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AVOCADO CULTURE IN CALIFORNIA – THE NUTRITIVE VALUE OF THE AVOCADO

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The investigation here reported includes the analyses of 28 different varieties of the avocado. These data emphasize the value of this fruit as an excellent source of easily digested vegetable fat.

Composition of Fruits.—.A reference to the composition of fresh fruits in general shows that the amount of water is *large* and that the percentages of the nutrients indicate that the main food value is derived from carbohydrates. In nearly all cases the sugars predominate, starch being present in small amounts only.

The protein content of fruits is low, varying from .2 per cent as an average for the loquat to 2.5 per cent for the olive. The stone-fruits contain, on the average, less than 1 per cent.

The figures for the mineral matter or ash in fresh fruits are, in general, much lower than the corresponding data for meats or grain. The average for meat is about 1 per cent, while for fruit it is much less.

It must not be forgotten, however, that while the *amount* of ash is small, the percentage of potassium, so essential to the animal economy, is high. This is a very valuable base-forming element which is necessary in the maintenance of the normal neutrality of the blood and tissues. The importance of the mineral matter in nutrition and the necessity of carefully selecting the dietary so as to secure a proper balance between the base-forming and acid-forming elements is becoming more and more apparent.

Fat is present in very small proportions in fresh fruits. This constituent is generally reported as "Ether Extract," which often contains other materials than true fat or oils, such as coloring matter, wax found in skin, etc. The figure, therefore, reported for fat in most fruits is seldom a true indication of the content of this nutrient.

COMPOSITION OF THE AVOCADO

A survey of the data presented shows the avocado to differ widely in many respects from the average of fresh fruits and proves it worthy of special consideration. It might almost be said to be in a class by itself.

TABLE 1.—SHOWING THE COMPOSITION OF AVOCADO

No. and Variety	Locality and Grower	Date	Wt. of fruit, gms.	Refuse				Edible portion		Analysis of edible portion				
				Seed, gms.	Skin, gms.	Total Gms.	Total Per ct.	Gms.	Per ct.	Water, per ct.	Protein, per ct.	Fat, per ct.	Carbohydrates, per ct.	Ash, per ct.
		1913												
1. Ganter	Whittier A. N. Rideout	1–3	205	24.0	10.0	34.0	16.6	171.0	83.4	63.86	2.25	25.60	6.58	1.71
2. Harman	Sherman	10–10	235	55.0	54.0	109.0	46.4	126.0	53.6	71.58	2.50	19.33	5.32	1.27
		1914												
3. Miller	Hollywood Jacob Miller	7–6	184	30.0	36.0	66.0	35.8	118.0	64.2	66.60	3.70	23.70	4.51	1.49
4. Walker	Sherman Ed. Harman	8–15	173.5	43.7	20.7	64.4	37.1	109.1	62.9	68.66	3.15	18.71	7.55	1.93
5. Sharpless	Santa Ana H. B. Sharpless	8–17	471	60.0	40.0	100.0	21.2	371	78.8	76.73	2.15	15.73	3.69	1.70
6. Chappelow	Monrovia Wm. Chappelow	9–21	180.5	22.0	19.5	41.5	23.0	139.0	77.0	60.94	1.40	29.10	6.85	1.71
7. Blake	Pasadena D. W. Coolidge	10–3	150	31.0	18.0	49.0	32.6	101.0	67.4	65.76	1.88	25.50	5.52	1.34
8. Chappelow	Monrovia Wm. Chappelow	10–15	142 191	32.7 33.8	21.0 26.0	53.7 59.8	37.8 31.2	88.3 131.2	62.2 68.7	*72.35	2.16	17.68	6.47	1.34
9. Carton	San Fernando P. F. Carton	10–15	189	36.5	31.0	67.5	35.7	121.5	64.3	63.53	1.34	.....	.....	1.30
10. Carton	San Fernando P. F. Carton	10–15	169	39.5	30.0	69.5	41.2	99.5	58.8	70.43	2.60	19.50	6.29	1.18
11. Unnamed	.....	10–21	217	31.8	21.0	52.8	24.4	164.2	75.6	65.50	2.60	23.10	7.40	1.40
12. Topa Topa	E. S. Thacher Nordhoff	10–21	123	21.0	13.0	34.0	27.7	89.0	72.3	75.00	2.30	15.48	6.14	1.08
13. Mattern	.....	10–22	92	28.0	12.6	40.6	44.1	51.4	55.9	61.55	2.20	25.70	8.94	1.61
14. Northrup	F. O. Popenoe	10–23	218	45.0	23.4	68.4	31.4	149.6	68.6	61.08	2.50	27.60	7.92	0.90
15. Seedling No. 1	Carpinteria O. M. Cadwell	10–22	148	37.2	12.1	49.3	33.3	98.7	66.7	62.65	1.70	27.89	6.83	0.93
16. Seedling No. 2	Carpinteria O. M. Cadwell	10–22	100	31.0	10.0	41.0	41.0	59.0	59.0	73.09	1.30	15.30	9.41	0.90
17. Seedling No. 3	Carpinteria O. M. Cadwell	10–22	122	23.8	12.4	36.2	29.7	85.8	70.3	65.10	1.60	23.40	8.74	1.16

