**California Avocado Society 1970-71 Yearbook 54: 79-84**

# RESEARCH ON AVOCADO PROCESSING AT THE UNIVERSITY OF CALIFORNIA, DAVIS

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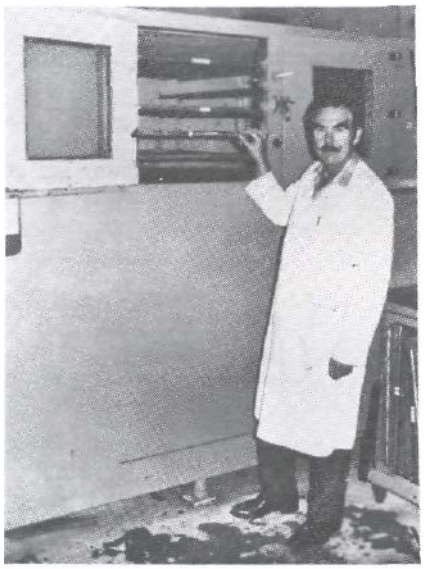
Avocados are grown in many countries of the world and are consumed principally as fresh fruits. In marketing fresh avocados, imperfect and odd-sized fruits are usually rejected. In addition, the fruits selected require special handling because of their highly perishable nature. Therefore, the development of new avocado products and of improved methods of preservation are of interest to avocado growers. Better utilization of cull and surplus avocados is of particular importance to developing tropical countries where, as compared to California, labor costs are lower but adequate storage and transportation facilities are lacking.



Professor L. M. Smith and dehydrator.

Much experimental work in California, Florida, Hawaii, and Israel has been directed toward development of products that might profitably utilize the cull or surplus fruits. Unfortunately, avocados are not well adapted to canning or most other means of preservation. Undesirable changes in flavor, texture, or color occur. However, the recent development of a freon freezing technique appears promising as a means of preserving

fresh avocados in California. This method is presently being studied in the Department of Food Science and Technology at U.C. Davis. The possibility of utilizing avocados as a source of edible oil also is being explored. Obviously, the economics of avocado production in California presently precludes the production of fruits for avocado oil, but production might be feasible in a developing country such as Indonesia. This report summarizes our recent research on freon freezing of fresh avocados and on the preparation of dehydrated avocado tissue as a source of edible oil.

## Preservation by Freon Freezing

Freezing of avocados is being studied along with that of individually Quick Freezing (IQF) of other fruits and berries. Although earlier conventional methods of freezing by frigid air or plate methods have proved satisfactory for meats, vegetables, and fruits immersed in syrup, two problems are inherent in freezing individual sections of products such as avocados or other fruits that are to be eaten uncooked. One is the formation of large ice crystals in a slow freeze, and the other is discoloration upon thawing. The ice crystals result in a breakdown of texture, while the discoloration, besides its lack of esthetic appeal, is accompanied by off-flavors. Very rapid freezing results in smaller ice crystals and better retention of texture, but discoloration upon thawing still remains a problem.

In recent years, rapid freezing by nitrogen, carbon dioxide, or freon has provided a means of texture retention. In our experiments we have used freon, a colorless liquid at low temperatures that boils at approximately -22°F. Its use has been approved by the Federal Food and Drug Administration. To improve color and flavor retention, we have dipped the fruits in an antioxidant solution of ascorbic acid (vitamin C) and malic acid (a naturally occurring acid in fruits and vegetables) prior to freezing.

