Influence of Avocados on Serum Cholesterol. (25722)

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Serum cholesterol values are lower when dietary fats are of vegetable rather than of animal origin. It is generally agreed that while degree of unsaturation of lipid is important, it is not necessarily the sole factor involved(1). Because of its high lipid content (5 to 25%) and palatable and convenient form, it was decided to use the avocado for partial replacement of mixed dietary fat with a fat of vegetable origin. Although few analyses have been made of the composition of avocado lipids, some representative values are shown in Table I. Total lipid content and possibly its composition vary with variety of avocado and degree of ripeness.

Materials and methods. Sixteen white male patients aged 27 to 72 years in Veterans Admin. Hospital, Coral Gables, Fla., took part in this study. Five patients were on salt restricted diets in which daily intake varied between 5 to 10 g. Three diabetic patients were given prescribed diets with respect to calories, fats, carbohydrates and protein, maintained throughout the study. All others ate regular hospital diet. Venous blood samples were drawn from all patients twice a week before breakfast. Total, ester and free cholesterol values were measured in serum by Sperry and Webb method(3) and phospholipids by the method of Zilversmit(4). Fat and calories were estimated from food tray by the dietician and diet lists prepared each day. All supplemental feedings were also recorded. Total calories and weight of fat were calculated from standard charts or from chemical analysis as described. The Fuerte variety of avocado was used from Feb. to May 1959 and the Hass variety from June to Sept. 1959.* To estimate total lipids of avocados, aliquot of pulp was extracted continuously with alcohol-ether mixture and total lipids weighed after solvent removal. Analyses of edible pulp were made in Jan., Feb., March and August and average values for total extractable lipids were respectively 21.8, 22.8, 22.9 and 20.6%. The edible portion of avocados averaged 200 g. Since an estimated 2 to 4% of total lipids are nonsaponifiable and presumably not assimilated, an average of 20% lipid content was used in calculations. With 200 g of edible material the average fruit contained 40 g of lipid. During control period, *i.e.*, 8 to 56 days, all subjects consumed regular diets without avocados. When reasonably constant blood values were obtained, from 0.5 to 1.5 avocados/day were incorporated into diet as shown in Table III. Animal fat equivalent to half or more of the avocado lipid was removed from the basal diet of 17 subjects. In subject 10, however, the avocado was added to his unchanged basal diet. Daily fat consumption before and during avocado feeding period is shown in Table III. Blood values and diet calculations were continued for duration of avocado feeding period.

Results. A summary of average blood values of all subjects is presented in serial order in Table II. Measurements made during control period are compared

TABLE I. Lipid Composition of Avocado Oil.

Source	Calif. & Fla.	Calif.	
Variety		Hass	Fuerte
Saturated fatty acids (% of total fatty acids)			
Myristic	.1		
Palmitic	7.2	22.1	14.1
Stearic	.6	.7	.2
Arachidic	trace		
Unsaturated fatty acids (% of total fatty acids)			
Palmitoleic		11.0	5.5
Oleic	80.9	51.9	70.7
Linoleic	11.2	14.3	9.3
Non-saponifiable (% of total lipid)	1.6		2–4
Iodine No.	94.4		
Reference	(2)	*	*

* These data were kindly supplied by Judd C. Nevenzel, Univ. of Calif., Los Angeles.

* All avocados used were supplied by Calavo Growers of Calif.

TABLE II. Serum Cholesterol and Phospholipids Values in 16 Patients.

Control period				Avocado feeding period							
Total chol.	Free chol.	Chol. esters	Phospho-lipids	Total chol.	P value	Free chol.	P value	Chol. esters	P value	Phospho-lipids	P value
367.0	97.0	270.0	14.6	236.7	<.01	64.7	<.01	172.0	<.01	11.5	<.01
296.0	92.0	205.0	11.6	169.0	"	48.0	"	121.4	"	8.0	"
267.0	71.5	195.5	16.2	198.6	"	54.2	"	144.1	"	10.9	N S
249.0	63.0	185.8	10.6	179.8	"	53.0	"	126.8	"	8.8	<.01
215.6	60.6	155.0	11.0	171.6	<.02	52.3	N S	119.2	<.02	8.4	<.02
270.6	69.3	201.3	12.8	196.0	<.01	53.1	<.01	142.9	<.01	11.2	"
331.0	90.8	240.2	16.7	302.3	"	81.5	"	221.0	N S	14.3	<.01
240.0	62.3	177.7	12.7	203.0	"	67.0	N S	134.0	<.01	10.0	N S
290.3	78.3	212.0	12.6	258.0	N S	69.0	<.04	189.5	N S	10.7	<.04
300.0	94.6	206.0	14.2	301.0	"	83.4	N S	217.8	"	10.8	N S
259.0	72.2	186.8	11.1	235.5	"	68.4	"	167.1	.01	11.5	"
305.0	84.6	220.8	13.3	271.8	"	73.8	.01	198.0	N S	12.9	"
552.0	234.2	317.8	26.2	547.2	"	217.8	N S	329.0	"	27.7	"
271.0	67.4	203.4	12.2	253.1	"	62.0	"	190.1	"	11.3	"
233.0	81.8	151.4	15.6	212.0	"	86.3	"	125.7	"	10.3	"
299.0	85.6	213.6	12.4	254.0	"	75.5	"	179.0	"	12.5	"