* Analysis-average of two samples.

TABLE 1.—SHOWING THE COMPOSITION OF AVOCADO—(*Concluded*)

No. and Variety	Locality and Grower	Date 1914	Wt. of fruit, gms.	Refuse: Seed, gms.	Refuse: Skin, gms.	Refuse: Total Gms.	Refuse: Total Per ct.	Edible portion Gms.	Edible portion Per ct.	Analysis of edible portion: Water, per ct.	Protein, per ct.	Fat, per ct.	Carbohydrates, per ct.	Ash, per ct.
18. Seedling No. 4	Carpinteria O. M. Cadwell	10–22	93	30.0	9.5	39.5	42.5	53.5	57.5	68.00	1.50	20.75	8.44	1.31
19. Seedling No. 5	Carpinteria O. M. Cadwell	10–22	114	32.0	12.5	44.5	39.0	69.5	61.0	68.07	1.50	13.00	16.17	1.26
20. Seedling No. 6	Carpinteria O. M. Cadwell	10–22	94.5	25.0	29.0	54.0	57.1	40.5	42.9	67.58	1.60	17.20	12.36	1.26
21. Harman	Sherman	10–26	243	57.0	32.0	89.0	36.6	154.0	63.4	*74.70	1.60	18.30	4.60	0.80
	Ed. Harman		283.5	56.0	37.0	93.0	32.8	190.5	67.2					
22. White	Santa Barbara	10–26	171	42.0	19.8	61.8	36.1	109.2	63.9	*77.06	1.74	14.64	5.49	1.07
	E. L. White		154.5	35.0	18.3	53.3	34.4	101.2	65.6					
23. Fowler	Pasadena	11–2	135	34.5	14.0	48.5	35.9	86.5	64.1	*70.33	1.60	21.20	5.61	1.26
	Mrs. Fowler		129	32.5	13.6	46.1	35.7	82.9	64.3					
24. Northrup	Pasadena	11–4	120	36.4	12.4	48.8	40.7	71.2	59.3	*61.20	3.40	.....	.....	.....
	W. India Gardens		117	35.7	12.3	48.0	41.0	69.0	59.0					
25. Cardinal	Larkin, Dade Co., Florida Dorn Bros.	11–4	587	72.1	39.2	111.3	19.0	475.7	81.0	79.66	2.56	10.70	6.48	0.60
26. Northrup	Santa Ana	11–6	198	48.0	17.0	65.0	32.8	133.0	67.2	*66.31	2.36	23.00	7.12	1.21
	E. Bartley		127	32.0	14.5	46.5	36.6	80.5	63.4					
27. Trapp	Larkin, Dade Co., Florida Dorn Bros.		637.8	129.5	52.6	182.1	28.5	455.7	71.5	78.66	1.61	9.80	9.08	0.85
28. Azusa	Azusa Volney Metcalf		198	36.1	20.0	56.1	28.3	141.9	71.7	67.05	1.94	21.06	8.59	1.36

No. and Variety	No. of analysis	Wt. of fruit, gms.	Refuse: Seed, gms.	Refuse: Skin, gms.	Refuse: Total Gms.	Refuse: Total Per ct.	Edible portion Gms.	Edible portion Per ct.	Analysis of edible portion: Water, per ct.	Protein, per ct.	Fat, per ct.	Carbohydrates, per ct.	Ash, per ct.
29. Maximum	28	637.8	129.5	54.0	182.1	57.1	475.7	83.4	79.66	3.70	29.1	16.17	1.93
30. Minimum	28	92.0	21.0	10.0	34.0	16.6	40.5	42.9	61.08	1.30	9.8	3.69	0.60
31. Average	28	197.4	40.0	22.5	62.5	34.3	135.8	65.7	69.16	2.08	20.1	7.39	1.26

* Analysis-average of two samples.

