California Avocado Society 1920-21 Yearbook 7: 59-68

DISCUSSION OF ANALYSES OF AVOCADOS FROM THE STANDPOINT OF NUTRITION

PROF. M. E. JAFFA

A Nutritional Review

In view of the interest that is being taken by the public in this fruit, evidenced by our station correspondence and interviews, it appeared to me that it might not be out of place to repeat some of the data which has been previously given with reference to the comparative nutritional value of the avocado and other foods.

We will first compare the avocado with other fruits and then with some of the more commonly used or staple foods.

There has been, during the last decade or so, a much fuller understanding of the nutritive value of fruits than previously existed and this is well indicated by quotations from the introduction and conclusion, respectively, of Bulletins 107 and 132 by the writer, published in 1903 by the U. S. Department of Agriculture.

Introduction. "Fruit is considered by the majority of persons as an accessory or supplementary food, eaten for its agreeable flavor or supposed hygienic or medicinal virtues, rather than as a staple article of diet. Perhaps for this reason very little scientific study has been given to fruit as compared with the investigations which have been carried on in connection with other more common food materials. Chemical analysis has shown the comparative composition of fruits, but our knowledge of their dietetic value, digestibility, and comparative cost as sources of nutrients is far from being complete. In view of these facts it has been thought best that California should undertake, as her share of the nutrition investigations made under the auspices of the United States Department of Agriculture, studies of the nutritive value and digestibility of fruit. Perhaps no State in the Union is in better condition to exploit such problems. No month in the year finds the California market without fresh fruit of local production, and many people are to be found in the State who make this article an important part of their dietary."

Conclusion. "No extended comments can be made on these results, because, as before stated, there are *few, if any, similar investigations at hand* for comparisons. Further investigations along this line are needed."

The further investigations suggested were carried on in 1902-3 at the University of California with most satisfactory results and two paragraphs from the summary would seem quite pertinent:

"Although it is undoubtedly advisable to wait until more data have been gathered before making definite statements regarding the digestibility of different fruits and nuts, enough work has been done to show that they are quite thoroughly digested and have a much

higher nutritive value than is popularly attributed to them. In view of this it is certainly an error to consider nuts merely as an accessory to an already heavy meal and to regard fruit merely as something of value for its pleasant flavor or for its hygienic or medicinal virtues.

As shown by the composition and digestibility, both fruit and nuts can be favorably compared with other and more common foods. As sources of carbohydrates, fruits at ordinary prices are not expensive; and as sources of protein and fat, nuts at usual prices are reasonable."

It will be noticed that only the carbohydrates of fruits are emphasized, no mention being made of any other nutritional value. In order to thoroughly understand how much more complete is our knowledge of fruit and nuts today than it was in 1902 it will be necessary to briefly review the progress nutrition has made since that year.

A few years ago our evaluation of a diet was based on:

1. Content of protein.
2. Content of fat.
3. Content of carbohydrates.

If a diet contain sufficient protein in addition to the necessary fat and carbohydrates to meet the caloric requirement it was considered well balanced, without regard to the sources of the respective nutrients. Today we have a different yard stick and measure quite differently. We realize, as we did in the past, that calories are vitally necessary, but we pay more attention to the sources of the required calories. This is particularly true in the case of the young and growing child, and of the invalid and convalescent.

Perhaps the only nutrient which has not been affected by later theories is the starch or carbohydrates of our foods. The same opinions which were held years ago with reference to the role of starch in nutrition, are valid today. Not so, however, with reference to any other nutrient. We know today that proteins from different sources have different biologic values. The proteins from cereals, fruits, and vegetables alone are not adequate for optimum growth and development. These proteins lack sufficient amounts of certain building stones or units of structure, chemically called amino acids, which are well supplied by animal proteins, such as that of meat, milk and eggs. It is therefore absolutely necessary that there be a liberal amount of animal protein included in the diet of the young and growing animal.

The newer knowledge of the proteins has only been obtained as result of the investigations carried on during the past, say, 15 years.

Previous to such studies there was very little differentiation regarding the biologic values of proteins. It was a case of quantity and not quality. Today the reverse is true. It is the quality which must be given equal consideration with the quantity.

