

NUTRITION STUDIES OF SOME NEW VARIETIES OF CITRUS FRUITS AND AVOCADOS

Seventh Annual Meeting, California Avocado Association, May 13th, 1922, Pasadena, Calif.

In view of the fact that the members of the California Avocado Association constitute a most progressive group it would appear that it would be of interest to present to the meeting, before discussing the avocado, results obtained by the Nutrition Division with reference to the Nutritive value of some of the new varieties of citrus fruits.

Nutritional Study on New Group of Citrus Fruits

M. E. JAFFA AND H. Goss

The literature is replete with full descriptions of these hybrid products, but no mention is made of either their chemical composition or food value. In order, therefore, to supply such data, a nutritional study was undertaken, on available samples, of some of the varieties of these new fruits.

Through the courtesy of the Citriculture Division samples were obtained of the Tangelo, Citrange and Orange-lemon. A further sample of the Tangelo was received from the Citrus Experiment Station, submitted by Dr. Barrett. The analyses of these fruits are given herewith:

<i>Physical Analysis</i>								
Tangelo								
	Variety Sampson				Orange-lemon		Citrange	
	Sample 1		Sample 2		Hybrid	Variety	Coleman	
	Grams	Pr. ct.	Grams	Pr. ct.	Grams	Pr. ct.	Grams	Pr. ct.
Rinds	32.5	21.4	32.0	21.9	56.0	34.0	41.5	28.5
Seeds	1.5	1.0	2.3	1.6	1.0	0.6	0.8	0.5
Pulp, pressed....	41.5	27.4	47.9	32.9	42.0	25.5	28.2	19.2
Juice	76.0	50.2	63.8	43.6	66.0	39.9	75.0	51.8
Whole Fruit....	151.5*	100.0	146.0	100.0	165.0	100.0	145.5*	100.0

*Average of 2 fruits.

<i>Chemical Analysis of Juice</i>						
Tangelo						
	Sample 1		Sample 2		Orange-lemon	Citrange
	Per cent		Per cent		Per cent	Per cent
Protein	0.66		0.74		0.63	1.32
Ash	0.42		0.37		0.40	0.52
Acid as citric.....	1.83		1.41		7.37	3.72
Sucrose		3.95		4.00	0.29	2.72
Invert		5.05		5.75	1.53	4.14
Total Sugar	9.00		9.75		1.82	6.86
Total Solids	11.91		12.27		10.22	12.42
Water	88.09		87.73		89.78	87.58
Total	100.00		100.00		100.00	100.00

The Tangelo

The Tangelo is a hybrid produced between the Pomelo and the Tangerine. The fruit is larger in size than the tangerine but much smaller than the average Pomelo. It combines the flavor of the two parental varieties. The bitter taste, so pronounced in the grapefruit, is practically absent in the Tangelo. The acid approaches that of the grapefruit which varies from 1.7 to 2.0 per cent in mature fruit. It will be noticed that the acid content of the samples of Tangelos examined ranges from 1.4 to 1.8, the latter representing a fruit not fully matured.

The sugar percentage, however, of the new fruit is only slightly higher than that recorded for the mature grapefruit.

In view of the attractive appearance, color of flesh and the lack of bitter taste, it is believed that this will become a very popular fruit and be more acceptable than grapefruit to many as a breakfast fruit.

The Orange-lemon Hybrid

The orange-lemon is a hybrid produced between the orange and lemon. The above analysis shows that the acidity of the lemon is preserved while the physical characteristics of the orange are much in evidence, particularly with reference to the color of the skin, rind, etc. The shape, however, is more that of the lemon than that of the orange. The sugar content corresponds to that found in the lemon and not the orange.

The Citrange.

The citrange is a hybrid between a common sweet orange and the trifoliolate orange and which promises to be of considerable value. The acid content is about half that recorded for the lemon, while the percentage of sugar is practically 50 per cent of that yielded by the orange. In this case then the fruit, as regards sugar and acid, is half way between a lemon and an orange, and therefore, decidedly different from any other of the new citrus fruits.

Further nutritional studies will be made of these new varieties from the crop of 1922.

Further Studies on the Avocado.

M. E. JAFFA AND EATON M. MACKAY

The enclosed table of analyses represents results of analyses of 22 samples of avocados submitted during the month of August, 1921.

Ten of the analyses refer to samples of new varieties grown by Mr. W. A. Spinks, Duarte, Calif. Two specimens were received from Mr. Popenoe, Altadena, Calif. Seven analyses were made on samples of fruit submitted by Mr. J. T. Whedon, Yorba Linda, Calif.

The Division of Pomology, Department of Agriculture, Berkeley, Calif., submitted four samples, as indicated on the table.