The tables are replete with interesting points, all very favorable to the avocado. The total dry matter in the edible portion is, in nearly every instance, greater than that noted for any fresh fruits. The average for the avocado is 30.84 per cent. The nearest approach to this figure is found in the banana, with about 25 per cent dry matter. It must be remembered; however, that while there may not be so much difference in the total solids of the two fruits in question, there is a great difference in the nature of the nutrients. Sugar and starch predominate in the banana as against fat in the avocado.

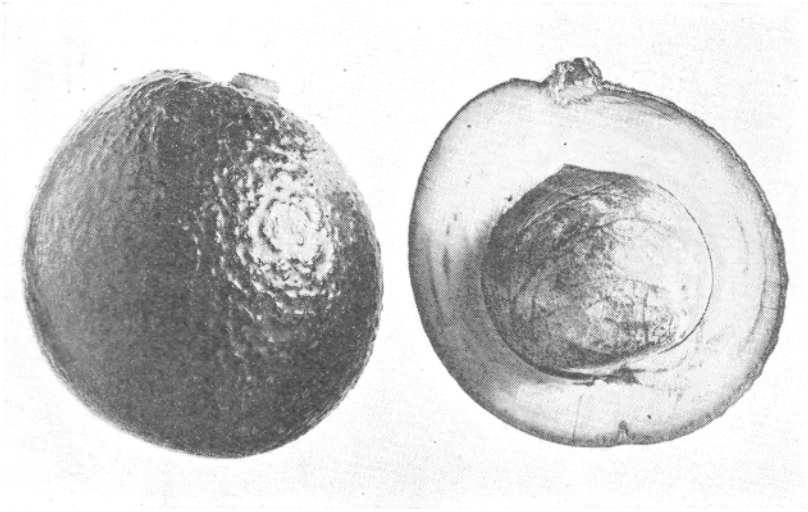

Fig. 8.—The Challenge has a thick, hard shell; rough, shiny surface, rather large seed, and fair quality of flesh. The original tree is productive, about 2500 fruits having been picked in 1915. Size of fruit, 3½ by 3½ inches.

It has been stated that the protein per cent in all fruits is low averaging less than 1 per cent. It will be seen from the table that the *minimum* figure for protein, 1.30 per cent, is nearly equal to the maximum indicated for fresh fruit, 1.5 per cent, noted for figs and currants. The maximum, 3.7 per cent, corresponds somewhat closely to the protein content of some dried fruits. In three varieties the protein is present in excess of 3 per cent; in ten varieties considerably above 2 per cent; while the average for the 28 varieties is 2.08 per cent. It. therefore, may be said that so far as protein in fresh fruits is concerned, the avocado stands far in the lead.

The carbohydrate content of the avocado, with the exception of seedlings Nos. 5 and 6 submitted by 0. M. Cadwell of Carpinteria, is low as compared with this constituent in fresh fruit. The average for the 28 varieties is 7.39 per cent, and this would have been appreciably lowered if the data for the two seedlings above mentioned had been 'omitted from the average.

The figures quoted in the table for carbohydrate include crude fiber, which was not determined in every case. Analyses have shown, however, that this ingredient is present to the extent of about 1.75 per cent, comparing favorably with the content of fiber in the other fresh fruits.

It is of decided interest to note that the mineral matter in the avocado is much greater than that found in any fresh fruit. Just how much importance can be attached to this fact can better be stated after the conclusion of the detailed analysis of the ash, which will indicate the per cent of potassium, calcium, phosphoric acid, iron, etc. The results of the ash analyses will be published as a supplementary report.

