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# FURTHER INVESTIGATIONS OF THE COMPOSITION AND FOOD VALUE OF THE AVOCADO

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The data here reported represents the partial results of chemical studies of the avocado which have been carried on at our station. The complete analysis, physical and chemical of each sample is on record and will be published later by the University. For the present brief discussion, however, the oil content seems to be the most important. Credit is due to Miss Stover, former assistant in the laboratory, and Mr. Albro, at present associated with the Nutrition Division, for the analytical work.

The results of 95 analyses are summarized in the accompanying tables. Tables Nos. I and II refer to those varieties which are generally supposed to mature in the late summer and fall and Table No. III to those varieties whose season is the first half of the year. In Table No. I the figures relate to but one sample, quite often to but one fruit, while in Table No. II they indicate analyses of two or more samples of the same fruit. The tabulated data might best be discussed under several different heads:

A. Total amount of oil.

B. Content of oil in seedlings vs. that in the known varieties.

C. Oil content of large fruit as compared with that of small fruit.

D. The development of the oil in the fruit during the ripening process.

## A. The total amount of oil

The highest percentage noted, 31.60, is to be credited to the Purdy variety from Whittier. This is a small fruit analyzed on the 9th of this month. It must be remembered, however, that only one fruit was analyzed. It is our intention to make further analyses of the Purdy in order to ascertain whether or not this high percentage will obtain. The nearest approach to the oil content of the Purdy in the spring varieties is noted for the Miller with an oil percentage of 27.45 and the Knowles from Santa Barbara 27.11. If we omit from the discussion the Knowles and the Miller, it will be observed that the spring varieties do not range as high in oil as do the fall varieties. Before such a statement can be considered as a fact, however, it will require more thorough investigation which the station will be only to glad to undertake. Furthermore it will be noticed that more analyses have been made of the fall varieties than of the spring and there are a greater percentage of immature and unripe representatives of the latter class.

The Chappelow ranks next to the Purdy as far as the oil content is concerned—the Northrop with 27.60 per cent the next highest. The lowest content of oil noted for fruit stated to be fully ripe is in the case of the Beauty from Orange, showing 15.25 per cent.

In view of the fact, however, that the determination on the Beauty included but one fruit it will be necessary to make more examinations in order to have enough data to warrant the drawing of dependable conclusion. From the present figures it would appear that there is a range of from 15 per cent to 31 percent in the different varieties, said figures based on ripe fruits in all cases.

TABLE I.—SHOWING PERCENTAGE OF OIL IN THE AVOCADO

Varieties Maturing July-December.

Single Sample of Fruit Submitted.