Not only have great strides been made with reference to the fuller appreciation of the value of proteins but also in connection with the biologic values of different fats. A quarter of a century ago all fats were considered of equal nutritional value and their main function was to build fatty and nerve tissues or yield energy, and practically no other nutritional property was credited to them. Today the situation is entirely different

and we know that all fats have not the same biological value; that there are two good fats, that of milk and egg yolk, which stand out most prominently, as far as nutrition is concerned, in that they both contain the so-called fat-soluble vitamine. This is a dietary essential at present not identified, but absolutely necessary in any well balanced diet for old or young, and particularly the latter. There are many other edible fats which are the equal of butter fat and egg yolk fat as far as caloric value is concerned but they are not the rich source of this dietary essential as is noted for the other two fats.

One of the most important phases of the newer knowledge of nutrition relates to the importance of mineral elements in nutrition.

For many years it was considered that, as far as the mineral matter was concerned, almost any diet was adequate and very little attention was, therefore, paid to the role of the mineral ingredients. Today, however, as result of nutritional studies we note that our previous views and opinions were riot sound and that more consideration should be given to the mineral matter of the diet than was previously supposed necessary. It is now known that cereals alone are deficient in certain minerals, such as sodium, calcium and chlorine, required for growth and normal development in the young animal. Again we know that, as a result of the work of recent years, the mineral matter of our foods may be divided into two main groups, the "acid forming" and the "base forming." It is absolutely necessary, according to the best authorities, that there be a generous representation in the diet of both these groups in order that the mineral equilibrium of the body should not be altered and the alkalinity of the blood be not disturbed.

The chief foods which furnish the "acid forming" mineral elements are, cereals, meat and eggs, while those supplying, in the main, the base forming minerals are the fruits and vegetables.

Mention has been made of milk fat and egg yolk fat containing vitamins. These were discovered by Osborne and Mendel, McCollum and others, as result of dietary experiments and the name given to such dietary essentials was "vitamine" by some, and "growth promoting substance" by others. During the past ten years much work has been done by leading nutrition investigators in connection with the studies of vitamins and their role in nutrition. The question the layman might naturally ask is, *"What is a vitamine?"* It has been known for many years that there exist in fresh food some substances which are essential for the prevention of scurvy. These are called, by some, *"antiscorbutic substances"* (effective against scurvy). Beriberi is another deficiency disease which can be prevented by a diet adequate in *anti-neuritic substances,* (a remedy of service in nervous diseases), so that we have two substances, antiscorbutic and anti-neuritic, present in foods which are evidently curative for these two diseases. Naturally there was a desire on the part of many investigators to quantitatively separate these materials from the foods. Funk and his collaborators, however, devoting much time and energy to the problem, succeeded, in 1912, in devising a method which led to a product of high physiological activity and curative powers. To this preparation Funk gave the name "vitamine," from "Vita," life, and "amine" meaning a substance essential to life.

It should be said that these unknown essentials have no direct relation to the ordinary nutrients such as protein, fats, carbohydrates and mineral matter.

The three terms, "antiscorbutic vitamine," "anti-neuritic vitamin," and "growth promoting substances" are not the only designations that have been proposed or suggested. Others are, "growth substances," "growth determinants," "food hormones," "accessory food substances," "dietary essentials," "fat-soluble vitamins," "water-soluble vitamins." It has been quite clearly shown that there are two groups of these so-called "vitamins," one soluble in fat and one soluble in water. The latter again have been divided into two subgroups, anti-neuritic vitamine, fairly widely distributed in plants and necessary to prevent polyneuritis and beriberi, and the anti-scorbutic vitamine so necessary for prevention of diseases like scurvy. There have been suggested, therefore, the provisional names "fat-soluble A," "water-soluble B" for the anti-neuritic vitamine; and "water-soluble C" for the antiscorbutic vitamine. All three are necessary in the diet for optimum growth and normal development of the young and for the maintenance of health and activity and ability to work in the adult.

It is of interest to relate the foregoing discussion to the Avocado and other fruits. Fruit has long been used as a food for man but it is only of recent years that the role of fruit in nutrition has been appreciated, and this is due entirely to the investigations above referred to.

The composition of fruits as determined by chemical analysis, indicating the percentage of the several nutrients, including *mineral matter,* has been well known for many years, but the character and importance of the latter were not until recently, properly recognized. The predominating ingredients of the ash or inorganic part of fruits are potash, soda, lime and magnesia. These are basic in character and tend to balance the chief ingredients of the cereals, meats, etc., which are of an acid nature, namely, phosphorous, sulphur, chlorine, etc.

