

EFFECTS OF PECTIN ON WEIGHT, FOOD INTAKE, AND TOTAL SERUM CHOLESTEROL IN ADULT MICE

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(Accepted September 9, 1985)

Yueh Chen and Joan A. Yuhas (1986) Effects of pectin on weight, food intake, and total serum cholesterol in adult mice. *Bull. Inst. Zool., Academia Sinica* 25(1): 7-11. Dietary fiber is classified to insoluble fiber and water-soluble fiber. Pectin is a type of water-soluble fiber that might exert distinct hypocholesterolemic effects. Fifteen adult male mice were divided to three groups and fed three levels of dietary pectin (2%, 5%, and 10%), respectively, for four weeks.

The results were: (1) a slightly higher intake of pectin (5%) is related to a trend of decreased average food consumption and energy intake; (2) higher pectin intake were associated with lower mean total serum cholesterol levels.

Coronary heart disease is a leading cause of death in western countries. There are many risk factors for the disease, including elevated total serum cholesterol level and obesity. Much research is being conducted to investigate ways to control these risk factors, such as modification of the diet. One element of the diet under study is dietary fiber.

Pectin is a type of water-soluble fibers. Chemically, it is a polymer of galacturonic acid with esterification of the uronic acid with methyl or acetyl groups (Cummings, 1976). Pectin can be dissolved in water to form a gel, has considerable water holding capacity, and especially, it appears to decrease lipid absorption and affect cholesterol metabolism by binding bile salts in the intestine of animals or human (Anderson & Chen, 1979). These effects may contribute to a reduction of total serum cholesterol level, and thus may lower the risk of coronary heart disease. Citrus fruits are particularly high in pectin, although this may represent primarily the pectin from the white portion of citrus peel rather than the substance of the fruit

itself. Also, squash and carrots are vegetable sources very high in pectin (Kuske, 1983).

Along with physiochemical properties of pectin, both the amount and the length of time of dietary pectin consumed are influential factors in lowering total serum cholesterol. However, the level of dietary pectin that has the greatest efficiency in lowering total serum cholesterol levels is still uncertain. The purpose of this study is to investigate if there is the same effect of dietary pectin on total serum cholesterol concentration on mice as in rats and to compare the effects of different levels of dietary pectin on reducing the total serum cholesterol. The following issues were addressed in this study:

(1) Will the total serum cholesterol level decrease progressively with increasing level of pectin in the diet?

(2) Are the effects of pectin on serum cholesterol level maintained over time?

(3) Are kilocalorie consumption and mass of food consumption affected by increasing levels of pectin in the diet?

(4) Is body weight affected by increasing levels of pectin in the diet?

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MATERIALS AND METHODS

1. Animals and Diets

Fifteen albino adult male mice, 21 days old, of the Swiss Webster strain were randomly divided into Group 1, Group 2, and Group 3. The mice had twelve hours of light per day, and an air conditioning maintained a temperature of about 20°C and a humidity of about 55%. The total period of this study was four weeks. Fresh water was provided *ad libitum* daily throughout the study.

During the first week, all mice were supplied *ad libitum* USB19258 pelleted purified standard mouse diet (2% pectin) (Table 1). At the start of week 2, the mice were offered *ad libitum* the respective test diet over the next three weeks. The control diet (2% pectin, 4.23 Kcal/gram) was fed to the control group (Group 1). The mice in Group 2 and Group 3 were provided 5% pectin (4.1 Kcal/gram) and 10% pectin (3.88 Kcal/gram), respectively. In formulating the experimental diets, the amount of the remaining dietary constituents were decreased proportionately. All diets manipulations were done by the U. S. Biochemical Corporation, from which the diets were purchased.

2. Measurements

Blood specimens of approximately 20 μ l were obtained from one orbital sinus of each mouse without anesthetization after eight hours without food. Blood samples were collected and analyzed total serum cholesterol levels on day 7 for predicting baseline values after one week on the control diet. In this way, control data was established for comparison with the results of Group 2 and Group 3, which were the experimental groups. On day 17 and 28, blood samples were gathered again to evaluate the progressive effects of the test diets. Body weights were recorded at these same time intervals.

Food consumption was measured daily and average daily consumption was determined for each of the three time periods. The pelleted diet was pre-weighed before being given to the mice each day. The next day whatever was left was weighed to determine how much was consumed over the twenty-four hours.

After the blood samples were collected and centrifuged, fasting total serum cholesterol were analyzed immediately by the method described in Sigma Technical Bulletin No. 350

TABLE 1
The composition of experimental diets

Comp.	Group 1		Group 2		Group 3	
	%	kcal/100 g diet	%	kcal/100 g diet	%	kcal/100 g diet
Casein	30	120.00	29.1	116.40	27.6	110.40
Pectin	2		5		10	
Cod liver oil	0.2	1.80	0.194	1.74	0.184	1.65
Corn oil	10	90.00	9.7	87.30	9.2	82.80
Sucrose	52.8	211.20	51.156	204.62	48.416	193.66
Salt mix	5		4.85		4.6	
*Vitamins						
Total	100.0	423.00	100.0	410.06	100.0	388.51
*Vitamins		mg/100 gm	*Vitamins		mg/100 gm	
Thiamine		0.5	Pantothenic acid		6	
Riboflavin		1	Folic acid		0.05	
Nicotinic acid			Choline		150	
B ₆		0.5	α -Tocopherol		6	
Biotin		0.02	Menadione		1	

(Enzymatic Determination of Total Cholesterol). The light absorbance of this substance was at 500 nm using a Bausch-Lomb Spectronic 20 spectrophotometer.