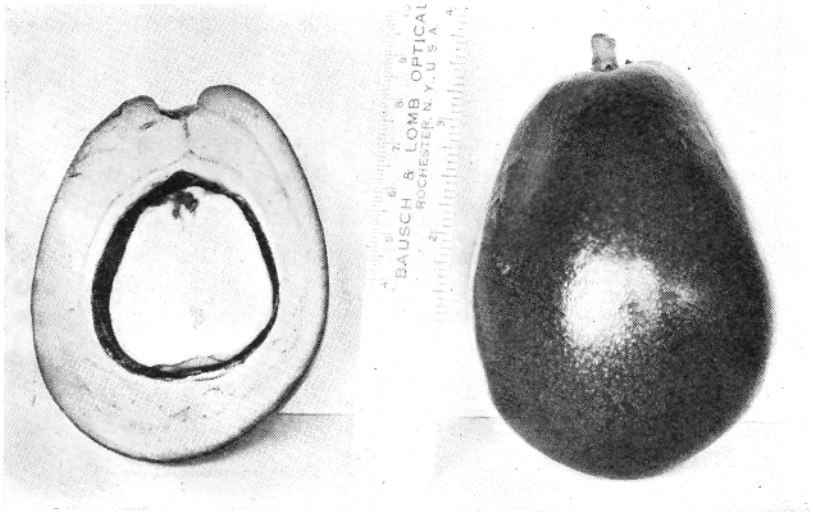

Fig. 9.—The Ganter is a green-fruited variety having a thin skin and good quality of flesh. The rattling of the loose seed in the cavity with the consequent bruising of the flesh is a slight disadvantage in marketing.

The minimum per cent of ash, .60, noted for the variety, Cardinal, from Florida, exceeds the per cent of ash determined for apples, apricots, grapes, blackberries, oranges, pears, and plums, and fully equals the corresponding figure for cherries, figs, melons, and prunes.

The minimum per cent of ash noted for a variety grown in California is 0.80 per cent, exceeding that found in any of the fresh fruits. As seen from the table, the average for the 28 varieties is 1.26 per cent, only slightly below the ash percentage in dates.

The foregoing discussion clearly indicates that so far as protein and ash in fresh fruits are concerned, the avocado stands at the head of the list, and, with reference to the carbohydrates, contains on an average fully 50 per cent of that found in many fresh fruits. These facts alone would warrant due consideration being given to the value of the avocado as a fresh fruit.

The chief value of the avocado as food, however, is due to its high content of fat. This varies, as shown by the analyses, from a minimum of 9.8 per cent to a maximum of 29.1 per cent, with an average of 20.1 per cent.

Reviewing the analytical data, it will be seen that ten varieties show more than 23 per cent fat and seven other varieties an excess of 18 per cent.

The only fruit comparable with the avocado in this respect is the olive. In this connection, it is of interest to compare, as shown in the following table, the fat percentages of the edible portion of those ten varieties of the avocado containing 23 per cent, or upwards, of fat with ten varieties of the olive.

TABLE 2.—SHOWING PERCENTAGE OF FAT OR OIL IN THE AVOCADO AND OLIVE

Avocado				Olive	
Original material water free Edible portion				Original material Edible portion	
No. and Variety	Water, per ct.	Fat, per ct.	Fat, per ct.	Variety	Oil, per ct.
8. Chappelow	60.94	29.10	78.01	Corregiolo	27.68
15. Seedling No. 1	62.65	27.89	74.67	Nigerina	26.16
14. Northrup	61.08	27.60	70.88	Nevadillo Blanco	22.92
13. Mattern	61.55	25.70	66.84	Mission	22.51
1. Ganter	63.86	25.60	70.84	Rubra	22.01
7. Blake	67.40	25.50	74.48	Pendulina	21.36
3. Miller	66.60	23.70	70.96	Redding Picholine	20.83
17. Seedling No. 3	65.10	23.40	67.05	Macrocarpa	20.41
11. Unnamed	65.50	23.10	66.96	Manzanillo	19.73
26. Northrup	66.31	23.00	68.27	Columbella	19.54

The figures in Table 2 indicate that the avocado ranks higher in fat or oil than the average or commonly used olive. The latter fruit also has the disadvantage of requiring special treatment before it is ready for consumption and should really rank as a processed fruit rather than a fresh one. The data in the table show that when considering the dry matter only No. 8, Chappelow, shows the highest percentage of fat. In the original conditions the Northrup and an unnamed fruit differ by nearly 4 per cent, which difference is practically eliminated when comparison is made on a water-free basis, which is the only true way to compare the nutritive value of fruits.

