

STUDIES ON THE COMPOSITION AND NUTRITIVE VALUE OF SOME SUB-TROPICAL FRUITS

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AVOCADO

The accompanying tables indicate the chemical and physical analyses of the avocado and other sub-tropical fruits that have been completed at our station laboratory since the last meeting of the Avocado Association:

- A. Avocado
- B. Guava
- C. Sapote
- D. Feijoa

The main part of the report submitted herewith refers to work done on the avocado. The tables are arranged according to varieties rather than chronologically, as the latter seems to be the more logical way of presenting the results of our investigations. Tentative conclusions drawn by previous studies would seem to be pertinent at present writing. While it is true that the larger fruit appeals to the public and commands a higher price, it must be remembered that it is not the larger fruit that contains the highest percentage of oil; in fact, the reverse is true as indicated by the following tabular statement:

Weight Fruit grams	Weight Seed grams	Seed Per Cent	Oil Per Cent
Large—			
1060	399	38	13.1
877	127	14	16.1
800	90	11	13.5
733	76	10	15.7
928	93	10	13.4
626	107	17	18.5
669	80	12	16.4
730	181	25	15.9
705	110	16	14.1
560	86	15	11.81
Weight Fruit grams	Weight Seed grams	Seed Per Cent	Oil Per Cent
Small—			
169	11	7	22.6
158	43	27	26.1
260	37	14	29.1
168	36	21	31.6
80	25	30	25.4
148	37	25	27.9
123	29	22	26.7
150	31	20	25.5
181	22	12	29.1
218	45	20	27.6

More illustration could be given, but the same general showing would be made. It has been said that in the large fruits the percentage of seed is less than in the small. This statement, however, is not borne out by the above figures. The average percentage of seed in the fruits, whether it refer to the large or small fruits, differs but little. This is an important point when considering the total food value, because it will be noticed by an inspection of the tables of the analyses that the higher the percentage of oil the lower the percentage of water and vice versa. The other ingredients of the fruit do not vary to the same extent. The percentage of oil at present from the standpoint of food conservation is very important.

Experiments which have been conducted at the Nutrition Laboratory have shown that the digestibility of the avocado oil is equal to that of other oils. Therefore, this fat or oil can be very advantageously used as a substitute for butter fat.

The honor ration which the United States Food Administration has recently offered to the people of the United States with the hope that they will adopt it, includes 7 ounces of butter fat per week, or 1 ounce per day, per person. For many this would appear to be an insufficient amount. There are other varieties of fat for the adult which can be utilized if the amount of butter indicated by the ration appears to be too small. The avocado pulp offers itself as an excellent source of fat, and it can be spread upon bread similar to butter. It may be said that it would be an expensive substitute. This is true if purchases are to be made in the open market, but the foregoing suggestions are offered to those who grow the avocado and who consume considerable quantities of this fruit. Such consumption might not be considered as economical, but it certainly would be in the line

of conservation. For feeding very young children it would be well to supplement the butter with the avocado, but not to use avocado entirely in the place of butter, owing to the fact that butter fat has properties essential for growth which the avocado may not contain. On the other hand, it must not be forgotten that when butter is consumed, it is only the fat which is really concerned. When the avocado is used we have not only a rich nutritive fat, but we have the mineral matter and organic salts which are so valuable to the human body.

Recorded examinations of avocados tend to show that the time of picking is materially concerned with the flavor. The best flavor is not as a rule associated with those fruits which hang for too long a period on the tree. The financial return for the time being from the sale of such fruit may exceed that of earlier fruits, but sooner or later this condition is bound to change in favor of the highest flavored fruit.

The advantage of the slight increase in fat which may result from a very late picking is more than offset by the deterioration of the flavor, etc. Quite often the fat does not increase after a certain point, no matter how long the fruit may remain on the tree. It is agreed by all that the larger use of the avocado is desired, and therefore, it must be borne in mind that it is very necessary that the fruit be marketed at its best, and in many instances this is not the case when the fat percentage is at its maximum. Several studies on different varieties during the past season has strongly emphasized this point. An increase of from 26 to 28 per cent in fat content has been accompanied with a much poorer quality of fruit.

SAPOTE, GUAVA AND FEIJOA

The results of the examinations of the guava, sapote and feijoa recently made at the Nutrition Laboratory are presented on Page 91.