3. Data Analysis

All data of the body weight changes, food energy intakes, grams of food consumed, and the fasting total serum cholesterol levels of the three groups of mice are presented and compared in tabular form. All data in the tables is expressed as Mean \pm S.D. The F-test was used to compare the within and between variables. After contrast by F-test, posteriori comparison was applied to identify the relationship between dependent variables (food consumption, energy intake, weight changes, and total serum cholesterol) and independent variables (three levels of pectin intake and day of the study). Probability values of $p < 0.05$ were considered significant.

RESULTS AND DISCUSSION

In terms of the objectives of the study, following conclusions were made, concerning the effects of pectin consumption in mice in a short-term investigation.

(1) A slightly higher intake of pectin (5%) was related to decreased average food consumption (Table 2) and energy intake (Table 3), perhaps due to satiating effects. An adjustment time is needed in the consumption of a higher pectin diet. However, after these mice adjusted to their new diet, their average energy intake increased. That is, Group 3 had a significantly higher ($p < 0.05$) energy intake than both Group 1 and Group 2 from day 7 to 28 and day 17 to 28.

(2) Related to No. 1, higher pectin intakes might moderate rate of weight gain except in the case of over compensation (Table 4).

TABLE 2
The effect of pectin supplemented diet on the food consumption for adult mice. (gram)

	Group 1 (2% pectin)	Group 2 (2% pectin)	Group 3 (2% pectin)
Baseline value (Day 7)	3.9 \pm 0.3	4.1 \pm 0.2	4.2 \pm 0.1
	Group 1 (2% pectin)	Group 2 (5% pectin)	Group 3 (10% pectin)
Day 17	3.9 \pm 0.2	4.0 \pm 0.3	4.4 \pm 0.1
Day 28	4.1 \pm 0.1	3.8 \pm 0.2	4.9 \pm 0.4

TABLE 3
The effect of pectin supplemented diet on the energy intake (kcal) for adult mice

	Group 1 (2% pectin)	Group 2 (2% pectin)	Group 3 (2% pectin)
Baseline value (Day 7)	16.6 \pm 1.0	17.2 \pm 0.6	17.7 \pm 0.3
	Group 1 (2% pectin)	Group 2 (5% pectin)	Group 3 (10% pectin)
Day 17	16.2 \pm 0.8	16.5 \pm 1.0	16.9 \pm 0.5
Day 28	17.1 \pm 0.5	15.5 \pm 0.7	18.9 \pm 1.3

TABLE 4
The effect of pectin supplemented diet on the rate of weight gain for adult mice. (gram)

	Group 1 (2% pectin)	Group 2 (2% pectin)	Group 3 (2% pectin)
Baseline value (Day 7)	30.9±0.6	32.2±0.5	32.7±1.0
	Group 1 (2% pectin)	Group 2 (5% pectin)	Group 3 (10% pectin)
Day 17 (Wt. change)	32.4±0.3 (+1.5)	33.0±0.5 (+0.8)	33.3±0.8 (+0.6)
Day 28 (Wt. change)	33.8±1.1 (+1.4)	33.9±0.6 (+0.9)	36.2±0.7 (+2.9)
Total Wt. change	(+2.9)	(+1.7)	(+3.5)

TABLE 5
The effect of pectin supplemented diet on the level of total serum cholesterol for adult mice. (mg/dl)

	Group 1 (2% pectin)	Group 2 (2% pectin)	Group 3 (2% pectin)
Baseline value (Day 7)	250±40	372±38	261±16
	Group 1 (2% pectin)	Group 2 (5% pectin)	Group 3 (10% pectin)
Day 17	247±47	306±40	208±15
Day 28	265±31	300±38	222±17

(3) The effects of pectin on the level of total serum cholesterol may differ due to the initial total serum cholesterol levels (Table 5). A higher total serum cholesterol may decrease more rapidly than a lower level of total serum cholesterol, which may be in a more normal range already.

According to Leveille *et al.* (1966), there are two possible ways for pectin to produce hypocholesterolemic effects. First, the effects of dietary pectin might be an alternation of the intestinal microflora. Second, pectin might decrease the enterohepatic circulation of bile acid by interfering with bile acid absorption.

The significantly lower total serum cholesterol level seem with the higher pectin

intake is supported by Story *et al.* (1977) who suggested that pectin may exhibit a hypocholesterolemic effect. The effect is due to the fact that pectin can influence the distribution of cholesterol within the body tissues. Also, binding bile salts in the intestine, pectin may interfere with bile acid reabsorption, and thus increase cholesterol degradation and excretion.

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Pectin 對小老鼠 (mice) 的體重，食物攝取量 以及血清膽固醇的影響

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膳食纖維 (dietary fiber) 可分為非水溶性纖維和水溶性纖維兩種。Pectin 是一種水溶性纖維，它可能扮演著降低膽固醇的角色 (hypocholesterolemic effect)。15 隻雄性成年小老鼠分為三組，每組分別以不同份量的 Pectin (2%, 5%, 10%) 飼養四個禮拜。結果發現 (1) 隨 Pectin 含量的增加，其平均食物攝取量及熱量的攝取均有較低的趨向。(2) 隨 Pectin 的增加，小老鼠的總血清膽固醇 (total serum cholesterol) 之平均值有下降之趨勢。