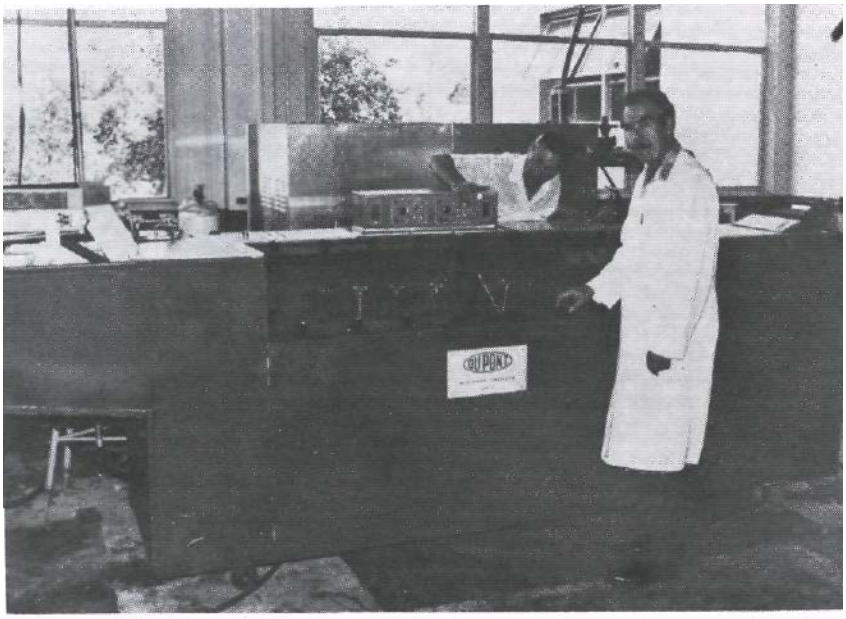



Figure 1. Equipment used in freon freezing of fresh peeled and halved avocados.

Figure 2. Cabinet dehydrator used to dry avocado pieces.

Locally purchased 'Hass' and 'Fuerte' varieties of avocado were halved, pitted, and peeled by hand, and then treated with different combinations of ascorbic and malic acid for various lengths of time. The tissue was then sprayed with freon in a du Pont Minimark Freezer, a small version of their larger commercial freezer (Figure 1). Freezing time was between three and four minutes.

Results to date indicate that the freon method of freezing, with proper antioxidant pre-treatment, will produce a product comparable to fresh fruits. However, storage stability studies will not be completed for some time. Frozen samples are being held in $0^{o}F$ storage for further evaluation at various time intervals up to one year.

Of interest, is our research in IQFing tropical fruits other than avocados. Frozen salads prepared with avocados and fruits such as citrus, papayas, or mangoes, offer interesting possibilities for institutional and restaurant trade as well as for regular retail sales.

**Avocados as a Source of Edible Oil**

This research involved (1) development of a suitable method to preserve avocados, (2) experiments to determine the storage stability of the dehydrated material, (2) recovery of the avocado oil, and (4) refining and evaluation of the oil.

Dehydration was selected as the best means of preserving avocados until the oil could be recovered.

In developing countries, especially, some means of preservation is essential since the capacity to handle large amounts of fruits is lacking. In addition, we have found that the oil can be recovered more simply from dried rather than from fresh avocado tissue. A steam-heated cabinet dehydrator was used (Figure 2). The avocados were of the 'Hass' and 'Fuerte' varieties and were purchased locally. To study the effect of size of avocado piece on drying rate at 158°F, the individual fruits were cut into two, four, or eight pieces. Moisture concentration in the several lots was determined at intervals up to 120 hours dehydration. Time required to reduce moisture to 10% was 275, 260, and 245 hours, respectively, for the halves, quarters, and eights. The one-eighth size was selected for further study since it dehydrated quickly and was a convenient size to handle.

The two methods of drying the avocado pieces were compared. In method A, the pieces were kept at 230°F for 4 hours; then the temperature was lowered to 194° for 8 hours and finally to 158° for the remainder of the drying period. In Method B, the temperature was kept constant at 158°F. The pieces dried by Method A were "puffed" in appearance (see Figure 3) and had a brittle texture. In contrast, those prepared by Method B were shriveled and tough.