The data is interesting, particularly with reference to the sapotes which contain about 20 per cent of sugar. Cane sugar predominates, in that 12 per cent of the 20 consists of this most desirable form of sugar. Two samples from different localities both show identically the same percentage of cane sugar, and the figure for invert sugar differs by less than 1 per cent. Two feijoas contain a much higher percentage of water and less than 5 per cent of total sugar, the remainder of the carbohydrate content being starch, etc. The starch figure for the sapotes, on the other hand, is less than 4 per cent.

The nutritive value of the sapotes far exceeds that of the other fruits mentioned in the table, with the exception, of course, of the avocado. This is clearly shown by the following figures representing the caloric value per pound of the edible portion of the fruits in question.

Lemon Guava ..	224 calories per pound
Strawberry Guava	287 calories per pound
Sapotes	483 calories per pound
Sapotes	440 calories per pound
Feijoa	226 calories per pound
Feijoa	240 calories per pound
Sp. Cacti	244 calories per pound

Avocado 984 calories per pound

The harvesting and palatability, etc., have to be taken into consideration in drawing conclusions regarding the market values of fruits and other foods. It can be seen readily, however, that if there were at hand a generous supply of sapotes, and this fruit met with public favor that the sugar content would help in the matter of conservation of sugar which is so urgently necessary at the present time.

The records of the various chemical and physical analyses are given in the following tables:

ANALYSIS OF AVOCADO
"A"—KNOWN VARIETIES

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water	Protein	Fat	Ash	Carbohydrate
							Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
2066	Azusa, Nov. 29, 1916	V. Metcalf, Azusa	169.	11.	12.	146.	62.69	2.91	26.44	1.81	6.15
2123	Carmen, Jan. 2, 1917	F. O. Popenoe, Altadena	139.	26.	15.	98.	63.39	1.22	26.38	1.55	7.46
2381	Caribou, July 19, 1917	Wm. A. Spinks, Duarte	464.	86.	58.	320.	82.31	1.34	10.33	1.42	4.60
2383	Caribou, July 19, 1917	Wm. A. Spinks, Duarte	486.	96.	55.	335.	79.02	2.21	12.00	1.34	5.43
*2495	Challenge, Sept. 26, 1917	Walker, Hollywood	1060.	399.	31.5	629.5	79.61	3.43	13.14	1.20	2.62
2577	Challenge, Nov. 1, 1917	W. P. Sherlock, Pasadena	666.	113.	54.	499.	79.93		13.70		
2048	Dickinson, Nov. 14, 1916	T. U. Barber, Los Angeles, Grown at Puente	254.	51.	46.	157.	72.04	1.56	20.36	1.35	4.69
**2325	Dickey, May 24, 1917	T. U. Barber, Puente, Grown by E. S. Thacher, Nordhoff	560.	86.	51.5	422.5	81.10	2.01	11.81	1.33	3.75
**2044	Fuerte, Nov. 10, 1916	J. T. Whedon, Yorba Linda	254.	38.	22.	194.	80.88	1.04	11.61	.94	5.53

*Taken from tree Sept. 26, 1917—Condition Overripe.
**Variety Uncertain—Thought to be "Dickey A".
***Fruit Immature.

ANALYSIS OF AVOCADO
"A"—KNOWN VARIETIES

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water	Protein	Fat	Ash	Carbohydrate
							Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
2167	Fuerte, Jan. 22, 1917	J. L. Whedon, Yorba Linda	315.	60.	21.	234.	66.30	1.42	25.32	1.28	5.68
*2196	Fuerte, Jan. 27, 1917	J. L. Whedon, Yorba Linda	566.	111.	37.	418.	68.32	1.36	24.23	1.27	4.82
2328	Fuerte, May 27, 1917	F. O. Popenoe, Altadena	269.5	49.	20.5	200.	65.26	1.40	26.68	1.44	3.22
2345	Fuerte, June 12, 1917	F. O. Popenoe, Altadena	255.5	52.	21.5	182.	65.67	1.51	26.60	1.60	4.62
2374	Fuerte, June 19, 1917	F. O. Popenoe, Altadena	254.0	26.	28.	200.	60.86	1.25	29.14	1.35	7.40
2374-A	Fuerte, June 19, 1917	F. O. Popenoe, Altadena	278.	48.	35.	195.					
**2377	Fuerte, June 25, 1917	F. O. Popenoe, Altadena	366.	42.5	25.	298.5			30.72		
2576	Seedless Ginters, Nov. 1, 1917	W. L. Rideout, Whittier	60.	3.	57.	70.72	3.34	18.12	1.39	6.49	
2375	I.X.L., June 19, 1917	Wm. A. Spinks, Duarte	705.	135.	88.	482.	84.27	2.12	7.50	1.41	4.70
2389	Lyon, July 10, 1917	Beck, La Habra	453.	76.	44.	333.	74.80	2.76	15.58	.85	6.01
2574	Lyon, Nov. 1, 1917	W. L. Rideout, Whittier	563.	96.	49.	418.	75.54		16.43		

*Average of Two Fruits
**Condition Overripe.

