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Investigations on the Utilization of Cull Avocados

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In recent years the production of avocados has greatly increased and this fruit is now becoming so well known through its distribution by grocery stores and fruit stands that most customers now know them as avocados rather than as "alligator pears." Because of increasing production it has become necessary to extend the marketing of this fruit, a need that has been met by the formation of the effective and active Calavo Growers of California, very ably managed by George B. Hodgkin.

Mr. Hodgkin has realized that strict grading and the packing of only high quality fruit for the fresh market are the first fundamentals of the successful distribution of any fresh fruit and these principles have been put into practice. As the crop continues to increase, grading must become even more rigid and exacting. This naturally results in the accumulation of important quantities of culls, most of them fruit of sound condition and edible but blemished, misshapen, very small or under the legal limit in oil content. The small Mexican varieties, in time, may be unable to compete profitably with the larger varieties. From these two sources, culls and small size varieties, there will soon 'be at the present rate of increase, according to Mr. Hodgkin, sufficient fruit for commercial utilization in byproducts. He has wisely chosen to investigate such by-products before the cull problem has reached the acute stage and it has been very largely at his request that the investigations reported in this paper were undertaken.

Early Investigations—In 1914 and 1915 S. K. Mitra, a graduate student at the University from India, became interested in the study of the preservation of avocados as a means of extending the season for this important fruit in his own country and under the direction of the senior author conducted numerous experiments on canning, drying, salting, pickling, etc., of avocados. The results are to be found in the Proceedings of the 1916 Annual Meeting of the California Avocado Association. Mitra's avocado products soon lost their fresh flavor, or color or both and in time took on a disagreeable acrid taste. Only two products gave much promise; these were avocado slices packed in glass in a moderately sweet syrup acidified with lemon juice and pulp or slices in liquid acidified with vinegar. The experiments with vinegar were conducted after the meeting referred to above and have not been published heretofore.

Dehydrations—Investigations on the dehydration of avocados were conducted by A. W. Christie and E. H. Guthier several years ago. None of the dehydrated products were entirely satisfactory and most of them were of disagreeable flavor. There investigations were published in the Los Angeles Times several years ago.

Preservation in Freezing Storage—Many fruits are preserved for use in the making of ice cream and for the preparation of jams, jellies and preserves, by storing at a freezing

temperature, usually below 15°F. We have found that avocado pulp prepared by peeling and pitting the fruit, grinding in a food chopper, and adding a small amount of cider vinegar or of sugar keeps well in sealed containers, glass or enameled tin preferred, at 0-10°F. The sweetened pulp is thoroughly satisfactory for use in ice cream and the pulp containing vinegar is suitable for a base for sandwich fillings. Sugar 1 part by weight to 3 of fruit or cider vinegar 1 part to 5 of fruit are satisfactory.

Pulp lightly salted did not retain its fresh flavor very well and was decidedly inferior to that mixed with a small amount of vinegar or sweetened with a small proportion of sugar. It has found necessary to allow in the containers only enough room for expansion during *freezing;* excessive head space in the jar or can permitted browning of the pulp at the surface. For the same reason it was equally necessary to tightly seal the containers in order to exclude air. Browning by oxidation is one of the serious problems connected with the preservation of all avocado products. Vacuum sealing of the jars will reduce the darkening.

Use of Avocados in Ice Cream—In co-operation with Professor G. D. Turnbow of the University Farm, it was found that avocado ice cream has much to commend it to the ice cream trade. We do not claim originality for avocado ice cream, as it is fairly well known in Southern California through the efforts of the Association to introduce it through their banquets and in the leading hotels.

Either the fresh fruit or that preserved by freezing storage may be used. In using the fresh fruit the following procedure has proved satisfactory in our tests. The fruit is peeled, pitted, and is then ground in a food chopper rather finely. Before it has had time to turn brown in color by oxidation it is used in the cream as follows. An ordinary vanilla ice cream mix is prepared as for vanilla ice cream, except that the vanilla flavor is omitted. To the ground avocado pulp is added 1 pound of sugar to each 3 pounds of pulp and the sugar is stirred in until well dissolved. Of this sweetened pulp about 18-20 per cent by weight is added to the ice cream mix, preferably after the mix has been added to the freezer and the paddles have been set in motion. For 10 gallons of finished cream use 36 pounds of the basic mix and to this add 9 pounds of the prepared avocado pulp. Freeze to 100 per cent "over-run," that is the mix and the pulp equal about 5 gallons before freezing and about 10 gallons after freezing. There need be no worry about the cream containing the minimum of 8 per cent fat required by law for fruit ice creams, because the avocado pulp itself will exceed this amount and the usual vanilla mix contains about 10½ per cent butterfat.