CALORIC VALUE

While it is true that the real value of any food is not always represented by the heat units or calories, at the same time the *total* food value is so indicated. This difference between the real value and total food value is not always properly understood. For instance, the energy value of a pound of sugar is 1820 calories, while the corresponding value for lean meat is less than 1000 calories. Yet we would hardly say that the real value of a pound of sugar was 1.8 times that of a pound of lean meat, if the question of growth were under consideration. When, however, the matter of energy is being discussed the case is entirely different, and the value of a food as a source of energy varies directly with its caloric value.

The energy values of the edible portion of the commonly used fresh fruits are low, ranging from a minimum of 175 calories to a possible maximum of 400 calories per pound.

An inspection of Table 3 shows that the avocado has a far higher value in this respect; the average of twenty-six varieties being 984 calories per pound, or more than twice the maximum noted for other fruits. The minimum figure, 597, is also in excess of this maximum. The maximum, 1325 calories per pound, approaches that noted for some varieties of dried fruits. It corresponds to about 75 per cent of the fuel value of the cereals and is not far from twice that noted for average lean meat.

TABLE 3.—SHOWING THE ENERGY VALUE OF THE AVOCADO

No. and Variety	Energy value per lb. Calories	No. and Variety	Energy value per lb. Calories
1. Ganter	1194	15. Seedling No. 1	1282
2. Harman	923	16. Seedling No. 2	812
3. Miller	1107	17. Seedling No. 3	1132
4. Walker	952	18. Seedling No. 4	1019
5. Sharpless	741	19. Seedling No. 5	846
6. Chappelow	1325	20. Seedling No. 6	948
7. Blake	1147	21. Harman	852
8. Chappelow	867	22. White	722
9. Carton	.....	23. Fowler	987
10. Carton	949	24. Northrop	.....
11. Unnamed	1115	25. Cardinals	597
12. Topa Topa	778	26. Northrup	1101
13. Mattern	1240	27. Trapp	599
14. Northrup	1303	28. Azusa	1042

DIGESTIBILITY

There have been 110 metabolism experiments carried on in connection with the avocado, yet it is only fair to assume that this fruit is as easily digested as many others whose coefficients have been determined. Such data clearly prove that the fruits are quite thoroughly digested. While the availability of the protein rates below, the digestion coefficients of the carbohydrates compare favorably with, and those of the oils and mineral matter are fully equal to those obtained for the mixed diet. .

DIETETIC VALUE

The dietetic value of fruit, aside from the actual nutrients which it contains, lies in its succulency—its minerals and organic acids. If gauged by its nutritive value alone, fruit would seem to be an expensive form of nourishment, but when its hygienic qualities are considered its money value to the consumer is difficult to estimate. Some fruits carry more nourishment with their hygienic properties than others. Some contain minerals which are more valuable to the system or less commonly distributed than others. Therefore, while there are general properties which are common to all fruits, each has special properties which justify individual consideration.

While the special dietetic value of a food can not always be forecast by the chemical analysis, it is certainly permissible to suggest the possibilities which are indicated through such investigation. It is always necessary that such theory be confirmed by clinical experience.

Judging from its composition, the avocado should perhaps prove to have laxative qualities of a peculiar or individual type, possessing as it does the combination of the usual "fruit principles," and that of fat or oil. The laxative properties of most fruits depend upon the stimulating effects of the fiber upon the wall of the intestine and partly upon the organic acids and minerals. Oil has a tendency to soothe and to lubricate the intestine even while it acts as a mild laxative. The avocado is a natural combination of these two types of foods—as if fruit and olive oil had been chemically combined by nature.

Whether or not there is any special advantage in this natural combination over that made by a proper selection of foods remains to be proved. There are no clinical data on the subject, but future experimental work may give some interesting results.

The fact that the native Cubans prefer this fruit to any other of their abundant supply may be due to its flavor alone, but it is more than likely that the preference is more deep seated, and that it is the result of generations of experience or of a knowledge of its beneficial effects.