EFFECT OF VEGETABLE AND ANIMAL FATS ON DISTRIBUTION OF EXOGENOUS CHOLESTEROL IN ANIMALS

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In rats receiving sunflower oil with the diet for 30 days, the quantity of radioactive cholesterol entering the liver after administration of a single dose of the isotope is increased compared with that in animals receiving the quantity of animal fat (lard) equivalent in its calorific value for one month. Addition of sunflower oil to the diet led to an increase in the cholesterol content in the blood and liver, and to a decrease in its content in the adipose tissue.

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Studies of the effect of dietary fats on lipid metabolism have shown that vegetable oils, if present in the diet in physiological quantities, increase the absorption of exogeneous cholesterol [7, 8], and increase the rate of its metabolism [5] and the elimination of its conversion products [6]. Lipids containing large quantities of saturated fatty acids modify cholesterol metabolism to a lesser degree [4, 10]. These results were obtained in experiments on animals receiving a diet containing 10-30% of these fats (in calorific value). It has recently been shown that diets with a high fat content activate lipolytic enzymes in the liver, adipose tissue, and aorta and modify the lipid content of these tissues [1-3]. It is not clear to what extent the supply of cholesterol to, and its distribution in the tissues and organs are modified should the physiological norms of qualitatively different fats in the diet be exceeded.

In the present investigation the content and distribution of labeled cholesterol following administration of a single dose of the isotopes were studied in the organs of rats receiving diets of identical calorific value but containing increased quantities of animal or vegetable fats, over long periods of time.

EXPERIMENTAL METHOD

The experimental animals were 40 male Wistar albino rats weighing initially 120-150 g and divided into four groups: the first control group received a diet containing 27% lard, the second control group a diet containing 27% sunflower oil, and the third and fourth experimental groups received 60% lard or sunflower oil (calculated relative to calorific value), respectively. The content of protein, vitamins, and salts was adequate and identical for all groups. The equality of calorific value of the diets was attained by reducing the carbohydrate content to 22%. After the end of 30 days the animals received cholesterol-4C^{14} (25 μCi), dissolved in 0.5 ml sunflower oil, as a single dose by mouth, and 24 h later they were killed by exsanguination. Cholesterol-digitonin complex was isolated by a modified method of Sperry and Webb [9]. The results were calculated in mg cholesterol/g tissue, in pulses/min/mg cholesterol (specific radioactivity), and in microcuries per weight of cholesterol isolated from 1 g tissue or from the whole organ.

EXPERIMENTAL RESULTS

No significant changes in the cholesterol content were found in the rats of group 3 compared with those of group 1, except that its content in the adrenals was reduced (Table 1). In the rats of group 4 the cholesterol content in the blood and liver rose considerably, while in the adipose tissue it fell by comparison with the corresponding control group. Comparison of the indices for control groups 1 and 2 revealed appreciable differences in the cholesterol content in the liver and, to a lesser extent, in the kidneys

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TABLE 1. Cholesterol Content in Fresh Tissue, Specific Radioactivity of Cholesterol

Organs and tissues	Cholesterol content (in mg/g body weight)				Specific radioactivity (in pulses/min/mg)			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Blood	53±3,8*	55±3,0*	60±4,2*	65±3,6*,†	6 200±1 000	5 330±772	3 680±228†	3 560±332†
Heart	1,2±0,045	1,19±0,08	1,17±0,09	1,36±01	1 850±415	1 650±215	1 620±144	1 530±177
Lungs	3,82±0,48	3,95±0,23	3,4±0,6	4,34±0,2	3 210±282	2 250±41	2 100±18,4†	1 900±18,7†
Liver	2,06±0,18	2,8±0,4	2,3±0,33	4,7±0,8†	3 160±463	3 030±481	3 180±390	2 150±343
Kidneys	3,42±0,17	2,96±0,15	3,42±0,12	3,2±0,1	710±99	460±47	538±39	480±50
Spleen	3,1±0,15	3,18±0,14	2,8±0,18	2,9±0,09	3 880±242	3 580±202	3 970±314	3 560±454
Brain	7,8±0,24	8,16±0,46	7,95±0,2	8,15±0,1	28±3,1	26±1,6	22±2,4	22±3,6
Fat	0,6±0,1	0,57±0,05	0,58±0,06	0,38±0,07†	595±43,3	3 485±133	462±98	409±72
Adrenals	22,8±2,47	23,8±3,5	14,7±0,9†	28,5±3,2	2 230±260	2 039±208	2 860±344	2 272±310
Aorta	3,40±0,74	3,1±0,7	3,62±0,8	2,67±0,33	259±29	239±28,6	290±47	274±56

*In mg/100 ml.

†Results statistically significant when $P \leq 0.05$.