A. KNOWN VARIETIES

| Variety | Locality | Condition of fruit | Date | Wght. of fruit grams | Percent of oil |
|---|---|---|---|---|---|
| Azusa | Azusa | Badly shrunken | 11-19-16 | 198 | 21.06 |
| Bartley | Santa Ana | mature | 7-31-16 | 928 | 13..35 |
| Beauty | Orange | fully ripe | 8-21-15 | 439 | 15.26 |
| Cardinal | Florida | flesh soft | 11- 9-14 | 587 | 10.70 |
| Champion | Orange | ripe | 8-12-15 | 524 | 16.54 |
| Fowler | Pasadena | ripe | 11- 2-14 | 132 | 21.20 |
| Mattern | | ripe | 10-22-14 | 96 | 25.70 |
| Pomona | Sacramento | fully ripe | 10-19-16 | 80 | 25.36 |
| Purdy | Whittier | fully ripe | 10- 9-16 | 168 | 31.60 |
| Purple Prolific | Orange | ripe | 8-21-15 | 219 | 19.93 |
| Topa Topa | Nordhoff | flesh soft | 10-21-14 | 125 | 15.48 |
| Trapp | Florida | flesh hard | ..... | 638 | 9.80 |
| Ultimate | Orange | flesh soft | 8-20-15 | 290 | 14.51 |
| White | Santa Barbara | flesh hard | 10-26-14 | 166 | 14.64 |
| | | B. SEEDLINGS | | | |
| Seedling 1 | Carpinteria | fully ripe | 10-22-14 | 150 | 27.89 |
| Seedling 2 | Carpinteria | flesh hard | 10-22-14 | 101 | 15.30 |
| Seedling 3 | Carpinteria | flesh soft | 10-22-14 | 125 | 23.40 |
| Seedling 4 | Carpinteria | medium soft | 10-22-14 | 105 | 20.75 |
| Seedling 5 | Carpinteria | medium soft | 10-22-14 | 117 | 13.00 |
| Seedling 6 | Carpinteria | very soft | 10-22-14 | 96 | 17.20 |
| Seedling | Nordhoff | ripe | 10-21-14 | 223 | 23.10 |
| Seedling | Whittier | ripe | 9-27-15 | ... | 20.07 |
| Seedling | Whittier | ripe | 9-27-15 | 171 | 20.15 |
| Seedling | Taft | flesh hard | 10-15-15 | 127 | 17.42 |
| Seedling | Altadena | ripe | 9-22-16 | 123 | 26.73 |
| Seedling 1 | Hollywood | ripe | 9-28-16 | 90 | 22.13 |
| Seedling 2 | Hollywood | ripe | 9-28-16 | 158 | 21.89 |
| Seedling 3 | Hollywood | ripe | 9-28-16 | 88 | 25.84 |
| Seedling | Whittier | flesh soft | 9-29-16 | 80 | 18.47 |
| Seedling | Whittier | not very ripe | 9-29-16 | 90 | 14.74 |
| Seedling | Oroville | ripe | 9-30-16 | 127 | 24.88 |
| Oval Shape | Riverside | flesh hard | 10- 2-16 | 70 | 15.46 |
| Pear Shape | Riverside | flesh hard | 10- 2-16 | 68 | 15.58 |
| Green Lined | Altadena | ripe | 10- 6-16 | 135 | 23.00 |
| Green Lined | Altadena | fully ripe | 10- 6-16 | 125 | 25.61 |
| Black Variety | Altadena | flesh hard | 10- 6-16 | 107 | 14.78 |

It is of interest to note that Table No. I includes the test of one variety, the Pomona, grown at Sacramento, analyzed the 19th of this month, showing 25.36 per cent of oil, also the analysis of a seedling from Oroville analyzed in September yielding 24.8 per cent of oil, both good records.

Averages have not been indicated in any of the tables because there is such a variation in the oil content and again there are many determinations made of immature fruit. It was therefore, deemed best to present only individual analyses.

**B. Content of oil in seedlings vs. that in the known varieties**

The highest percentage noted for the seedlings is 27.89, reported for Seedling No. 1, from Carpinteria, two years ago. This percentage has not been equaled by any seedling submitted for examination since that time, the nearest approach being a seedling submitted by Mr. Popenoe under date of September 22nd of this year, yielding 26.7 per cent of oil. There are six samples of seedlings as indicated by the tables which yield between 24 and 26 per cent of oil—a most excellent showing—five seedlings testing between 20 and 23 per cent, making a total of thirteen seedlings reported in the table with a credit of above 20 per cent of oil. Comparing the seeedlings with the known varieties, it will certainly be seen that, as far as the oil content is concerned, many of them are, caeteris paribus, well worth propagating.

TABLE II.—SHOWING PERCENTAGE OF OIL IN THE AVOCADO

Varieties Maturing July-December.

