

EFFECT OF QUALITATIVELY DIFFERENT CARBOHYDRATES ON LIPOPROTEIN SPECTRUM AND COMPOSITION OF BLOOD LIPIDS

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Experiments on rats showed that a high-carbohydrate diet with starch causes no changes in the lipoprotein spectrum or concentration of lipids in the blood. Diets containing sucrose lead to an increase in the triglyceride concentration and raise the level of pre- β -lipoproteins. However, the effect of sucrose depends on the qualitative relations between the carbohydrate and lipid components of the diet. A fall in the low-density lipoprotein content and a decrease in the total cholesterol/phospholipids ratio on account of an increase in the blood phospholipid concentration is observed in rats receiving sucrose as a constituent of a high-carbohydrate diet with reduced unsaturated fat content. Inclusion of sucrose in a diet with the physiological level of carbohydrates and fat (56 and 26%, respectively, of the total calorific value) is accompanied by elevation of the β -lipoprotein level and an increase in the cholesterol concentration and in the total cholesterol/phospholipid ratio.

KEY WORDS: lipoprotein spectrum; lipid concentrations; high-carbohydrate diet; starch; sucrose.

Disturbance of lipid metabolism, expressed as hyperlipemia and an increase in the concentration of low-density lipoproteins, is regarded as a risk factor in the development of atherosclerosis [1, 2]. Among the causes of disturbance of lipid metabolism the alimentary factor must be mentioned. The leading role of an excessive intake of easily assimilable carbohydrates in the development of hyperlipemia and an increase in the concentration of low-density lipoproteins has been demonstrated [3, 4]. However, some workers consider that lipid components of the diet also have a definite effect [5].

In this investigation the state of the blood lipoprotein spectrum and changes in the concentrations of triglycerides, phospholipids, and cholesterol and its esters in the blood under the influence of qualitatively different carbohydrates in diets with physiological and low levels of saturated fat were studied.

EXPERIMENTAL METHOD

Eighty male Wistar rats weighing initially 150-160 g were used. For 30 days the animals received semisynthetic diets of equal calorific value (60 cal/100 g body weight), containing the necessary amounts of salts and vitamins, ad lib. The animals were divided into one control and three experimental groups.

Animals of the control group received a diet containing 56% starch, 26% lard, and 18% casein (the percentages relate to the total calorific value of the diet).

The diet for the first experimental group was identical with the control, except that some starch was replaced by sucrose (41% of the total calorific value of the diet). In the diet for the rats of group 2 the source of carbohydrates was starch (71% of the total calorific value), and in the diet of group 3 it was

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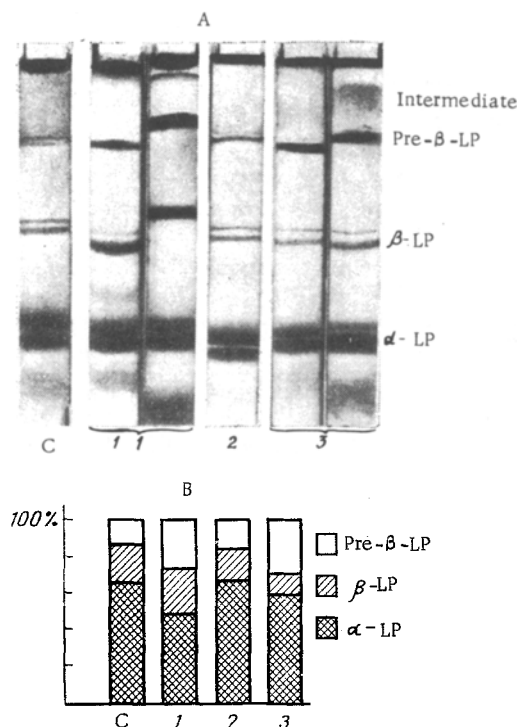


Fig. 1. Blood serum lipoprotein spectrum of rats: A) electrophoresis; B) relative percentages of fractions; C) control; 1, 2, 3) groups of rats; LP) lipoproteins.

TABLE 1. Blood Lipid Concentrations (in mg %; $M \pm m$)

Lipids	Group of rats			
	control	1	2	3
Triglycerides	148 ± 12	181 ± 14*	157 ± 12	194 ± 16*
Phospholipids	115 ± 10	128 ± 13	118 ± 12	163 ± 13*
Total cholesterol	66 ± 8,3	107 ± 10*	69 ± 7,4	73 ± 9,2
Cholesterol esters	46 ± 4,0	80 ± 5,1*	44 ± 3,2	58 ± 3,7*
Total cholesterol/phospholipids	0,57	0,83	0,58	0,44

* $P < 0.05$.

starch and sucrose (30 and 41%, respectively, of the total calorific value). The fat content in the last diets was reduced to 11%.

The animals were decapitated when hungry and blood was taken for investigation. Serum lipoproteins were fractionated by electrophoresis in polyacrylamide gel [3]. The content of the various lipoprotein fractions and their relative proportions were calculated from the areas of the peaks obtained after recording on the ERI-65 M (East Germany) densitometer. Quantitative analysis of triglycerides and phospholipids was carried out by the method of Verheyden and Nys, and free cholesterol and its esters by the method of Liebermann and Burchard; these lipid fractions were obtained by fractionation of total lipids in a thin layer of silica gel [4].

EXPERIMENTAL RESULTS AND DISCUSSION

As Fig. 1 shows, the fraction of pre-β-lipoproteins was increased in the blood of the rats of groups 1 and 3, which received sucrose in their diets. The lipoprotein spectrum of some rats of these groups contained an additional fraction which occupied an intermediate position between the starting band, corresponding to chylomicrons with an excess of dye, and pre-β-lipoproteins. However, in the animals of those groups the changes in the β-lipoprotein fraction differed in character. In the rats of group 1 the intensity of this fraction was increased, whereas in those of group 3 it was reduced compared with the control.

It will be clear from Table 1 that the content of triglycerides and cholesterol esters was increased in the rats of groups 1 and 3. However, the changes in the contents of total cholesterol and phospholipids were unequal, so that the total cholesterol/phospholipids ratio was changed in different directions compared with the control. This ratio was increased in the blood of the rats of group 1 because of an increase in the total cholesterol, whereas in the animals of group 3 it was reduced because of an increase in the

phospholipid content. No significant changes were found in the lipoprotein spectrum or composition of the blood lipids in the rats of group 2.

Diets containing sucrose thus lead to an increase in the content of triglycerides and of pre- β -lipoproteins in the blood. The disturbances observed under these conditions are due not only to the presence of the easily assimilable disaccharide sucrose, but also to the relative amounts of carbohydrates and fat in diets with normal calorific value.

A decrease in β -lipoproteins and in the total cholesterol/phospholipids ratio, on account of an increase in the concentration of phospholipids in the blood, was observed in rats receiving sucrose as a component of a high-carbohydrate diet containing a reduced amount of saturated fat.

The inclusion of sucrose in a diet with a physiological level of carbohydrates and fat is followed by some increase in the β -lipoprotein level and in the cholesterol concentration and the total cholesterol/phospholipid ratio. On the basis of these results, prolonged administration of diets containing sucrose, regardless of the ratio between the carbohydrate and fat components in them, must be regarded as a risk factor in the development of disturbances expressed as elevation of the triglyceride and pre- β -lipoprotein blood levels.

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