NUTRIENT INTAKE *and* BLOOD FINDINGS *of Men on a* DIET DEVOID OF MEAT

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FOR THE PAST few years this laboratory has been interested in a community of men subsisting on a diet devoid of meat and low in animal protein, fat, and cholesterol. A previous study[1] disclosed that despite the low animal protein intake for periods of from 12 to 47 years, the erythrocyte count, hemoglobin and hematocrit values, blood iron, glucose, nonprotein nitrogen, total serum protein, albumin, and globulin levels were within normal limits. A further study of this community was thought to be of interest. Accordingly, the work and rest habits, the average daily nutritive intake, and the kinds of foods served were studied. Serum cholesterol and cholesterol-ester determinations were made to investigate the effect of a persistently low cholesterol intake on these values. In order to study the effect of low animal protein intake on the nonprotein nitrogenous constituents of blood, determinations of nonprotein nitrogen, urea nitrogen, uric acid, and creatinine levels in the blood were also performed.

WORK, REST, AND FOOD PATTERNS

The community was self supporting. The members of the community were engaged in land reclamation, raising of crops, breeding of dairy herds, construction of living quarters for the men and barns to house animals and crops, making and repair of apparel and furnishings, maintenance of farming tools, and farming. Thus, the men were very active physically. They worked eight hours a day, six days a week at their respective occupation. The men rose at 2:00 a.m. every morning; they retired at 7:00 p.m. during the winter months and at 8:00 p.m. during the summer. In the summer they rested one hour after dinner; thus the men slept or rested 7 hours per day throughout the year. The remaining 9 hours were spent in mental activities and moderately active physical activities.

With few exceptions, all the foods served were raised by the men. All meals were prepared on the premises and were always served at the same hour of the day in a common dining hall. Six and a half months of the year—September 14 to March 30, designated as the first period in this study—the food intake was more restricted than during the remaining five and a half months—April 1 to September 13, designated in this study as the second period. Table I summarizes the meal pattern followed throughout the year.

Meat was never served, nor was meat stock added to the soup. Likewise eggs, as such, were never served; however, 10 ounces of dried eggs (1.36 per cent) were added to a 46-pound batch of raisin bread which was served 28 times during the year. Also, the plain cake or cookies which were served only 10 times during the year contained fresh eggs according to the recipe used. The barley coffee contained 9.26 per cent fresh skim milk, and the whole wheat bread contained 2.17 per cent dried skim milk. Although vegetables and fruit of all varieties were permissible, the variety was limited to a great extent to those crops native to the area in which the com-

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TABLE I

Meal Pattern

Meal	Time	First period: Sept. 14 to Mar. 30	Second period: Apr. 1 to Sept. 13
Breakfast	6:00 a.m.	2 oz. whole wheat bread, barley coffee	6 oz. whole wheat bread, barley coffee
Dinner	12:00 a.m.	Vegetable soup portion, a serving of two vegetables, whole wheat bread, barley coffee	Vegetable soup portion, a serving of two vegetables, a fresh fruit or 2 oz. stewed fruit, whole wheat bread, barley coffee
			Mon. Wed. Fri. & Sat.
Supper	5:30 p.m.	6 oz. whole wheat bread, 2 oz. fruit sauce, barley coffee	Vegetable soup portion, a fresh fruit or 2 oz. stewed fruit, whole wheat bread, barley coffee
		17 Sundays	*Sun. Tues. & Thurs.*
		Milk, skim, American Cheddar Cheese, 3 x 2 x 1/8 portion, whole wheat bread, barley coffee	Milk, skim, American Cheddar Cheese, 3 x 2 x 1/8 portion, whole wheat bread, barley coffee

munity was located. The whole wheat bread was made from wheat grown and milled by the men. A tablespoon of margarine or butter was served 28 times per year. In Table II are summarized the foods served and in some instances the number of times the food was served during the year.