Physical Analysis

Commenting on the samples submitted by Mr. Spinks, it may be said that the samples varied in weight from about three-quarters of a pound to about 1 3/4 pounds, or from 310 grams to 860 grams.

The variety Pankay shows a high percentage for the skin and the pit resulting in a, comparatively speaking, low percentage of edible portion as against corresponding figures for the Cantel and Nimlioh, which shows 75 per cent edible portion. These latter fruits possess a very fine flavor which appeared to be better, to the writer, than that of the Pankay. It would appear from the analysis of the sample sent that this fruit ranked lowest in flavor.

The two specimens of variety Popenoe 101 show an average of nearly 74 per cent edible portion with low percentage of seed and pit. The flavor was excellent and texture good.

The smallest percentage of pit and skin was spoken for the Linda submitted by Mr. Whedon as indicated by the figures 13.9 for pit or seed and 8.29 for skin, respectively. The next lowest was indicated for the Popenoe with 9.48 per cent of pit and 14.34 for skin, respectively.

It is true that lower percentages are yielded, of pit and skin, by the fruit obtained from the Division of Pomology, but their samples were not in as normal a condition as were those received from other sources, as indicated on page 3.

Chemical Analysis

Very interesting data are presented by the results of the chemical analyses of the samples under discussion. Three of the new varieties submitted by Mr. Spinks, Cabnal, Benik and Mayapan, show, respectively, 23.71 per cent, 22.02 per cent, and 22.83 per cent fat. At the same time it will be noticed that these percentages are greatly exceeded by the figures indicated for Popenoe 101, the two specimens containing 31.59 per cent fat and 29.78 per cent fat, respectively. The percentage of protein yielded by the new varieties are, comparatively speaking, low.

Commenting upon the analyses of the older varieties, samples submitted by Mr. Whedon, it may be said that the Knight, with 23.31 per cent fat, heads the list as far as nutritive value is concerned. Both specimens of Linda show low per cent. Similarly with reference to the two specimens of variety Kist.

The analysis 3746a represents that of the Kist 3746 after further ripening.

The analyses of some of the older varieties were not completed for lack of time. It was considered more necessary to make complete analyses of the newer varieties.

Remarks on Samples of Avocados

A. Remarks on samples submitted by W. A. Spinks, Duarte, Cal.

The samples mentioned in the table were received at the laboratory through Mr. F. O. Popenoe, Altadena, Cal., on the 17th of August. The samples were all immature, and, as it was not possible for the few days following to conduct the analyses, it was decided to place the fruits in the refrigerator.

Samples Nos. 3759 and 3760, Cabnal and Benik, respectively, were placed in the refrigerator room from 17th August to 2nd of September, when they were taken out and kept at room temperature for three days previous to being analyzed.

Sample 3761, Mayapan, was taken out of the refrigerator on the 21st of August and kept at room temperature for 6 days before the fruit appeared to be mature and ripe.

Sample 3769, another specimen of Mayapan, remained in the refrigerator from the 17th of August to the 31st, and then at room temperature until the 2nd of September, when the analysis was made.

Specimens 3762 and 3773, Pankay, were kept in the refrigerator from the 17th of August to the 31st of August, and then at room temperature for 5 days before they were considered ripe enough for consumption.

No. 3764, Lamat, was taken out of the refrigerator August 31st and remained at room temperature until the 4th of September, when it was considered ripe enough for consumption.

No. 3765, Cantel, remained in the refrigerator until the 1st of September, and then at room temperature for 4 days more.

No. 3766, Nimlioh, remained in the refrigerator from the 17th of August to the 2nd of September, when it was taken out and kept at room temperature for 3 days previous to its being analyzed.

B. Samples submitted by F. O. Popenoe, Altadena, Calif.

The two specimens of Popenoe 101 were separately analyzed because they were at different stages of ripeness when received.

No. 3763 was in the refrigerator for 5 days and at room temperature for 1 day.

No. 3768 was in the refrigerator 4 days and at room temperature for 3 days additional, analyzed August 27th.

C. Samples submitted by J. T. Whedon, Yorba Linda, Calif.

The fruits submitted by Mr. Whedon were also immature and therefore were not analyzed upon arrival at the laboratory. They were kept at room temperature, as indicated below:

No. 3742, Queen, for 5 days before being analyzed.

No. 3744, Knight, for 8 days.

No. 3745, Linda, 13 days, from 19th July to 1st August, inclusive.

No. 3746, Kist, was kept at room temperature for 9 days, July 19th to 28th, inclusive, on which date it seemed to be mature. Upon cutting the fruit, however, it was found greener than anticipated. A portion of it was analyzed and another portion was kept covered for 4 days and separately analyzed. During this period the fruit ripened without any indication of having spoiled. The analysis is given in the table under 3746a.