ANALYSIS OF AVOCADO
"A"—KNOWN VARIETIES

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water	Protein	Fat	Ash	Carbohydrate
							Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
2147	Monrovia, Jan. 8, 1917	F. O. Popenoe, Altadena	166.	36.	9.	121.	64.18	2.09	25.34	1.66	6.73
2326	Meserve (I)	T. U. Barber	328.	74.	62.	192.	74.66	2.19	17.01	1.36	4.78*
*2326	Meserve (II) May 24, 1917	T. U. Barber, Puente	334.	82.	49.	203.					
**2043	Puebla, Nov. 10, 1916	F. O. Popenoe, Altadena	168.	45.	12.	111.	80.59	1.76	11.32	1.11	5.22
2175	Puebla, Jan. 24, 1917	F. O. Popenoe, Altadena	280.	63.	14.	203.	69.47	1.66	20.94	1.28	6.65
2243	Puebla, Feb. 26, 1917	F. O. Popenoe, Altadena	158.	43.	14.	101.	67.53	1.83	26.14	1.34	3.16
2243-A	Puebla, Feb. 26, 1917	F. O. Popenoe, Altadena	165.	42.	9.	114.	63.32	1.80	26.63	1.56	6.64
2042	Queretaro, Nov. 10, 1916	J. T. Whedon, Yorba Linda	216.5	64.	18.	134.5	71.46	2.85	17.45	1.45	6.79
2047	Queretaro, Nov. 13, 1916	F. O. Popenoe, Altadena	164.	44.	16.	104.	71.46	2.34	18.21	1.43	6.56
2026	Royal Purple, Nov. 3, 1916	H. H. Himebaugh, San Diego	200.	39.	13.	148.	72.96	1.72	19.39	1.09	4.84

*Composite Sample I and II.
**Fruit Immature.

ANALYSIS OF AVOCADO
"A"—KNOWN VARIETIES

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water	Protein	Fat	Ash	Carbohydrate
							Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
2164	Sharpless, Jan. 15, 1917	B. H. Sharpless, Santa Ana	594.	93.	45.	456.	71.21	1.70	20.54	1.12	5.43
2294	Sharpless, Apr. 4, 1917	B. H. Sharpless, Santa Ana	536.	86.	43.	407.	72.63	1.27	18.77	.94	6.39
2379	Spinks, I.X.L., July 19, 1917	Wm. A. Spinks, Duarte	800.	90.	92.	618.	78.12	2.17	13.47	1.50	4.74
2380	Spinks (I), July 19, 1917	Wm. A. Spinks, Duarte	433.	88.	39.5	305.5	76.22	1.50	14.83	1.49	5.96
2380	Spinks, (II), July 19, 1917	Wm. A. Spinks, Duarte	343.	78.	39.	226.0					
*2515	Spinks (Large Fruit) October 10, 1917	Wm. A. Spinks, Duarte	877.	127.	51.	699.	75.72	2.10	16.01	1.43	4.74
2515	Spinks, (Small Fruit), Oct. 10, 1917	Wm. A. Spinks, Duarte	434.	76.	37.	321.			21.75		
2578	Sinaloa, Nov. 1, 1917	W. L. Rideout, Whittier	616.	72.	72.	472.	73.55	2.67	16.43	1.78	5.57
2581	Spinks, Nov. 1, 1917	Wm. A. Spinks, Duarte	520.	89.	39.	128.	74.76		16.74		
2579	Dr. Weldon, Nov. 1, 1917	Wm. A. Spinks, Duarte	450.	99.	84.	267.	63.75	2.57	24.29	1.69	7.79

*Overripe. †Too old and dry.

**ANALYSIS OF AVOCADO
"B"—UNKNOWN VARIETIES**

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water Per ct.	Protein Per ct.	Fat Per ct.	Ash Per ct.	Carbohydrate Per ct.
2019	Unnamed, Grown at Eagle Rock, Nov. 1, 1916.	F. O. Popenoe, Altadena.	733.	76.	63.	594.	74.68	2.30	15.67	1.62	5.73
*2335	Unknown, May 18, 1917.	Ed. H. Rust, Pasadena.	343.	90.5	35.5	217.	74.75	2.06	17.55	1.12	4.52
2604	Unknown, Nov. 20, 1917.	H. J. Webber, Citrus Experiment Station, Riverside.	315.	64.	30.	261.	71.20	.....	21.04	.....	.....