Cholesterol expressed in mg/100 ml and phospholipids as mg lipid P/100 mg.
All data are arranged in serial order of patients.

with those taken during avocado feeding period. Percentage change and "P" value by Wilcoxon Rank test(5) are shown. Of 16 subjects, 8 gave decreases in total serum cholesterol from 8.7 to 42.8%, which were statistically significant. Although both free and ester forms decreased significantly, changes in esters generally exceeded those in the free form. Serum phospholipids decreased at the same time as did cholesterol values. In no subject did cholesterol or phospholipid concentrations rise significantly during avocado feeding period. Such increase failed to occur in spite of appreciable increases in fat and calorie intake in several patients. Average values for daily fat and total calorie consumption and body weight during control and avocado feeding periods are given in Table III.

In 2 patients (1st and 6th) at end of avocado feeding period, a second control period was instituted, followed by second avocado feeding. The first was particularly interesting, because total fat intake during first control and avocado periods was low but was considerably higher during both second control and avocado periods. In both patients despite differences in fat consumption and calorie intake between first and second se-

TABLE III. Dietary Values and Body Weights.

Control period				Avocado feeding period				
Days	Fat/day	Calories/day	Body wt	Days	Avocado/day	Fat/day	Calories/day	Body wt
22	57	2307	147	34	1.5	83	2577	143
21	41	1179	147	13	.5	72	1550	140
56	70	1582	165	31	1.5	76	1657	161
25	50	1237	156	36	1.0–1.5	59	1363	154
13	94	2271		25	1.5	103	2161	
37	46	1251	143	41	1.5	98	1833	145
14	44	1654	151	72	1.5	115	2706	152
20	25	1027	183	9	1.5	86	1666	186
8	71	1629	150	33	.5	71	1629	150
12	85	2029	154	21	1.0	154	2965	154
17	60	1228	170	50	.75	60	1228	162
14			132	85	1.5	105	2052	133
12	71	1834	139	76	1.5	102	2336	140
8			131	25	1.5	105	1972	129
19	27	838	160	39	.5	38	891	154
14	50	1200	130	20	.5	50	1200	127

All data are arranged in serial order of patients.

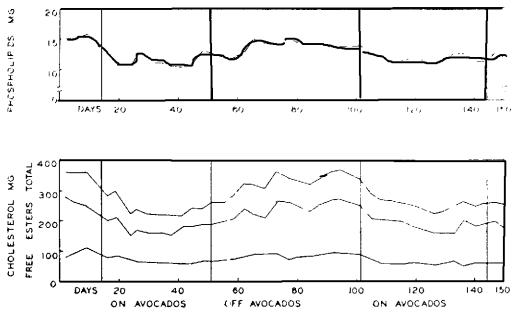

FIG. 1. Serum cholesterol and phospholipid values in a single subject.

ries, decreases in total cholesterol values were similar.

To illustrate time sequence in feeding trials, total, free and ester cholesterol, and phospholipid values obtained from one subject were graphed in Fig. 1. Total serum cholesterol and phospholipid values began to fall in a week after inclusion of avocados in the diet. Changes in ester form were far more striking than those in free cholesterol.

Discussion. Partial substitution of avocado lipid for mixed dietary lipids produced a significant decrease in serum total cholesterol values in 8 subjects. An obvious explanation lies in the unsaturated, fatty acid content of avocado fat which has an Iodine No. of 94 (Table I). Another possibility concerns the 1 to 4% unsaponifiable fraction of avocado lipid which appears to be a sitosterol in nature. When 10 g or more of sitosterol were fed daily a decrease in serum cholesterol was observed(6). One avocado contains about 40 g of lipid. Assuming an average nonsaponifiable fraction of 2%, a single fruit would have about 0.8% g of a sitosterol. Although daily consumption of sitosterol alone may have been ineffective, its combination with unsaturated avocado may have increased its efficacy.

Average daily fat and calorie consumption in general increased during avocado feeding period, yet body weights did not increase as expected (Table II) and in some subjects declined from 1.5 to 4.8%. Small changes in body weight, however, were not correlated with changes in serum cholesterol. This apparent discrepancy between increased fat consumption and changes in body weight is under investigation.

In 8 subjects, decreases in serum cholesterol values were not statistically significant. While there is no complete explanation for lack of response, there are certain differences between the group responding and that not responding. Of those showing no real change, 3 were mild diabetics and another had hypercholesterolemia of unknown origin. A fifth subject not responding was treated differently from all others in that the avocado was added to his diet without removing existing fat.

Summary. 1. Sixteen male patients aged 27 to 72 years were given 0.5 to 1.5 avocados /day. Animal fat equivalent to a portion of added avocado fat was removed from the basal diet. 2. Serum total, free and ester cholesterol and phospholipids were measured twice a week during control and avocado feeding periods. 3. Of 16 patients during avocado feeding period, 8 gave significant decreases in total serum cholesterol from 8.7 to 42.8% and in phospholipids of from 12.5 to 21.0%. Decreases in ester form exceeded those in free cholesterol. 4. In no individual did cholesterol values rise during avocado feeding. Of 8 patients whose cholesterol values were unchanged, 3 were diabetic and one was hypercholesterolemic.

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Received February 8, 1960. P.S.E.B.M., 1960, v104.