Two or More Samples of Fruit Submitted

| Variety | Locality | Condition of fruit | Date | Wght. of fruit grams | Percent of oil |
|---|---|---|---|---|---|
| Blake | Pasadena | ripe | 10- 3-14 | 150 | 25.50 |
| Blake | Whittier | ripe | 10- 4-15 | 120 | 21.65 |
| Carton | San Fernando | not ripe | 10-15-14 | 189 | 15.20 |
| Carton | San Fernando | fully ripe | 10-15-14 | 169 | 19.50 |
| Carton | Riverside | flesh hard | 10-16-16 | 108 | 12.76 |
| Chappelow | Monrovia | fully ripe | 9-21-14 | 181 | 29.10 |
| Chappelow | Monrovia | fully ripe | 10-15-14 | 191 | 17.68 |
| Chappelow | Altadena | immature | 9-24-15 | 80 | 14.66 |
| Chappelow | Monrovia | immature | 9-24-15 | 148 | 13.86 |
| Chappelow | Monrovia | immature | 9-24-15 | 126 | 16.55 |
| Chappelow | Monrovia | not ripe | 9-24-15 | 145 | 16.26 |
| Chappelow | Monrovia | ripe | 11- 1-15 | 181 | 24.43 |
| Chappelow | Monrovia | flesh hard | 11- 1-15 | 103 | 22.81 |
| Chappelow | Monrovia | fully ripe | 11- 1-15 | 108 | 27.66 |
| Chappelow | Riverside | flesh hard | 10- 2-16 | 114 | 20.31 |
| Chappelow | Monrovia | flesh hard | 10- 6-16 | 206 | 18.29 |
| Chappelow | Monrovia | flesh hard | 10-11-16 | 159 | 20.28 |
| Condon | Pasadena | ripe | 10- 7-15 | 143 | 21.00 |
| Condon | Pasadena | ripe | 9-28-16 | 150 | 23.55 |
| Ganter | Whittier | ripe | 1- 3-13 | 205 | 25.60 |
| Ganter | Whittier | immature | 9-27-16 | 196 | 16.48 |
| Harman | Sherman | ripe | 10-10-13 | 235 | 19.33 |
| Harman | Sherman | ripe | 10-26-14 | 263 | 18.30 |
| Harman | Sherman | flesh soft | 9-28-15 | 127 | 15.25 |
| Harman | Sherman | flesh soft | 9-28-15 | 136 | 15.34 |
| Harman | Sherman | ripe | 9-28-15 | 170 | 16.26 |
| Harman | Sherman | ripe | 11- 8-15 | 134 | 21.51 |
| Harman | Sherman | ripe | 11- 9-16 | 215 | 18.68 |
| Harman | Sherman | ripe | 11- 9-16 | 143 | 19.18 |
| Northrop | Altadena | ripe | 10-23-14 | 218 | 27.60 |
| Northrop | Santa Ana | ripe | 11- 6-14 | 163 | 23.00 |
| Sharpless | Santa Ana | flesh soft | 9-13-15 | 555 | 15.87 |
| Sharpless | Santa Ana | not ripe | 8-17-14 | 471 | 15.73 |
| Taft | Orange | flesh soft | 8-11-15 | 626 | 18.54 |
| Taft | Orange | not ripe | 9-13-15 | 639 | 16.39 |
| Taft | Orange | ripe | 10-20-16 | 417 | 14.67 |

## C. Oil content of large fruit as compared with that of small fruit.

As previously stated, the Purdy showing the highest percentage of oil, 31.60, is a small fruit, weighing approximately one-third of a pound, and by an examination of the data presented in the tables, it will be noticed that all the high percentages are in connection with comparatively speaking small fruits. The Chappelow with 29.1 per cent weighing 181 grams: the Northrop with 27.60 per cent weighing 218 grams: the Blake with 25.50 per cent weighing 150 grams: the Mattern with 25.7 per cent weighing 96 grams: the

Pomona with 25.36 per cent weighing 80 grams: seedling from Carpinteria with 27.89 per cent weighing 150 grams: and the Knowles with 27.11 per cent weighing 100 grams. We do not find any large fruits containing a high percentage of oil. This is emphasized by a reference to Table No. Ill where will be found listed the Blakeman with 17.27 per cent weighting 472 grams and the Taft with 18.5 per cent weighing 626 grams.

TABLE III.—SHOWING PERCENTAGE OF OIL IN THE AVOCADO
Varieties Maturing January-June.