*Shape: pear. Color, green-brown mottled. Taste: O.K.; slightly sweet. Condition, ripe, soft.

**ANALYSIS OF AVOCADO
"C"—SEEDLINGS**

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water Per ct.	Protein Per ct.	Fat Per ct.	Ash Per ct.	Carbohydrate Per ct.
1747	Seedling, Purple Skin, Mexican, Jan. 4, 1916.	G. P. Wilder, Honolulu.	730.	181.	72.	477.	76.81	1.31	15.87	.86	5.15
2049	Variegated Seedlings, Nov. 15, 1916.	H. H. Himebaugh, San Diego.	173.	34.	20.	119.	69.10	1.30	24.04	1.29	4.27
2061	Seedling, Nov. 27, 1916.	H. H. Himebaugh, San Diego.	184.	24.5	17.5	142.	63.07	1.67	25.82	1.69	7.75
**2384	Seedling (I), July 6, 1917.	Hertrick, Los Angeles.	338.	79.	22.	237.	70.10	3.33	17.10	1.23	8.24
**2384	Seedling (II), July 6, 1917.	Hertrick, Los Angeles.	328.	92.	24.	212.					

**Skin peels off perfectly in quarters—flesh not sticking to it. Ripe.

**ANALYSIS OF AVOCADO
"C"—SEEDLINGS—Continued**

Lab. No.	Variety and Date	Submitted by	Fruit Grams	Seed Grams	Skin Grams	Edible Portion Grams	Analysis, Edible Portion				
							Water Per ct.	Protein Per ct.	Fat Per ct.	Ash Per ct.	Carbohydrate Per ct.
2402	Seedling, Aug. 8, 1917.	M. P. Hayes, Hollywood.	704.5	110.	45.	549.5	72.95	2.20	14.14	1.37	9.34
*2575	Unnamed Seedling, Nov. 1, 1917.	Chas. Hamburg.	187.	37.	11.	139.	76.	1.93	15.09	1.59	5.39
2580	Unnamed Seedling, Nov. 1, 1917.	Chas. Hamburg.	173.	41.	12.	130.	70.53	1.79	21.34	1.44	4.90

*Seed loose

PHYSICAL AND CHEMICAL ANALYSES OF SOME SUB-TROPICAL FRUITS

Kind Fruit	Locality	No. of Fruits	PHYSICAL ANALYSES						
			Fruit Grams	Seeds Grams	Per ct.	Skin Grams	Per ct.	Edible Portion Grams	Per ct.
Lemon Guava	Southern California	6	300.0	27.0	9.0	28.0	9.3	245.0	81.7
Strawberry Guava	Southern California	8	76.0	.....	.....	11.0	14.4	65.0	85.6
Sapotes	Altadena	2	131.0	15.0	11.4	18.0	13.7	98.0	74.9
Sapotes	Whittier	2	140.5	7.5	5.3	11.5	8.1	121.5	86.6
Feijoa	Sultana	9	216.6	.....	.....	34.2	15.8	182.0	84.2
Feijoa	Altadena	4	191.5	.....	.....	19.0	9.9	172.5	90.1
*Sp. Cacti	Santa Rosa	6	146.6	5.7	3.9	57.6	39.3	83.3	56.8
**Avocado	Southern California	28	197.4	40.0	20.2	22.5	14.1	135.8	65.7

CHEMICAL ANALYSIS

Kind Fruit	Carbohydrates							
	Water Per ct.	Ash Per ct.	Protein Per ct.	Fat Per ct.	Fiber Per ct.	Sucrose Per ct.	Invert Sugar Per ct.	Starch, etc. Per ct.
Lemon Guava	84.00	.67	.76	.95	5.57	.....	5.45	2.60
Strawberry Guava	79.42	.77	.88	.80	6.58	.....	5.06	6.49
Sapotes	72.64	.44	.64	.46	1.26	12.20	8.44	3.92
Sapotes	74.74	.47	.87	.55	1.62	12.24	7.72	1.79
Feijoa	84.86	.56	.82	.24	3.55	1.58	2.66	5.93
Feijoa	83.87	.45	1.02	.05	3.45	.....	11.16	.....
*Sp. Cacti	86.02	.43	.76	.07	.26	.....	10.25	2.21
**Avocado	69.16	1.26	2.08	20.10	.....	.....	.....	7.40

*Average of 6 analyses.

**Average of 28 analyses. Bulletin 254, Agri. Exp't Sta., University of California.