How does the Avocado compare with other Fresh Fruits?

a. Water. The water content of pears, apricots and apples will average about 85 per cent; berries, 85-90 per cent; fresh prunes, 80 per cent; figs, 79 per cent; melons, 90-93 per cent; oranges, 85 per cent. The average for all fruits would therefore be about 82.5 per cent.

b. Protein. Apples and pears, 0.4-0.5 per cent; fresh prunes, 0.9; melons, 0.5; berries, 1-1.3 per cent; oranges, 0.8-1.0 per cent; grapes and bananas, 1.2-1.5. The average, therefore, for protein for the fresh fruits enumerated is practically 0.72 per cent.

c. Mineral Matter. Apples and pears, 0.3-0.4; grapes, 0.5; figs, 0.6;berries, 0.6; oranges, 0.5; melons, 0.5; fresh prunes, 0.6; bananas, 1.0. The average being 0.55 per cent.

The following tabular statement shows conclusively how much richer than other fruits is the avocado, in protein, mineral matter, and total solids; in other words, contains far less water.

		Avocado	*Other Fruits*
Water	60-80	Average 70	82.50
Protein	1.3-4.6	Average 2.50	0.72

Ash ..... 1.38-1.72 Average 1.50 0.51

In this connection it is also of interest to compare the avocado with some other foods. The avocado shows, on an average, about 70 percent of water; the potato, either raw or cooked, will vary from 75-78 per cent. The protein in the two foods is about the same, with the advantage on the side of the fruit.

Raw cereals yield from 1 0 to 12 per cent of protein; when cooked, however, will average about 7 ½ per cent: rice, less than 2 per cent. The mineral matter of the avocado will average at least 1.5 per cent; the corresponding figure for the potato is 1.0, either raw or cooked; cooked rice, 0.15; cooked cereals, 0.5; meat, 1.0; eggs, 1.0. It is thus seen that the avocado, when compared with cooked foods, which is the correct method of comparison, in view of the fact that we are discussing the material ready for consumption, is:

1. A richer source of mineral matter.

2. A richer source of protein than the potato, green vegetables, or the cooked cereals.

The main constituent of the foods mentioned is the carbohydrate, while the main ingredient of the avocado is the oil. The maximum percentage of carbohydrate in any of the foods in question, ready for consumption, does not exceed 20 per cent while the minimum percentage of oil noted for the avocado is 9 with a maximum of 32. As the caloric value of fat is 2 ¼ times that of the carbohydrates it is very obvious that the caloric value of a unit weight of the edible portion of the avocado is far greater than a corresponding weight of any of the foods above discussed.

This places the avocado, as previously stated, in a class by itself, and the only food that it can be compared with in this respect is the olive, but, as is well known, the olive requires processing before it is ready for consumption, which is not necessary in the case of the avocado.

In passing it may not be out of place to compare, as shown in the following table, the fat percentages of the edible portion of ten varieties of the avocado with ten varieties of the olive:

Avocado	Edible Portion Per cent	Olive	Edible Portion Per cent
Chappelow	29.10	Corregiolo	27.68
Blake	25.50	Nigerina	26.16
Puebla	26.68	Nevadillo Blanco	22.92
Sharpless	24.23	Mission	22.51
Northrup	25.30	Rubra	22.01
Lyon	26.89	Pendulina	21.36
Fuerte	29.93	Redding Picholine	20.83
Atlixico	28.50	Macrocarpa	20.41

Blakeman	21.55	Manzanillo	19.73
Miller	25.50	Columbella	19.54

The above figures indicate that the avocado ranks higher in fat oil than the average, or commonly used, olive.

Digestibility. Experiments carried on by the Nutrition Division of the University of California have clearly proven that the avocado is very easily digested by the human system and the digestion coefficient for the fat in this fruit was found to be practically equal to that of butter fat.