The cream is best when not frozen too hard and when served soon after freezing; it tends to darken on long standing and to acquire a stale flavor. Used fresh or within three or four days it is a cream of rich flavor somewhat like pistachio nut ice cream, of rich light green color and in general a "quality product" well worthy of gracing the menu of the Biltmore or the Ritz-Carlton. Yet it need not be expensive as the following consideration will indicate.

The ice cream trade pays for crushed cold pack berries about 15 cents a pound. Possibly this would be a fair price for the avocado pulp. It must be taken into account that the 9 pounds of avocado pulp replaces an equal amount of ice cream mix. This itself is valued at not less than 10 cents a pound. Most fruit ice cream formulae call for

45 pounds of mix, plus fruit and freezing to 10 gallons that is less than 100 per cent "over-run." In the formula given above, it will be noted that a total of only 45 pounds of mix and fruit is used for 10 gallons of cream. Taking all of these considerations into account, the avocado pulp at 15 cents a pound would increase the cost of the cream not over 5 cents a gallon compared with the cost of plain vanilla ice cream, or on the quart not over 1¼cents and on the serving a small fraction of a cent, an increased cost that we believe could be absorbed readily in the average factory.

The cold pack avocado pulp, that is the crushed pulp sweetened with 1 pound of sugar to 3 pounds of pulp and held until needed in sealed containers at 0-10°F., is used in the same proportions and manner as directed for the fresh pulp. The only precaution to be observed is to make certain that the pulp is well thawed and contains no ice crystals at time of addition to the mix.

Avocado *Cocktail*—As a result of rather extensive advertising and demonstration by the Avocado Association avocados are now quite generally used in cocktails to replace oysters in this classic dish. We are here to state that an avocado cocktail thus prepared is in no way inferior in flavor to its more famous relative the oyster cocktail and is, we believe, more readily digested. It occurred to us that perhaps the avocado when placed in oyster cocktail sauce might retain its flavor and other characteristics of the fresh fruit more satisfactorily than if put up unflavored.

Experiments proved this to be reasonably correct, although it was found necessary to considerably increase the acidity by the addition of vinegar in order to prevent fermentation. The addition of approximately 2 per cent of acetic acid in the form of vinegar prevented such spoilage and at the same time did not render the cocktail too sour "for comfort." We soon found that the avocado pulp exerts a strong "buffer effect" on the acid added; that is, added vinegar is not so apparent to the taste in avocado pulp as in, let us say, sliced beets. Also on account of this buffer effect, more vinegar is required to prevent fermentation than is required for the same purpose in other common foods. Using strong cider vinegar of 10 per cent acidity or 100 "grain strength" approximately 5 fluid ounces will be required for each pound of the cocktail sauce avocado mixture.

The avocado is prepared by slicing the peeled and pitted fruit, adding cocktail sauce to cover and then 100 grain vinegar in the proportion given above, mixing well. The vinegar should be of the best grade obtainable and well aged before use so that the flavor will be satisfactory.

The pulp should be packed in glass containers at once and sealed tightly to exclude air in order that oxidation of the color will not occur. In very warm climates the cocktail should be stored in a refrigerator at 32°F. or a small amount, about 1/10 of 1 per cent of sodium benzoate, should be added in order to prevent fermentation or molding. One tenth of 1 per cent ben-2oate corresponds to about 0.4 ounce of the bensoate to 25 pounds of the cocktail.

It is believed that this product has greater possibilities for use in restaurants and hotels than as a household product, and if prepared for such a trade it could be readily held in cold storage warehouses at 32°F. until required for the hotel and restaurant trade. Also the addition of vinegar would then not be necessary; the cold would preserve the

product a reasonable length of time.

Cocktail sauce is prepared in bulk by several commercial canners and could be obtained in quantity at moderate cost.

Avocado Mayonnaise—Avocado pulp finely ground through the nut butter attachment of a food chopper and whipped into ordinary mayonnaise gives a mayonnaise deluxe. We find that if to the avocado mayonnaise is added vinegar in a proportion to give l½ per cent additional acid the product keeps well at room temperature. The proportion of pulp to ordinary mayonnaise is about 2 of avocado to 1 of mayonnaise and of vinegar (10 per cent best distilled vinegar or 100 grain strength), about 3½ fluid ounces to each pound of the mixed mayonnaise. The proper method of preparing this mayonnaise would, of course, be in mayonnaise factories where about 2 thirds by weight of avocado pulp could be added to the regular mayonnaise mix of oil, egg, vinegar, salt, etc., and beaten in with the mayonnaise in the regular manner. Somewhat more vinegar than is customary with ordinary mayonnaise should be added; the exact amount could be readily determined by experiment.