| Variety | Locality | Condition of fruit | Date | Wght. of fruit grams | Percent of oil |
|---|---|---|---|---|---|
| Blakeman | Altadena | Fully ripe | 5-14-15 | 472 | 17.27 |
| Blakeman | Altadena | Fully ripe | 6-11-15 | 454 | 15.43 |
| Brodia | Orange | ripe | 5- 4-15 | 405 | 10.86 |
| Challenge | Hollywood | not ripe | 2-25-15 | 512 | 9.48 |
| Challenge | Hollywood | immature | 1-11-16 | 602 | 2.66 |
| Challenge | Hollywood | immature | 2- 2-16 | ... | 6.71 |
| Challenge | Hollywood | immature | 4-13-16 | 470 | 7.75 |
| Challenge | Hollywood | immature | 4-13-16 | 426 | 5.78 |
| Challenge | Hollywood | not fully ripe | 7-19-16 | 669 | 16.37 |
| Dickey | Hollywood | mature | 3- 1-15 | 363 | 16.46 |
| Knowles | Santa Barbara | fully ripe | 3- 2-15 | 100 | 27.11 |
| Lyon | Hollywood | flesh hard | 5-24-15 | 453 | 16.31 |
| Lambert | Hollywood | flesh hard | 3-14-16 | 285 | 14.31 |
| Miller | Hollywood | ripe | 7- 6-14 | 184 | 23.70 |
| Miller | Pasadena | ripe | 11- 2-15 | 275 | 27.45 |
| Rhoad | Orange | immature | 5- 3-15 | 395 | 9.78 |
| Rita | Orange | immature | 5- 3-15 | 321 | 14.13 |
| Royal | Hollywood | flesh hard | 3-27-15 | 600 | 15.61 |
| Senor | Orange | flesh hard | 5- 3-15 | 528 | 17.00 |
| Solano | Hollywood | immature | 3- 2-15 | 506 | 3.61 |
| Solano | Hollywood | immature | 3-27-15 | 545 | 4.09 |
| Surprise | Hollywood | flesh soft | 3-14-16 | 537 | 9.96 |
| Wagner* | Hollywood | flesh hard | 10- 7-15 | 259 | 16.03 |
| Walker* | Sherman | flesh hard | 8-10-14 | 174 | 18.71 |

*Mature, May-August.

## D. The development of the oil in the fruit during the ripening process

Definite conclusions can not be drawn on this phase of the work until more analyses have been made. From the data at hand, however, it would appear that the oil certainly increases with the ripening in that we have not analyzed any sample which is immature or partly ripe which shows as high a percentage as does the fully ripe fruit. In the case of the Chappelow we have an immature fruit showing as low as 13.86 per cent of oil while the fully ripe fruit the same season shows 27.66 per cent. In the same year we have a sample analyzed Oct. 15, 1914, showing 17.68 per cent and not fully ripe.

Again it is of interest to note, as was to be expected, that in different years or different seasons, the same variety will vary in its maximum oil content. This is emphasized by reference to the figures noted for the Chappelow, Harman and others. Further investigations may also indicate that the same variety grown in different places will yield different percentages of oil. Not enough analyses have been made to warrant the drawing of any definite conclusion on this point.

Avocados might be compared to milk. As is well know, there are certain breeds of cows yielding milk of different degrees of richness in fat and that said content of fat is more or less constant, for the respective breeds. While it is true that a herd of Holsteins may be bred to give a milk richer than a poorly bred herd, yet no matter how much breeding is

carried on or how well a herd is cared for, it cannot be expected that a Holstein cow will ever yield a milk as rich as will a Jersey cow. Nor is it right to expect that if a Jersey cow is treated as it should be, such cow will yield a milk with a low fat content. Similarly with reference to the avocado. Those varieties which yield a high percentage of oil will do this consistently under proper conditions, while those which yield a lower percentage of oil will not, it seems to me, increase the percentage of oil materially by any treatment which may be given to the culture of the respective variety.

It must not be considered, however, that because a variety is lower in oil than another variety, such a variety will not meet with public favor. While it is true the higher the oil content the greater the food value per unit weight, as is the case with milk, yet those with a lower percentage of oil, of fine flavor, and which are fully ripe will doubtless find a ready market if prices warrant. In fact, it might be said that in some instances a fruit with a medium oil content might be more desirable than one with a higher content as is oftentimes the case with milk, the Holstein being preferable to the Jersey on account of the fact that the latter is too rich in fat. Of course it must not be considered from the foregoing, that the caloric value of a unit weight of milk is equal to that of the avocado. What has been stated is merely to indicate that those varieties of the avocado which are lower in oil content but otherwise acceptable, may be highly desirable.

At the request of some members of the Avocado Association the accompanying set of recipes[1] were critically tried and the comments and criticisms concerning them are given herewith. A number of persons participated in the testing and among them might be mentioned Miss Josephine E. Davis, Assistant Professor of Household Science at the University, who rendered valuable help in this connection. The discussion of recipes involve the consideration of:

1. Palatability.
2. Nutritive Value.
3. Hygienic Value.
4. Esthetic Value.

If a combination is not palatable it matters but little whether the nutritive value is high or low. Again the food value or the nutritive value may be high while the combination may be objectionable hygienically, or esthetically. The latter point deserves the careful attention of all those engaged in the preparation of food for the table.