Caloric Value. The total food value is sometimes expressed in terms of calories per pound. This method gives us the value of a food for fuel purposes, so to speak. It is not always correct, however, to compare the food values on the basis of calories alone because the real value of a food to the body depends upon the purpose for which it is fed. For example, one pound of sugar contains 1820 calories; one pound of meat, less than 1000; yet one would hardly say that one pound of sugar is equal to a pound of meat when the question of growth is concerned. When, however, we are considering the question of energy alone, then the case is different. The following table shows the caloric value per pound and of the average helping for ten different varieties of the avocado:

Edible Portion

Variety	Weight Ounces	Calories per pound	Calories Average helping
Landa	20.4	659	418
Blakeman	13.9	1012	440
Taft	11.0	876	308
Sharpless	9.0	478	240
Puebla	4.4	1219	337
Spinks	12.2	884	334
Dickinson	6.8	736	312
Lyon	8.4	1228	306
Fuerte	10.6	1328	440
Snell	8.0	1430	308
Average			344

The corresponding figures for some fruits and other foods are indicated below:

Calories Food Calories

Food Material	Av. helping
Apple	72
Banana	127
Blackberries	60
Cantaloupe	93
Grape fruit	139
Grapes	112
Orange	100
Watermelon	39
Butter	119
Cheese, Cheddar	100
Cream, average	60
Milk, whole	160
Eggs, boiled	90
Beans, home baked	250
Potatoes, boiled	145
Bread, white	100
Bread, Graham	100
Macaroni, boiled	100
Ice cream, cone	115
Ice cream, dish	275
Ice cream soda	avg. 300
Ice cream sundaes	400
Nuts, almond	100
Peanuts	128
Walnuts	125
Flour	1600
Bread	1200
Cereals	1600
Rice	1600
Eggs, ed. Por.	750

Meat, lean	1000
Sugar	1820
Dried Fruits	1250
Potato	425
Milk	320

The above tables show conclusively the high nutritive value of the avocado, both as regards its total calories per pound and the calories per average helping. It should be stated that these latter figures refer to the avocado as such without the addition of any mayonnaise, French dressing, or other accessory. The addition of such to the fruit increases, proportionately, the caloric value.

Dietetic Value. The dietetical value of fruit, aside from the actual nutrients which it contains lies in its succulency, its mineral matter and organic acids. Very recent investigations by Osborne and Mendel have shown that fresh fruits contain appreciable quantities of the water-soluble vitamin. The fruits experimented with were orange and other citrus fruits, apples, pears, prunes, and grape fruit. It is to be hoped that in the very near future experiments may be conducted at the University which will show that the avocado is also rich in water-soluble vitamins. As Dr. Mendel states, the experiments with fruits placed the dietary value of these foods, hitherto recommended because of their salt content, their laxative properties, or their anti-scorbutic potency, in a new light as sources of water-soluble vitamine.

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 results of generations of experience or of a knowledge of its beneficial effects.

Nutritional Studies of the Avocado—1919-1921

M. E. JAFFA AND HAROLD GOSS

During the year 1919-192O only 9 different varieties of the avocado, represented by 14 samples, were studied at the Nutrition Laboratory. It has been noted in previous reports that the oil percentage varied inversely with the size of the fruit. That statement is further emphasized by the results indicated in Table I.

TABLE I

ANALYSES OF AVOCADOS

Variety	Sample Submitted by	Locality	Date 1919	Weight, Grams	Physical Analysis Whole Fruit: Seed, Per ct.	Skin, Per ct.	Flesh, Per ct.	Chemical Analysis: Water, Per ct.	Fat, Per ct.
Fuerte	I. J. Condit	Altadena	May 2	347	12.96	11.81	75.23	60.3	29.90
Atlixco	J. T. Whedon	Yorba Linda	May 13	352	15.34	11.36	73.30	63.7	28.50
Atlixco	J. T. Whedon	Yorba Linda	May 13	532	16.91	9.79	73.30	63.1	26.90
Monroe	H. B. Sharpless	Santa Ana	May 14	595	24.20	13.61	62.19	75.9	6.97
Mexican No. 2	A. R. Rideout	Whittier	May 16	628	12.42	12.10	75.48	76.8	14.60
Mexican No. 2	Condit, I. J.	Sherman	Jun. 20	496	21.38	16.12	62.50	78.9	11.23
Himebaugh	H. H. Himebaugh	San Diego	Jul. 18	451	17.95	14.62	67.43	78.2	9.90
Himebaugh	H. H. Himebaugh	Sierra Madre	Nov. 17	313	18.20	14.05	67.75	55.9	32.40
Himebaugh	H. H. Himebaugh	Sierra Madre	Nov. 17	300	14.66	12.00	73.34	54.5	32.90
Himebaugh	H. H. Himebaugh	San Diego	Dec. 22	165	21.21	13.93	64.86	56.5	26.70
Himebaugh	H. H. Himebaugh	San Diego	Dec. 22. 1920	256	10.18	9.66	80.16	50.6	23.20
Himebaugh	H. H. Himebaugh	Anaheim	Feb. 27	357	19.88	14.06	66.06	74.8	16.20
Himebaugh	H. H. Himebaugh	Anaheim	Feb. 27	383	20.10	9.90	70.00	80.0	13.30
Himebaugh	H. H. Himebaugh	Whittier	Feb. 27	510	12.19	14.70	73.11	80.9	10.28

