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Lowering of Human Serum Cholesterol by an Oral Hydrophilic Colloid.* (30643)

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The influence of the various forms of dietary bulk on serum cholesterol levels has not been extensively studied. Keys(1) found that addition of pectin but not cellulose to the diets of middle-aged male patients produced a small (5%) decrease in serum cholesterol values. Studies on pigs by Cooper(2) showed that addition of fibrous but not powdered cellulose to the diet lowered serum cholesterol and suggested that the ability of the fibrous cellulose to hold water may have been responsible for the difference. The present paper describes experiments on normal young male medical students which show that on mixed or egg-supplemented diets the addition of a hydrophilic colloid to the diet lowers the serum cholesterol to a statistically significant extent.

Materials and methods. A preparation of hydrophilic colloid derived from blond psyllium seed (*Plantaga ovata*-Forsk) available commercially as Metamucil,† was used as the bulk-increasing supplement and as supplied was mixed with an equal weight of dextrose. During the periods of mucilloid supplementation in all the experiments, 6.4 g of Metamucil were taken 3 times daily with meals, making a total of 9.6 g of hydrophilic colloid ingested each day. All serum cholesterol values were obtained by the method of Zlatkis (3) and carried out in duplicate. The experimental subjects were 14 normal male medical students, from 21-25 years of age, and one male faculty member 33 years of age. All subjects maintained their customary activi-

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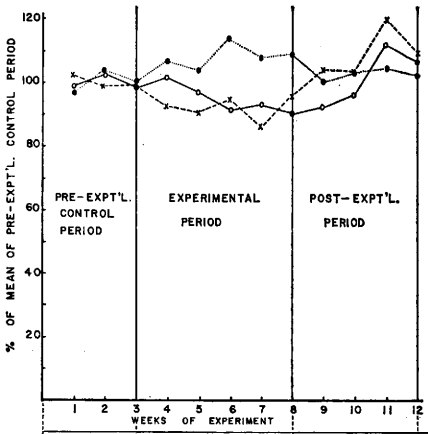

DIETARY	REGIMENS FOR EACH EXPT'L. PERIOD		DIETARY GROUPS
SSMD	SSMD + MUCILLOID	SSMD	1
SSMD	SSMD + EGGS	SSMD	2
SSMD	SSMD + EGGS + MUCILLOID	SSMD + EGGS	3

FIG. 1. Effects of various dietary regimens on serum cholesterol levels of young adult males. Group 1 —○—, Group 2 ·· ● ··, Group 3 -- × --; SSMD self-selected mixed diet.

ties during the study and only one student reported a gain in weight. Blood samples were drawn at the end of each week during the 12 weeks of the study. Three complementary experiments were carried out concurrently following the plan shown in Fig. 1. The subjects in groups 2 and 3 during the egg-supplementation periods took 2 eggs with breakfast and substituted 4-6 eggs for their usual lunches. This substitution was estimated to be roughly isocaloric with the students' usual lunches. For statistical purposes and for display in Fig. 1, the mean serum cholesterol value for the first 3 weeks (pre-experimental control period) for each subject was assigned a value of 100%. All subsequent serum cholesterol values for each subject were normalized by converting them to a percentage of his control serum cholesterol level. The t-test was used in all estimations of the significance of differences between mean values(4,5).

Results and discussion. The 5 subjects in Group 1 were used to determine the effect of the mucilloid supplement on serum cholesterol levels of subjects otherwise maintaining their self-selected normal mixed diets. Fig. 1 shows that lower values were established by the end of the third week on the supplement and that these lower values were maintained for 2 additional weeks. The mean serum cholesterol value of weeks 1, 2, and 3 was 198 mg% which normalized to 100% ± 4.76% (S.D.) for 15 determinations. The mean serum cholesterol value of weeks 6, 7 and 8 was 180 mg% which normalized to 91% ± 8.54% (S.D.) for 15 determinations. Thus, during the last 3 weeks of the experimental period there was maintained a 9% decrease in serum cholesterol which is equivalent to a decrease of 18 mg%. This lower level was statistically highly significant ($t = 3.56$, $n = 28$, $0.001 < P < 0.01$). On stopping the supplement at the beginning of week 9, the serum cholesterol values returned to pre-experimental control levels and then rose somewhat higher. This rebound was highest during weeks 11 and 12, with a mean of 218 mg% which normalized to 110 ± 9.68% (S.D.) for the 9 determinations made during those 2 weeks. This elevation was shown to be highly significant statistically when compared with the pre-experimental control period ($t = 3.43$, $n = 22$, $0.001 < P < 0.01$). It is concluded that addition of the mucilloid supplement to a mixed diet of active young adult males causes a statistically significant fall in serum cholesterol and that this fall disappears when the mucilloid is withdrawn and a rebound to values above control levels occurs.