No. 3747, another specimen of Kist, kept at room temperature from July 17th to 27th (10 days) previous to analysis.

D. Samples submitted by Division of Pomology, Berkeley, Calif.

No. 3740, Linda, was received in a very poor condition. It was overripe and almost rotten. It had been stored at the Division of Pomology for a period of 16 days at room temperature of about 66° F.

No. 3741, Queen, had been picked July 8th, stored in refrigerator from July 11th to July 27th, when it was sent to the laboratory. Upon cutting the fruit it was found to be quite immature. The two halves were therefore tied together and kept at room temperature for 4 days, or until the 1st of August. During this period it had ripened and was a far more palatable fruit than when originally cut.

No. 3748, Queen, was received at the laboratory on the 19th of July, having been kept in cold storage for an unknown period, and similarly with reference to No. 3750, Dickinson.

THE AVOCADO AS A SOURCE OF VITAMINS

M. E. JAFFA

The chemical investigations of the avocado have shown it to be a most valuable and desirable fruit, in that it is exceedingly rich in fat content and has an appreciable amount of protein, in some cases exceeding 4 per cent, and an adequate supply of mineral

matter. The study of vitamins, however, has not been included in the work done by the Nutrition Division of the University of California, the reason being that there were no funds available for carrying out such investigations. This subject, however, has been investigated by Mr. Francisco O. Santos, traveling fellow of the University of the Philippines, who obtained the degree of Doctor of Philosophy at Yale. The data in regard to the avocado is taken from the dissertation presented by Mr. Santos for his degree.

The avocado was studied for its content of vitamins B and C.

The edible portion of the dried fruit was ground and extracted with ether, to remove most of the fat. Rats which had been declining in weight, due to lack of vitamin B, easily recovered upon the administration of either one gram or one-half gram of extracted avocado daily, in addition to the standard ration. One-tenth gram was found to be insufficient, and four-tenths gram seemed to be just enough to cause maintenance, but not complete recovery of the weight. The standard diet consisted of:

Per Cent	
Casein.....	18
Salt mixture	4
Starch	50
Butter fat	9
Lard.....	19

From the results of Mr. Santos' experiments, it is conclusively shown that the avocado is an excellent source of vitamin B, or anti-nuritic.

Unfortunately, the experiments with the avocado for the purpose of ascertaining its content of vitamin C were unsuccessful.

In testing for vitamin C, guinea pigs were used as the experimental animals. Hess and Unger's (23) scorbutic diet of hay, oats, plus 0.5 to 1 cc. of cod liver oil, daily, and water ad libitum, was used as the basal diet in most of the tests. The oil was given by a pipette. At first, finely chopped hard boiled egg (yolk plus white) was offered instead of the cod liver oil, but the animals would not eat the former. In the experiment with avocado, no use of cod liver oil was made. On the basal ration control guinea pigs (Nos. 2, 13 and 14) succumbed to scurvy after 16, 26 and 27 days, respectively. In all of the guinea pigs autopsied it was found that the hemorrhages were more severe in those that were not given oil than in those animals that ate the improved diet. At first curative experiments were tried; but it was difficult to make the guinea pigs eat when they were already suffering from scurvy, and therefore preventive tests were performed. In the curative experiments the animals demonstrated the external signs of scurvy, such as the scorbutic position (22), crying when handled, painful or swollen limbs, and pale gums, before the materials to be tested were given as supplement to the scorbutic diet.

Discussions of the Materials Used and the Feeding Experiments

Inasmuch as in every-day nutrition the materials to be tested here are never eaten alone, since the amount that an individual can eat in a day is dependent in part on his

alimentary capacity, and since, further, our object was to get a comparative estimate of the possible value of the foods as practical sources of vitamin C, a daily supplement of 10 grams to each guinea pig in addition to the basal ration was considered the maximum.

Avocado (*Persea persea*). This fruit is eaten raw, and if it could be shown to be high in vitamin C, it would be of great value. Unfortunately the guinea pigs would not eat the avocado; so both the preventive and curative experiments were unsuccessful.

It is true that the guinea pigs did not like raw avocado as such, but there is no doubt but what the guinea pigs would have eaten the avocado had it been mixed with powdered graham cracker. The graham cracker would have made an excellent carrier for the avocado and would not have interfered with the accuracy of the test, in that the graham cracker is deficient, and sadly so, in this vitamin.

In this connection it might be said that the Nutrition Laboratory will, within the next few months, continue the work started by Mr. Santos, with the hope that by modifying the diet as above indicated, the guinea pigs will eat the avocado raw, the only way, of course, in which it should be consumed.