TABLE II

ANALYSES OF AVOCADOS

Variety	Sample Submitted by	Locality	Date 1919	Weight, Grams	Physical Analysis Whole Fruit: Seed, Per ct.	Skin, Per ct.	Flesh, Per ct.	Chemical Analysis: Water, Per ct.	Fat, Per ct.
Seedling	H. C. Galloupe	Los Angeles	May 1	346	5.2	20.0	74.8	73.2	17.60
Victory (Seedling)	H. A. Phelps	Sherman	May 1	418	19.8	12.0	68.2	79.0	9.60
Victory (Seedling)	H. A. Phelps	Sherman	May 1	405	21.0	11.3	67.7	81.2	8.00
Queen	J. T. Whedon	Yorba Linda	July 8	745	13.6	12.0	74.4	79.0	13.40
Whittier	Chas. Hamburg	Whittier	Aug. 16	687	11.5	11.5	77.0	75.2	21.20
			1921						
Seedling No. 20	E. C. Dutton	Anaheim	Mar. 28	266	9.4	11.6	79.0	83.5	7.05
Colorado	R. Agnes McNally	Whittier	Mar. 23	461	10.0	7.0	83.0	72.5	16.83
Colorado	R. Agnes McNally	Whittier	Mar. 23	270	13.7	10.2	76.1	75.7	14.80
Fuerte	R. Agnes McNally	Whittier	Mar. 22	261	15.7	7.3	77.0	68.4	23.80
Stephens No. 15	R. Agnes McNally	Montebello	Mar. 31	428	16.6	14.3	70.1	77.0	13.66
Stephens No. 15	Wm. D. Stephens	Montebello	Apr. 18	311	16.3	15.3	68.4	73.1	17.57*
Stephens No. 15	Wm. D. Stephens	Montebello	Apr. 18	309	18.8	13.7	67.5	74.3	16.77**

*Protein 2.47 per cent.
**Protein 2.36 per cent

It will be observed from the table that a new variety of the avocado received from Sierra Madre, from Mr. A. F. Snell, weighing 313 grams, shows 32.4 per cent fat for the edible portion for the flesh. The corresponding figure for a second sample, weighing 300 grams, of the same variety being 32.9 per cent. This is the highest percentage of fat recorded by this Laboratory for any variety of avocado. The next highest 31.6 is credited

to the Purdy grown at Whittier. The Fuerte, from Altadena, weighing 347 grams, or about three quarters of a pound, contains 29.9 per cent fat. Another variety, Atlixco, from Yorba Linda, weighing 352 grams yields a fat percentage on the edible portion of 28.5. Seven of the samples analyzed showed upwards of 23 per cent fat, the average for the total number being 20.21.

Table II presents the results of investigations carried on during the past year, which have been limited to the study of 12 samples representing 8 different varieties.

It will be noticed from the table that there are only two varieties showing above 20 per cent fat.

The samples as received at the laboratory would seem to indicate that the fruit is picked before maturity, the result being that the percentage of fat obtained by analyses is lower than that which the mature fruit would yield. This condition is well illustrated by the three analyses of Stephens No. 15, the first sample being received between two and three weeks earlier than the second and third. The percentage of fat in the last two is considerable higher than that noted for the former.

Unfortunately there appears to be a tendency upon the part of some shippers to endeavor to market their fruit as early in the season as possible so as to take advantage of the higher price. Such a practice is not conducive to the best interest of the avocado industry nor is it just to the consuming public in that the immature avocado is not only lower in fat than the mature but is also far less palatable. The result of marketing immature avocados will tend to discourage rather than to encourage the use of this valuable, highly nutritional fruit. At the same time it is not advisable to allow the fruit to remain on the tree until the maximum possible of fat is obtained because the percentage of fat will often increase for a period after maturity, the fruit in such cases becoming soft and more or less unpalatable.