The avocado mayonnaise can be used in the same manner as any mayonnaise on salads, in sandwich spreads, etc.

Sandwich Spreads—Our first work had for its main purpose a product that could be used in salads or in sandwiches. Our early results were so disappointing that we had nearly given up the problem as hopeless. The products all acquired sooner or later (and generally sooner than later) a very disagreeable acrid, stale taste that rendered the mixture, whatever its nature, almost inedible.

Finally about two years ago we decided to repeat Mitra's work using the principle developed by him as a result of a suggestion by one of us (W. V. Cruess) in 1915; the principle being acidification of the product with vinegar to the point where the undesirable changes in flavor were arrested and masked by the vinegar. This "lead" has proved a very fruitful line of attack. We soon found that the vinegar "did the trick;[1]" it prevented almost completely the undesirable changes in flavor, although it must be admitted it permitted bleaching of the color from the well known light green to a pale yellow or cream color. Also there was some softening of the flesh through continuation of the ripening process, even in the presence of the vinegar, so that the straight pulp-vinegar mixture was somewhat too soft for use in sandwiches satisfactorily. This defect and that of color also were overcome to a marked degree by the addition of coarsely ground sweet cucumber pickles, free of onion. Onion (it was found by Miss Harrold) is not compatible with the avocado flavor.

The formula that has given the best results in Miss Harrold's tests is the following:

5 pounds of coarsely ground avocado pulp
1 pound of medium ground sweet pickles.
1 pound of mayonnaise
1 pound of ground canned pimento
1 ½ pints of best grade 100 grain vinegar

Further work is now being done to increase the proportion of avocado!

*Canning *of Avocados*—Canning would appear to be a convenient and logical manner

of preserving avocado meat. We tried many different methods. One series consisted of canning the peeled and pitted halves or quarters in brines of various strengths, heating the canned product to various temperatures and for various times to sterilize it. Without exception all spoiled; either the canned product "blew up" from bacterial action or took on the disagreeable acrid taste previously mentioned.

We tried canning the slices in diluted vinegar and preserving by heat. While it was possible to prevent bacterial spoilage even at 180°F., the flavor of the products was unsatisfactory.

We also tried canning in syrup. In plain syrup the fruit promptly-spoiled by bacterial growth. However, when the syrup was heavily acidified with lemon juice and the canned product sterilized at 175-180°F. it kept well, but to say the least the canned product was a "novelty." It was neither "fish nor fowl;" while it tasted like avocado, probably no one would want to eat such a product; it would be like eating any salad product such as cucumbers or olives with sugar and cream — it "just isn't done."

The pulp canned and sterilized without addition of any other substance was too soft and of poor flavor.

Pasteurizing in Glass—Packing in glass jars in diluted vinegar and pasteurizing at 175°F. for 30 minutes gave better results than packing in tin, but the results even with the glass were not entirely satisfactory.

Summary and Conclusions

Since 1914 experiments on the preservation and utilization of surplus avocados have been conducted with the following results:

1. The pulp kept well at 0-10°F. when sweetened with 1 part of sugar to 3 of pulp, or acidified with vinegar and sealed in glass containers. This sweetened product is satisfactory for use in ice cream and the sour product for use in sandwiches.
2. Cooperative experiments with the Dairy Industry Division gave an excellent ice cream made either with the fresh or with the sweetened cold pack pulp.
3. Sliced avocado in cocktail sauce acidified with vinegar kept well, but further study of this product is necessary.
4. Mayonnaise made with very finely ground avocado pulp commercially prepared mayonnaise and vinegar was pleasing in flavor and appearance and kept well.
5. A sandwich spread prepared with coarsely ground avocado pulp, ground sweet cucumber pickles, mayonnaise and vinegar was attractive in appearance, pleasing in flavor and of good keeping quality.
6. Dehydrated avocados did not retain the flavor of the fresh fruit satisfactorily, but dehydration is a logical step in oil making.
7. Canned avocados did not appear to have the qualities desired. They either spoiled through bacterial action or acquired a disagreeable flavor or if put up in syrup not of the flavor desired.

*Numerous canning experiments were also made by A. Matthew, a graduate student,

in 1924; all with unsuccessful results.