The analytical work on the avocado by the Nutrition Division, University of California, has been quite limited during the past year, due to a slight misunderstanding. It was earnestly hoped that the Nutrition Laboratory might have been able to undertake studies on the avocado in regard to its vitamin content. Such an investigation would involve considerable expense, and it was found out later that the necessary funds could not be obtained. This was communicated to the President of the California Avocado Association. It was not intended, however, to convey the impression that no further analytical work could be conducted, because such was not the case. The present personnel and equipment does allow for the analyses and nutritional studies of the avocado; and the Nutrition Laboratory is more than willing to continue such work if members of the Association so desire.

In connection, however, with such investigations, it must be understood at the outset that the data submitted to individual members is for their own private use and cannot be used for publication or advertising purposes until after said data has been presented at a meeting of the Association, and published in the proceedings of the respective meeting. It is to be regretted that this point has to be so strongly emphasized, but, owing to an unfortunate experience during the past six months, it would appear that this public statement is called for.

The Nutrition Laboratory has tried to be of help to the growers of the avocado in the matter of ascertaining the chemical composition of new varieties of fruit or of standard varieties from different places and grown under different conditions. It would appear that such information is of value, but from the point of view of the Laboratory that value should be for the guidance and help of the individual and not to be used publicly immediately upon receipt of said information. It is to be hoped that the experience referred to will be the one and only—that is, the first and last.

ANALYSES OF AVOCADOS

Samples submitted by W. A. Spink, Duarte, California, Aug. 1921.

Physical Analysis

Lab. No.	Variety	Whole Fruit			Analysis of Edible Portion.						
		Weight Grams	Pit Pr. ct.	Skin Pr. ct.	Flesh Ed. Por. Pr. ct.	Water Pr. ct.	Protein Pr. ct.	Fat Pr. ct.	Ash Pr. ct.	Crude Fiber Pr. ct.	N-free extract Pr. ct.
3758	Cabnal	459	13.51	19.60	66.89	67.15	2.08	23.71	1.37	1.80	3.89
3760	Benik	518	17.55	13.51	68.94	69.98	1.97	22.02	1.61	1.76	2.66
3761	Mayapan	397	14.61	22.67	62.72	68.33	1.77	22.83	1.48	1.88	3.71
3769	Mayapan	449	14.03	14.03	71.94	70.26	2.25	21.80	1.56	0.84	3.29
3762	Pankay	385	15.33	25.97	59.70	73.15	1.58	14.56	1.61	2.20	6.90
3773	Pankay	310	20.32	25.80	53.88	71.01	1.64	16.30	1.42	3.06	6.55
3764	Lamat	332	9.34	21.08	69.58	77.32	1.42	14.29	1.40	1.29	4.28
3765	Cantel	351	9.98	14.81	75.21	72.04	2.43	19.00	1.59	1.34	3.60
3766	Nimlioh	860	14.54	9.88	75.58	78.55	1.53	13.93	1.16	3.45	1.38
Samples submitted by Mr. F. O. Popenoe, Altadena, Cal., Aug. 1921.											
3763	Popenoe 101	327	9.48	14.34	76.18	58.71	2.39	31.59	1.66	2.23	3.42
3768	Popenoe 101	375	14.40	14.94	70.66	60.78	1.82	29.78	1.70	2.41	3.51
Samples submitted by Mr. J. T. Whedon, Yorba Linda, Cal., Aug. 1921.											
3742	Queen	663	10.26	18.89	70.85	73.80	2.21	16.35	1.63	2.83	3.18
3743	Linda	832	13.90	8.29	77.81	83.41	1.89	8.47	1.43	1.73	3.07
3744	Knight	570	12.21	14.74	73.05	71.03	.....	23.31	.....	.....	.....
3745	Linda	438	12.56	15.06	72.38	79.83	.....	13.34	.....	.....	.....
3746	List	456	17.54	13.81	68.65	76.84	1.51	12.16	1.36	4.12	4.01
3746a	Kist	456	17.54	13.81	68.65	77.72	.....	15.50	.....	.....	.....
3747	Kist	478	17.90	10.30	71.80	74.71	2.41	14.92	1.47	1.98	4.51
Samples submitted by Division of Pomology, Berkeley, Cal., Aug. 1921.											
3740	Linda	890	11.91	8.32	79.77	82.66	.....	7.48	.....	.....	.....
3741	Queen	412	6.79	12.13	81.08	78.91	.....	13.32	.....	.....	.....
3748	Queen	638	11.59	10.66	77.75	79.38	.....	11.78	.....	.....	.....
3750	Dickinson	280	15.35	14.64	70.01	79.82	.....	11.51	.....	.....	.....