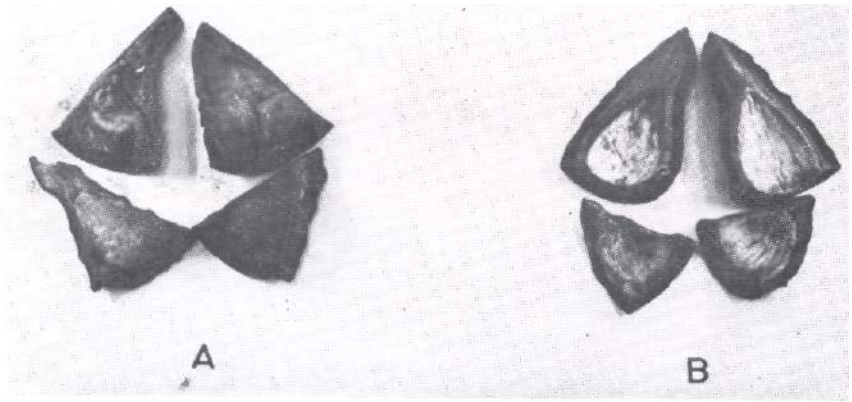



Figure 3. Avocado pieces dehydrated by Methods A and B as described in the text.

To compare storage properties of the dehydrated pieces, samples were stored for two months at 86°F and relative humidities of 63, 65, 80, and 83%. Samples dried by Method A absorbed moisture at 80% and 83% R.H. more readily than did those prepared by Method B. At 63 and 65% R.H., Method B samples lost moisture more readily than did Method A samples. Based on these results and on the lower specific volume of pieces dehydrated by Method B, this procedure was used in all subsequent storage experiments.

Samples of avocado pieces initially dehydrated to 19.7, 11.5, and 4.7% moisture were analyzed for moisture content and inspected for presence of mold at intervals during two months of storage at 86°F and 67, 74, and 100% R.H. No mold growth occurred at 67% R.H. At 74% R.H., samples with 19.7% initial moisture had mold growth after two weeks, but samples initially at 11.5% or 4.7% did not develop mold during the storage period. All samples stored at 100% R.H. produced mold growth after one week.

We concluded that dehydrated avocado pieces can be stored satisfactorily up to two months at 86°F without mold growth, providing the initial moisture content is low (11.5% or less) and very humid air (over 74% R.H.) is kept from the product.

We have used various methods to extract or recover oil from avocados. In 1962, Montano, Luh, and Smith (1) reported on a method of direct extraction from fresh avocado tissues, using a mixture of 95% ethanol and hexane. Since such methods require facilities to store and recover volatile solvents, the possibility of using simpler pressing procedures to recover oil was explored. Samples of ground, dehydrated avocado wrapped in canvas or placed in a perforated metal cylinder equipped with a piston, were pressed with a Carver laboratory press. Recovery of oil was not efficient with either procedure. Approximately 24% of the oil originally present in the ground avocado was left in the press cake. Undoubtedly, the use of a continuous screw press would improve oil recovery. We anticipate that the press cake would be valuable as a feed for poultry or livestock.

The crude avocado oil was dark green, with a pleasant avocado smell but a bitter taste. The oil was degummed with acetic anhydride and then bleached with a mixture of Fullers Earth and activated carbon. After this refining process, the oil was light green (0.30 ppm chlorophyll) and had both an agreeable taste and smell. Experiments to

determine the oxidative stability and other physical and chemical properties of the refined oil are in progress (2).

From the above studies it appears that dehydration is useful as a means of preserving avocados prior to pressing for recovery of oil. An edible oil can be obtained from the crude oil by simple refining procedures.

**Acknowledgments**

The research on IQF freezing of fruits was supported by the American Frozen Food Institute. Du Pont generously made available their Mini-mark Freezer and supplied the freon used.

The research on avocados as a source of edible oil was supported by the Agency of International Development. United States Department of State. Thanks are expressed to Professors Martin A. Miller and Leonard L. Morris for valuable advice and suggestions.

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