TABLE 2. Radioactivity of Cholesterol Isolated from 1 g Tissue and from Whole Organ

Radioactivity of cholesterol (in μCi)							
1 g tissue				organ			
1st	2nd	3rd	4th	1st	2nd	3rd	4th
$150 \cdot 10^{-3}$	$131 \cdot 10^{-3}$	$99 \cdot 10^{-3}$	$104 \cdot 10^{-3}$	$210 \cdot 10^{-2}$	$184 \cdot 10^{-2}$	$139 \cdot 10^{-2}$	$146 \cdot 10^{-2}$
$100 \cdot 10^{-3}$	$880 \cdot 10^{-4}$	$85 \cdot 10^{-3}$	$930 \cdot 10^{-4}$	$100 \cdot 10^{-3}$	$880 \cdot 10^{-4}$	$85 \cdot 10^{-3}$	$930 \cdot 10^{-4}$
$550 \cdot 10^{-3}$	$400 \cdot 10^{-3}$	$324 \cdot 10^{-3}$	$370 \cdot 10^{-3}$	$550 \cdot 10^{-3}$	$400 \cdot 10^{-3}$	$324 \cdot 10^{-3}$	$370 \cdot 10^{-3}$
$295 \cdot 10^{-3}$	$383 \cdot 10^{-3}$	$330 \cdot 10^{-3}$	$455 \cdot 10^{-3}$	$355 \cdot 10^{-2}$	$458 \cdot 10^{-2}$	$397 \cdot 10^{-2}$	$630 \cdot 10^{-2}$
$112 \cdot 10^{-3}$	$616 \cdot 10^{-4}$	$71 \cdot 10^{-3}$	$695 \cdot 10^{-4}$	$155 \cdot 10^{-3}$	$855 \cdot 10^{-4}$	$99 \cdot 10^{-3}$	$980 \cdot 10^{-4}$
$540 \cdot 10^{-3}$	$508 \cdot 10^{-3}$	$505 \cdot 10^{-3}$	$452 \cdot 10^{-3}$	$432 \cdot 10^{-3}$	$405 \cdot 10^{-3}$	$405 \cdot 10^{-3}$	$380 \cdot 10^{-3}$
$980 \cdot 10^{-5}$	$950 \cdot 10^{-5}$	$790 \cdot 10^{-5}$	$805 \cdot 10^{-5}$	$177 \cdot 10^{-4}$	$171 \cdot 10^{-4}$	$142 \cdot 10^{-4}$	$146 \cdot 10^{-4}$
$163 \cdot 10^{-4}$	$124 \cdot 10^{-4}$	$120 \cdot 10^{-4}$	$69{,}5 \cdot 10^{-4}$	$392 \cdot 10^{-4}$	$298 \cdot 10^{-4}$	$290 \cdot 10^{-4}$	$167 \cdot 10^{-4}$
$230 \cdot 10^{-2}$	$217 \cdot 10^{-2}$	$189 \cdot 10^{-2}$	$292 \cdot 10^{-2}$	$230 \cdot 10^{-4}$	$217 \cdot 10^{-4}$	$189 \cdot 10^{-4}$	$292 \cdot 10^{-4}$
$398 \cdot 10^{-4}$	$333 \cdot 10^{-4}$	$475 \cdot 10^{-4}$	$328 \cdot 10^{-4}$	$520 \cdot 10^{-5}$	$430 \cdot 10^{-5}$	$613 \cdot 10^{-5}$	$425 \cdot 10^{-5}$

(Table 1). The results obtained in experimental groups 3 and 4 indicate an even more marked increase in the cholesterol content in the liver when the diet was extremely rich in sunflower oil compared with a diet of lard, but in group 4 the cholesterol content in the adipose tissue was reduced.

The specific radioactivity in the blood and lungs 24 h after oral administration of cholesterol-4C^{14} was considerably lower in the animals of group 3 than in those of the first control group. If the content of labeled cholesterol was calculated per gram and per total weight of the lungs and blood, the difference between the control and experimental groups was 35-40%. In the animals of group 4 a decrease in specific radioactivity of cholesterol was found in the blood, lungs, and liver. The change in cholesterol content in some organs was such that the possible effect of dilution or concentration of the label had to be considered. In this case, a correction was given by information for the quantity of radioactivity of cholesterol isolated from 1 g tissue. It is clear from the results in Tables 1 and 2 that the entry of exogeneous labeled cholesterol into the liver, kidneys, adrenals, and heart was higher than in the control group, whereas in the lungs and adipose tissue it was somewhat lower. The difference between absorption and distribution of indicator quantities of exogenous cholesterol, after administration of a single dose, differed significantly in animals receiving qualitatively different fats over long periods of time. In group 2, for instance, the content of cholesterol-4C^{14} per gram of tissue was lower for most investigated organs than the corresponding values for animals on a diet of lard (group 1). The only exception was the liver, in which the cholesterol content in group 2 was 31% higher than that in group 1. The content of labeled cholesterol was higher in the liver, lungs, and adrenals of rats fed on 60% sunflower oil than in animals receiving lard, and lower only in the adipose tissue and aorta. On the whole, the difference between the total content of labeled cholesterol in the 10 investigated organs of rats on a high fat diet was 40% higher when the diet contained vegetable oil than when it contained lard.

These results indicate certain differences in the absorption and distribution of exogenous cholesterol depending on the preliminary dietary background, and especially on the presence of qualitatively different fat products in the diet. Under the present experimental conditions, absorption of exogenous labeled cholesterol cannot differ significantly in all the groups of animals, for cholesterol-4C^{14} was injected only once, dissolved in sunflower oil. Changes observed in the total content of radioactive cholesterol in the rats of group 4 compared with group 2 must be interpreted as the result of possible disturbances of transport and reabsorption of cholesterol due to prolonged feeding of the animals on a diet with a higher content of sunflower oil.

It can be concluded by saying that the alimentary factor largely determines not only the absorption of exogenous cholesterol from the intestine, but also modifies the conditions of its transport to various organs. The content of labeled cholesterol, which in both experiments was given dissolved in sunflower oil, was increased in the liver of the animals fed on a diet containing vegetable oils.

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