Avocado Served in the Skin: There does not seem to be any particular reason why the avocado should be served in the skin. By so doing there is obviously a greater percentage of waste than if the fruit were peeled before serving, in which case the entire portion could be eaten while when served in the skin this is impossible.

The consensus of opinion was that the fruit should be served with either lime juice or salt, salt being favored. No one cared for the avocado with sugar or with tomato catsup, and the use of mayonnaise and a French dressing rich in oil was decidedly objected to.

[1] The recipes referred to here were published in the Report of the First Semi-Annual Meeting of the California Avocado Association pp. 91-93.

The combination of the fruit and mayonnaise is hygienically a bad one in that we have two oily foods—the mayonnaise showing about 95 per cent oil while the avocados average about 20 per cent. Furthermore the strong, flavor of the mayonnaise hides the delicate flavor of the avocado while salt brings out the flavor very markedly and it should be said in this connection that the finer the grain of the salt the better. The objection to French dressing rich in oil is practically the same as that made against the mayonnaise. The tomato catsup also was objected to because the strong flavor of the catsup hid that of the fruit.

The riper the fruit the better, and it should not be served too cold.

Avocado on Toast: This, while being relished by some, was preferred by others when modified by Miss Davis as follows: Remove the pulp from the fruit and mash.

Spread lightly on a triangular piece of thin, hot toast. Sprinkle well with grated Parmesan cheese, add a little salt, a few drops of lemon juice. Paprika is added for flavor and color.

Avocado with Caviar: Objection—caviar too strong.

Avocado Cocktail: Objected to on the same ground as stated with reference to the use of tomato catsup.

**Salads**

Celery and Nuts: The objection to this combination was the use of mayonnaise and furthermore that celery itself has so strong a flavor as to detract, to a large extent, from that of the avocado.

Apple and Celery: The statements for Celery and Nuts apply here as well.

Combination Salad: It would appear to me that it would be hard work to find the avocado in such a combination and furthermore in view of the high price of the avocado it would seem decidedly undesirable to offer such a salad.

Avocado on the Half Shell: This was not tried but it does not seem to recommend itself for general use. The egg and the French dressing would tend to disguise the delicate flavor of the fruit.

Cuban Salad: This was not objected to except that the use of sugar was not advised although there may be some who would prefer it.

Onions: The combination of avocado and onions was not advocated under any circumstances.

Aspic Jelly: It has been suggested with reference to this recipe that the following be substituted:

1/2 box gelatine
1/2c. cold water
1/2c. boiling water
1/2c. thick tomato juice
1-1/2 c. diced avocado
2 t. of lemon juice
salt, paprika, etc.

Soak gelatin in cold water. Dissolve in boiling water. Strain and add avocado meat and tomato juice. Add seasonings and place on ice to harden. Serve on lettuce leaf.

It will be noticed that this recipe contains tomato juice but this is not tomato catsup.

With Bananas and Apple: There was a divided opinion with reference to the use of apples and bananas. Some liked it but others objected. The banana seeming to overpower the avocado. No French dressing or mayonnaise was used.

**Sandwiches**

The recipe for sandwiches is good but the use of pepper may be omitted according to some with advantage. A sandwich made of graham crackers, equal weights of fruit and crackers, makes a most inviting and appetizing sandwich (8 grams of fruit to a sandwich).

With Chili Pepper: This is objected to on account of the strong flavor of the pepper and the use of onion.

An Original and Delicious Desert: This is objected to because there is too much fat in the whipped cream.

Avocado Ice Cream: It would appear that in view of the high price of the avocado that it would not be profitable in any sense of the word to advocate the use of avocado ice cream. It is doubtful if anyone would be able to detect the flavor of the avocado among the eggs, milk, almond or vanilla extract, etc.

Avocado with Sea Foods: The serving of avocado with salmon or lobster was not relished but the avocado and tuna salad was preferred.

Soups: When the market price of the avocado is lower than at present the use of avocado soup may be advisable but under present conditions it would seem far better from every point of view to use the avocado as such with salt than to detract from its highly delicate flavor by making it into a soup.

It may be stated in summarizing the comments that the avocado served with salt met with more approval and favor than did the avocado served in any other way and personally the writer agrees.

For Invalids: There should be no objection whatever to the use of the avocado for invalids provided fat in the diet is not contraindicated.

We will be glad to confer with the officials of the Association with the view of revising the suggestions for preparing the avocado for the table.