TABLE II

Foods Served

		Occasionally
Vegetables		
Beets	Parsnips	Broccoli
Cabbage	Peas	Cauliflower
Carrots	Pumpkin	Rutabagas
Celery	Potato, Sweet	Sauerkraut
Corn	Potato, White	
Chinese Cabbage	Radishes	
Cucumber	Spinach	
Eggplant	String beans	
Endive	Tomatoes	
Lettuce	Squash, Summer	
Mustard Greens	Turnips	
Onions	Turnip Greens	
Okra		
Legumes		
Navy beans	Lima beans	
Fruit		
Apples	Peaches	Bananas
Cantaloupe	Pears	Blackberries
Figs	Watermelon	Grapefruit
Oranges		Grapes
		Raisins (in raisin bread)
Dairy Products		(*Occasionally*)
Milk, fresh skim and dried skim		
Cheese, American Cheddar		
Bread and Cereals		
Bread, whole wheat	Oatmeal	Corn Bread
Cornflakes	Rice	Raisin Bread (28 times per year)
Macaroni	Spaghetti	
Beverages		
Barley Coffee		Cocoa 10 times per year
		Coffee 15 times per year
Fat		
Wesson Oil®		Oleomargarine or butter 28 times per year
Tastex®-hydrogenated shortening		
Peanut Butter		
Miscellaneous		
Apple Pie, rarely	Ice cream 15 times per year	
Candy, hard or chocolate 30 times per year	Molasses, in raisin bread	
Honey, rarely	Sorghum, rarely	

Experimental Procedure

Six members of the community participated in the study. The men appeared to be "healthy"; they were free of symptoms of illness, considered themselves in normal health, and were actively engaged in their usual activities. However, they were not examined

TABLE III
Personal Data

Case No.	Age entering community	Number of years in community	Present age	Occupation	Height	Body structure	Actual weight	Desirable weight*	Remarks
	yrs.		*yrs.*		*in.*		*lb.*	*lb.*	
1	19	20	39	Farmer	71	Large	169	165–180	
2	21 1/2	19	40 1/2	Lecturer	71	Large	200	165–180	Overweight
3	27	15	42	Carpenter	68 1/2	Medium	160	147–158	
4	20	14	34	Teacher	74	Large	135	179–196	Underweight
5	19	22	41	Laborer	62	Small	140	116–125	Overweight
6	34	17 1/2	51 1/2	Plumber	67	Medium	145	141–151	

* Metropolitan Life Insurance Company: *Desirable Weights for Men of Age 25 and Over.*

clinically. The personal data on the subjects are summarized in Table III.

A three-day weight record of the food intake for each of the two periods was kept for each of the subjects. The average intake for calories, animal protein, vegetable protein, total protein, fat, carbohydrate, calcium, iron, vitamin A, thiamine, riboflavin, niacin, ascorbic acid, and cholesterol was calculated for the two periods for each subject. The nutrients were calculated from standard tables.[2,3] The cholesterol content was calculated from tables by Okey[4] and Ansbacher and Supplee.[5] Vegetable sterols are not utilized in the human body, and therefore they were not included in the cholesterol calculations. In Table IV are summarized the average daily nutrient and cholesterol intake. Fasting blood samples were obtained for both periods. The chemical blood findings are summarized in Table V.

