	3.7	4.2
S and C	3.8	24	94	4.3	3.8
S	3.8	28	94	8.4	0.7
C	4.0	25	90	2.7	4.6
Peaches					
S SO_2	2.0	26	—	19	—
S ascorbic acid	2.1	23	—	19	—
S	2.3	26	—	18	—
Commercial SO_2	1.6	—	—	25	—
Mangos					
S SO_2	2.3	50	81	41	14.8
C SO_2	2.4	44	87	31	14.3

[z]C: Conventional hot air dried; S: Solar dried.

Solar dried peaches showed little variation in rehydration ratios and coefficients of restoration. Rehydration ratios for the Florida samples were much higher than the average ratios of three commercially dried California samples. In the case of conventional dried peaches restoration could not be calculated because moisture content of the fresh peaches was unknown. Because of sample configuration no reliable estimates of shrinkage could be determined, and ascorbic acid values were not compared because storage times and conditions were not known for the commercial samples.

For mango products, no unusual differences between the physical properties of the S and C samples were noted (Table 3). Likewise, there were little differences in ascorbic acid content.

Average flavor scores are listed in Table 4 for dried celery, peach and mango samples. Although no significant differences were observed between the celery samples with different drying combinations, average scores of all approached the admissable or acceptable range. Flavor evaluations on peach samples indicated these products were acceptable. Differences in flavor scores between peach samples with the SO_2 and water dip, although not significant, could indicate a color bias. Panelists were given these samples with no instructions regarding color differences. Both the color of the SO_2 and ascorbic acid dipped samples were much closer to fresh peach color, with a more pleasant bright yellow hue, than the other dried samples which were darker and more brownish. The average score for mangos indicated that the flavor was acceptable, but no commercial samples were available for comparison.

Table 4. Average flavor scores on rehydrated celery stalk, mangos and peaches.[z]

Celery (rehydrated)			
Drying method[y]	C + S	S	S + C
Score	3.4	3.5	3.0
Peaches			
Pretreatment	SO_2 dip	Ascorbic dip	Water dip
Score	2.0	2.4	3.1
Mangos			
Pretreatment	SO_2 dip		
Score	1.6		

[z]Flavor scores were based on a hedonic scale of 1-5 (1 indicates a sample that is desirable, while 3 is an acceptable sample), and averages were obtained from eight panelists.
[y]C = conventionally hot air dried; S = solar dried.

Although no formal tests were made on carrots, green peppers and parsley, informal comments on odor and appearance indicate that they were liked more than their equivalent commercial counterparts.

In conclusion, preliminary solar drying tests have been made on two fruits and four vegetables grown in Florida. These tests with an experimental dryer, with solar energy increased two- to three-fold over direct radiation and forced air circulation, indicated acceptable dried fruits and vegetables can be produced by this method. Studies on combinations of solar with conventional hot air drying confirmed the possibility of maintaining acceptable *product quality* and feasible drying time while decreasing energy costs by augmenting with solar energy. These preliminary studies suggest further studies of such drying combinations, may lead to development of new methods of food dehydration beneficial to the food industry as more traditional energy sources are depleted.

Literature Cited

1. Association of Official Analytical Chemists. 1970. Official methods of Analysis, 11th ed., Washington, D.C. pg 777.
2. Beach, C. D. 1977. An experimental apparatus for direct solar drying. *Proceedings of the Flat-Plate Solar Collector Conference, Orlando, Florida,* March 1977 (in press).
3. Bryan, W. L. 1978. JASAE (in press).
4. Cruess, W. V. 1948. Commercial fruit and vegetable products. 3rd ed., McGraw-Hill Book Company, Inc., pg. 472-508.
5. Flink, J. M. 1977. Energy analysis in dehydration processes. *Fd. Technol.* 31(3):77-84.
6. Khan, E. U. 1964. Practical devices for the utilization of solar energy. *Solar Energy* 8:17-22.
7. Lawand, T. A. 1966. A solar-cabinet dryer. *Solar Energy* 10(4): 158-164.
8. Szulmayer, W. 1971. From sun-drying to solar dehydration. *Fd. Tech. in Australia* 23:440-441, 443.
9. Van Arsdel, W. B. 1963. Food Dehydration. Vol. 1. Principles, The Avi Publishing Company, Inc. pg 1-3.
10. Wilson, C. W. III. 1965. Dehydrated celery: improvement in texture and rehydration. *Fd. Tech.* 19(8) :98-101.

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POINT-OF-PURCHASE ADVERTISING MATERIALS FOR FRESH PRODUCE: RETAILERS' PREFERENCE[1]

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Abstract. **An estimated $1 million will be spent during 1977 for point-of-purchase (POP) advertising material to promote Florida agricultural products. Commodity organizations with modest budgets cannot afford effective television, radio, or newspaper promotion campaigns, but these groups can afford POP advertising.**

A primary concern among POP advertisers is retail acceptance and use of their materials. Several sources estimate that no more than 25% of POP materials sent to retail firms is actually used, even though the materials are provided at no cost.

This research reports on the types of POP advertising materials preferred for fresh produce items by produce merchandisers of 38 major food retail firms in five major U.S. markets for Florida produce. Results can be used by agricultural commodity groups to develop POP materials that better fit the needs and preferences of major retailers.

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Fifteen years ago, U.S. agricultural groups spent an average of 10% of their annual budgets on point-of-purchase (POP) advertising (7). Although current, precise figures on POP advertising by agricultural commodity groups are not available, some Florida commodity groups spend considerably more than 10% of their total budgets for POP advertising. It is estimated that approximately $1 million will be spent during 1977 for POP advertising material to promote Florida agricultural products. Commodity organizations with modest budgets cannot engage in effective television, radio, or newspaper promotion campaigns because of costs. However, smaller organizations can afford to use POP advertising.

A primary concern among POP advertisers is retailer acceptance of their material. A major U.S. food retailer interviewed by Florida Agricultural Market Research Center personnel estimated that only 25% of the ROP advertising material received by his firm was utilized. Others also said much was wasted, which agrees with previous research (5). There are very few recent published reports that deal specifically with the use of POP material for produce items. One study attempted to measure the overall effect of POP advertising on sales of fresh grape-