The 3 subjects in Group 2 were used to study the effect of an increase in consumption of hens' eggs on serum cholesterol levels. Fig. 1 shows an upward trend during the first 3 weeks on the egg diet, a stabilization at an elevated level for the balance of the experimental period and a return to pre-experimental values on stopping the supplement. The mean serum cholesterol value of weeks 1, 2 and 3 was 190 mg% which normalized to 100% ± 4.1% (S.D.) for 9 determinations. The mean serum cholesterol value of weeks 6, 7 and 8 was 213 mg% which normalized to 111% ± 10.4% (S.D.) for 8 determinations. This elevation of 11% which was equivalent to 23 mg% in serum cholesterol was statistically significant ($t = 2.94$, $n = 15$, $P = 0.01$). These results are in agreement with the reports of Wells(6) and Connor(7).

The 7 subjects in Group 3 were used to study the effect on serum cholesterol levels of addition of mucilloid to the egg-supplemented regimen. Fig. 1 shows that lower values were observed during the first week and that this lowering was maintained for the remainder of the experimental period. The mean serum cholesterol value of weeks 1, 2 and 3 was 198 mg% which normalized to 100% ± 4.77% (S.D.) for 21 determinations. The mean serum cholesterol value of weeks 6, 7 and 8 was 180 mg% which normalized to 93% ± 9.92% (S.D.) for 21 determinations. This latter value is lower by 7%, which is equivalent to a fall of 13 mg% of serum cholesterol and is statistically highly significant ($t = 2.93$, $n = 40$, $0.001 < P < 0.01$). After the 5-week experimental period, this group continued on the egg supplement but omitted the mucilloid and showed a rise to levels well above control values. This latter rebound effect may have been due simply to the unrepressed effect of the egg supplement or to some effect of stopping the mucilloid, or to some combination of these factors. The influence of the mucilloid on serum cholesterol levels of subjects taking the egg supplement was tested by comparing Group 2 with Group 3 during weeks 6, 7 and 8. The Group 3 subjects taking both eggs and mucilloid had a mean serum cholesterol value 18% below that of the Group 2 subjects taking only the eggs. This difference, which is equivalent to 36 mg% in serum cholesterol, is statistically highly significant ($t = 4.32$, $n = 27$, $0.0001 < P < 0.001$). It is concluded that the mucilloid is capable not only of neutralizing the influence of the egg supplement in raising the serum cholesterol but also is able to lower it below control values while on the high egg regimen. The possibility that some long-term, but uncontrolled, variable is responsible for the sequences of serum cholesterol values reported in this paper seems largely obviated by the rapid return to pre-experimental values on removing the variable being tested, and by the appearance of a rebound in 2 instances. The duration of the effect and the elucidation of the mechanism by which the mucilloid lowers serum cholesterol require further investigation.

Summary. An oral hydrophilic colloid (9.6 g/day), after a 3-week pre-experimental control period, was fed for a 5-week experimental period to normally active young adult males on several dietary regimens with the following results: 1) For subjects on a self-selected mixed diet, the mean serum cholesterol level obtained during the last 3 weeks of the experimental period was 9% below that of the control period. 2) For subjects on an egg-supplemented regimen, the serum cholesterol level obtained during the last 3 weeks of the experimental period was 7% below that of the control period and 18% below that of a comparable group receiving the egg-supplement but no mucilloid. All the above differences were statistically significant by t-test ($P \leq 0.01$).

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