TABLE IV
Average Daily Nutrient and Cholesterol Intake

Case No.	Calories	Animal protein	Vegetable protein	Total protein	Fat	Carbohydrate	Calcium	Phosphorus	Iron
		Gm.	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*mg.*
				First Period					
1	2825	12	48	60	21	599	0.70	1.50	14
2	2601	11	51	62	21	541	0.71	1.56	15
3	2070	10	44	54	22	414	0.69	1.39	14
4	2123	10	61	71	27	399	0.76	1.79	18
5	1920	10	35	45	20	390	0.56	1.11	10
6	2395	9	46	55	19	501	0.59	1.38	13
Av.	2326	10	48	58	22	474	0 67	1.46	14
Intake as calories	—	40	192	232	198	1896			
Intake as % of total calories	—	1.8	8.2	10.0	8.5	81.5			
				Second Period					
1	3149	24	51	75	21	665	1.40	1.79	16
2	2080	32	37	69	32	379	1.04	1.64	14
3	2402	16	46	62	22	489	1.13	1.54	16
4	2726	23	82	105	34	500	1.84	1.69	27
5	2477	22	39	61	17	520	1.00	1.51	12
6	2871	23	46	69	19	606	1.26	1.69	15
Av.	2617	23	50	73	24	527	1.28	1.64	17
Intake as calories	—	92	200	292	216	2108	—	—	—
Intake as % of total calories	—	3.5	7.6	11.1	8.3	80.6	—	—	—
National Research Council recommended allowances	2900	—	—	65	—	—	0.8	—	12

TABLE IV (*Cont.*)

Case No.	Vitamin A	Thiamine	Riboflavin	Niacin	Ascorbic acid	Cholesterol
	I.U.	*mg.*	*mg.*	*mg.*	*mg.*	*mg.*
			First Period			
1	857	1.8	1.3	15	60	12
2	11,233	2.0	1.4	17	91	11
3	11,383	1.7	1.3	15	86	12
4	11,923	3.5	1.5	20	101	13
5	609	1.3	1.0	11	45	12
5	5,177	1.7	1.1	15	61	9
Av.	6,863	2.0	1.3	15.5	74	11.5
			Second Period			
1	10,388	1.8	2.2	15	135	25
2	1,945	1.5	1.9	12	106	22
3	12,472	1.7	1.8	19	126	21
4	23,362	3.1	3.0	25	213	30
5	365	2.1	1.7	12	78	24
6	7,865	1.3	2.1	14	123	23
Av.	9,399	1.9	2.1	16	130	24
National Research Council recommended allowances	5,000	1.5	1.6	15	75	—

TABLE V

Chemical Blood Findings

Case No.	Total serum cholesterol[a]	Cholesterol ester[b]	Nonprotein-nitrogen[d]	Urea nitrogen[e]	Uric acid[f]	Creatinine[g]
	mg. %	*%*[c]	*mg. %*	*mg. %*	*mg. %*	*mg. %*
			First Period			
1	225.3	63.4	31.8	12.3	2.3	1.8
2	190.7	71.8	31.5	14.9	3.0	1.4
3	210.4	71.5	32.3	15.1	3.8	1.7
4	183.9	68.1	33.6	10.9	4.1	1.2
5	231.8	73.9	25.4	10.1	2.9	1.9
6	202.5	75.0	29.7	13.5	4.0	1.4
Av.	207.4	70.6	30.7	12.8	3.35	1.56
			Second Period			
1	229.0	65.0	35.3	14.5	2.6	1.7
2	190.9	72.3	33.1	15.1	2.9	1.2
3	207.4	69.8	35.0	13.9	4.2	1.7
4	192.3	64.4	29.5	12.9	3.2	1.3
5	235.4	71.9	28.7	10.7	3.0	1.5
6	199.8	68.9	30.0	14.0	3.7	1.5
Av.	209.1	68.7	31.9	13.5	3.26	1.48

[a] Bloor's Method. [b] Bloor and Knudson's Method. [c] Of total cholesterol. [d] Folin-Wu Method. [e] Van Slyke and Cullen's Aeration Method. [f] Modified Kock's Method. [g] Folin Method.

Discussion

It is apparent from Table I that the mainstays of the diet were whole wheat bread containing 2.17% dried skim milk, barley coffee containing 9.26% fresh skim milk, vegetables, and fruit. In addition, it will be noted that small amounts of animal protein, in the form of the skim milk present in the whole wheat bread and the barley coffee were ingested at each of the three meals. According to Leverton and Gram,[6] inclusion of animal protein at

each meal, particularly in cases in which the total protein and caloric intake is low, is essential for maximum nitrogen retention.

