

# Dietary Carbohydrates and Serum Cholesterol in Man

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**A**LTERATIONS in serum cholesterol levels in experimental animals and man have been studied mainly in relation to variations in dietary fat, fatty acids and cholesterol. The vast literature on this subject has masked the role that other dietary factors, such as carbohydrates, may play in altering blood cholesterol levels.

Keys, Anderson and Grande<sup>1</sup> in 1960 were among the first to study the effects of different carbohydrates on serum cholesterol levels in man. They compared the effects of two types of diets, which differed in the quality of carbohydrates, on serum cholesterol levels. One diet was relatively low in fruits and fresh vegetables and high in sucrose as compared to the other diet. These investigators concluded that serum cholesterol values tended to be higher with sucrose than with equal calories of carbohydrates contained in fruits, leafy vegetables and legumes.

Wells and Anderson<sup>2</sup> in 1962 published a report on the effect of lactose on serum cholesterol levels in human subjects. In four students fed a controlled natural diet for eight weeks, the sucrose component of the diet was changed isocalorically after three weeks to lactose. During the "lactose period" the serum cholesterol level increased from a "normal" level of 185 mg. per cent to 231 mg.

per cent and then decreased to 162 mg. per cent when sucrose was resubstituted.

### EXPERIMENTAL STUDIES

Because of the important clinical implications of these studies, carefully controlled experiments were performed in our laboratory on three volunteer students.

During the control period, which ranged from seventeen to twenty-two days, the students adhered to their regular diet and recorded their entire daily dietary intake. At the end of this period a fair estimate of the total caloric intake as well as the percentage of carbohydrate, fat and protein component of the diet were obtained (Table I). During the following

TABLE I  
Daily Caloric Intake on Natural and Synthetic Diet

Subject	Calories	% Carbo- hydrate	% Protein	% Fat
J. J.	2,560	50	20	30
I. P.	2,200	50	20	30
A. K.	2,600	50	20	30

ten weeks the three subjects were fed a homogenized synthetic diet in which the total daily caloric intake and the percentage of carbohydrate, proteins and fats were based on the values obtained during the control period. The daily formula diet consisted of casein, fat in the form of a 4:3 w/w mixture of olive oil and butter, 0.5 gm. of cholic acid, 1 gm. cholesterol, salt and vitamins. The carbohydrate component of the diet was changed isocalorically during the various experimental periods and included glucose, sucrose, lactose and

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TABLE II  
Cholesterol Levels During Various Experimental Periods

Period	No. of Days	Cholesterol $\pm$ S.D.
<i>Subject J. J.</i>		
Control.....	22	235 $\pm$ 19.5
Glucose.....	16	248 $\pm$ 14.3
Sucrose.....	22	240 $\pm$ 4
Lactose.....	25	250 $\pm$ 3.5
Control.....	11	244 $\pm$ 3.4
<i>Subject I. P.</i>		
Control.....	17	169 $\pm$ 2.6
Glucose.....	16	188 $\pm$ 6.5
Galactose.....	22	186 $\pm$ 5.2
Glucose.....	14	158 $\pm$ 6.5
Galactose.....	12	165 $\pm$ 9.4
Control.....	12	174 $\pm$ 5.8
<i>Subject A. K.</i>		
Control.....	17	295 $\pm$ 4.7
Glucose.....	24	288 $\pm$ 8.9
Galactose.....	20	278 $\pm$ 4.8

galactose (Table II).

Serum cholesterol levels were determined twice weekly according to the method of Abell et al.<sup>3</sup> The weight was recorded once weekly and one subject (J. J.) lost 1.5 kg. at the end of the experimental period. Our results (Table I) did not show any significant alterations in the serum cholesterol levels throughout the experimental periods. The slight alterations noted were consistent with what is seen in serial studies on the daily variations of serum cholesterol levels in normal man.

COMMENTS

This discrepancy between the results obtained by Wells and Anderson and our study, although unexplained, can best be solved by continued work in this field, particularly in view of the fact that the work performed to date has produced results of definite interest. Thomas et al.<sup>4</sup> in 1959 observed a higher incidence of coronary heart disease in ulcer patients maintained on a prolonged sippy diet compared with ulcer patients who were not maintained on

this diet. It has been assumed that the hypercholesterolemia which developed in the patients on a sippy diet resulted from the fat content of the milk. The observations of Wells and Anderson, which we have failed to confirm, suggest that lactose may be another hypercholesterolemic factor.

In animal experiments dietary carbohydrates have had a definite effect on the serum cholesterol level in the rat,<sup>5</sup> chicken<sup>6</sup> and rabbit,<sup>7</sup> but not in the cebus monkey.<sup>8</sup>

The mechanisms of alteration of serum cholesterol by dietary carbohydrates are poorly understood and have aroused much speculation. That the sugars have an effect on the intestinal absorption of cholesterol, excretion of bile acids and cholesterol in bile and on the intestinal flora have all been suggested. Bacterial flora of the intestine play an important part in cholesterol regulation. Bacteria are known to reduce cholesterol into relatively less absorbable products, i.e., coprostanol and cholestanol. These products also serve to inhibit the reabsorption of cholesterol from the gut and thus increase the fecal loss of sterols. In this connection carbohydrates may alter the nature and quantitative aspects of the intestinal bacterial flora and thus produce the variations described. In 1960 Wilbur<sup>9</sup> performed a quantitative study on bacterial flora of pigs and showed that pigs fed lactose had a much lower bacterial count than those fed starch. It is conceivable that man and monkeys, due to more efficient cholesterol homeostatic mechanisms, do not respond to these variations in carbohydrates and intestinal bacterial flora as do the rat, rabbit and chicken. Nevertheless, the clinical and possible therapeutic implications of these findings warrant further investigation.

SUMMARY

Carefully controlled experiments on three male volunteer subjects in which the carbohydrate component of a synthetic diet was changed isocalorically, failed to show any significant change in the serum cholesterol level. This is in disagreement with results obtained by other investigators on man and certain laboratory animals, but in agreement with results of studies on the cebus monkey.



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