The average daily intake of calories, total protein, calcium, and riboflavin for the *first period,* as shown in Table IV, was somewhat lower than the recommended allowances of the National Research Council.[7]

The average daily intake of riboflavin represented 81 per cent of the "recommended" allowance. Williams *et al.*[8] have reported 0.5 mg. of riboflavin per 1000 calories as representing the *minimal* daily requirement for riboflavin. Since the average daily caloric intake of the subjects was 2326 calories, the intake of 1.3 mg. of riboflavin would seem to satisfy the minimal daily requirement.

The average total protein intake was 58 Gm., with an average of 17.2 per cent of the total protein of animal origin. This figure is lower than the recommended allowances for protein and is also lower than the figures reported by Stare and Davidson[9] and Cuthbertson[10] for men.

Due to a paucity of information concerning the human requirement for fat, fat allowances must be based more on eating habits than on physiological requirements. Whereas the National Research Council has suggested that fat be included to the extent of 20 to 25 per cent of the total calories for adults, in this study the average daily fat consumption was only 8.5 per cent of the total caloric intake.

Further study of Table IV will show that with the exception of the caloric intake, the total protein, calcium, and riboflavin during the *second period* (which represented $5^1/_2$ months of the year) were within accepted recommended allowances. This was accomplished by adding to the diet of the first period skim milk as a beverage, cheese, a serving of soup at supper, and larger servings of whole wheat bread at breakfast and supper.

Despite the low fat intake (22–24 Gm. average) and a caloric intake within traditional limits (2326 and 2617 cal.) as shown in Table IV, two of the six subjects (Nos. 2 and 5) were overweight. There are insufficient data to explain this interesting finding.

Cholesterol

Although the cholesterol and fat intake of the subjects was low, the serum cholesterol and cholesterol ester values, as shown in Table V, were within normal ranges. This finding is in agreement with the report of Garn and Gertler[11] that the adult serum cholesterol of Aleuts receiving low calorie, low cholesterol diets did not differ from that of adult Americans. Since in recent years interest in dietary cholesterol has centered on its possible role in the development of arteriosclerosis, it is interesting to note that a low dietary (animal) cholesterol intake maintained over many years was associated with normal blood cholesterol levels.

Blood Findings

An animal protein intake of 10 Gm. for $6^1/_2$ months and of 23 Gm. for $5^1/_2$ months of the year did not produce changes in the nonprotein nitrogenous fractions of the blood. These fractions, as shown in Table V, were within the normal range. This is not surprising in view of the fact that part of the year the total protein intake was within the "normal" range and that the animal protein was distributed throughout the 3 meals.

It appears that although meat adds zest and variety to meals, an adequate diet can be planned in its absence. Prolonged consumption of a vegetable diet which included skim milk was compatible with apparent good health.

Summary

Prolonged consumption of a diet low in animal protein (10–23 Gm.) had no apparent deleterious effect on the health of members of a community which did not eat meat.

The addition of skim milk to a vegetable diet raised the nutritive value of the diet to within accepted standards.

The serum cholesterol and cholesterol ester levels were maintained at normal levels despite prolonged consumption of a low fat, low cholesterol diet.

A diet devoid of meat and low in animal protein had no effect on the nonprotein nitrogenous fractions of the blood.

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Resumen

Consumo alimenticio y estudios sanguíneos de hombres consumiendo una dieta sin carne

El consumo prolongado de una dieta pobre en proteína animal (10–23 Gm.) no parece haber tenido ningún efecto deletereo sobre la salud de los miembros de una comunidad que no consumía carne.

La adición de leche descremada a una dieta vegetal aumentó el valor nutritivo del régimen hasta encadrar dentro de los límites aceptados.

El colesterol sérico y los esteres de colesterol se mantuvieron a niveles normales a pesar del consumo prolongado de una dieta pobre en grasas y colesterol.

Una dieta sin carne y pobre en proteína animal no tuvo ningún efecto sobre las fracciones no proteicas de la sangre.