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Relation between dietary fat composition and lipid metabolism in the rat

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With 2 figures and 2 tables

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The relation between blood lipids and atherosclerosis is well known, no doubt the factors affecting blood lipid pattern gained much interest. Dietary composition is one of the most important factors that interfers with blood lipids.

The most important dietary constituents that gained much interest in relation to cardiovascular disorders are carbohydrates. Many authers pointed out the strong correlation between free sugars and ischemic heart diseases (18–21). Dietary carbohydrates was thought to induce hypertriglyceridemia (1). Dietary free sugars have been claimed to favour hyperlipidaemia more than starch (9), however, a slight decrease in cholesterol was observed when dietary free sugars were replaced by complex carbohydrates (5–7 & 12).

MacDonald 1971 (10) in fasting subjects reported that serum triglycerides were lowered by polyunsaturated, while raised by saturated fats irrespective of the nature of dietary carbohydrates.

In the present study, the relation between dietary percentages of peanut oil, maize oil or lard and blood and tissue lipid composition was studied in rats of both sexes.

Material and methods

The present experiment was carried out on 18 male and 18 female Wister rats 160 g initial body weight, fed with experimental diets reported in the following table. The daily quantity of diet for each rat was 10 g. The experimental treatment lasted 60 days. Throughout the experimental period the animals were inspected and the body weight recorded. At the end of 8 weeks the animals were then killed by decapitation.

Results and discussion

Feeding the rats with low fat content diets in males showed that weight gain percentage in case of maize oil was the highest however, insignificant difference between peanut oil and maize, while significant difference between maize and lard ($P < 0.025$) (table 1). Increasing the fat content of the diet to 20% showed insignificant differences in percentage of weight

Composition of the experimental diets.

	Low fat content diet %	High fat content diet %
Sucrose	58.9	56.9
Lactose	4.0	4.0
Peanut oil, maize oil, or lard	10.0	20.0
Casein (purified)	18.0	18.0
Choline chloride	0.1	0.1
Salt mixture	4.0	4.0
Cellulose	5.0	5.0
With the addition per kg of the diets of		
Water-soluble vitamin mixture	305 mg	
Alpha-tocopherol acetate	325 mg	
Vitamin A acetate	12,000 IU	
Vitamin D_2 acetate	1,000 IU	
Vitamin B_{12}	30 µg	

Lipids from serum, liver, omental, perirenal, epididymal, brown fat and aortas were extracted by chloroform, methanol 2:1 (*Folch* et al. 1957 [4]). Pools of 6 rats were run together, and estimates were repeated three times. The mean and SE were calculated. Aortas were dissected out from its begining up to the biforcation of iliac arteries (2). Total lipids were determined gravimetrically by evaporating a known volume of extract under nitrogen and keeping in dessicator till constant weight. Lipids were fractionated by thin layer chromatography (3). Quantitative estimation of each fraction was done by charring method (8).

gain. If comparing weight gain percentages in low fat and high fat diets and the corresponding fats, insignificant differences were found except in lard ($P < 0.025$). Insignificant differences were detected in the different fats or in low and high fat diets in case of female rats.

Atherogenesis in rats have been induced by many investigators using various amounts of cholesterol and fats in their diets.

Duration of treatment affects greatly the severity and plaque formation.

The results presented in this study shows that increasing dietary fat to 20% for two months duration did not cause drastic changes in serum total lipids of both male and female rats (fig. 1 & 2).

Table 1. Percentage weight gain at the end of experiment, in male and female rats, kept on low and high fat diets, containing different fats.

		Male			Female		
		Peanut oil	Maize oil	Lard	Peanut oil	Maize oil	Lard
Low fat diet	M	38.4	42.2	28.6	21.5	29.8	27.3
	SE ±	6.4	3.57	3.53	3.65	4.02	2.01
High fat diet	M	43.6	42.3	42.3	27.9	25.66	25.3
	SE ±	4.68	2.99	5.05	2.95	2.26	2.36

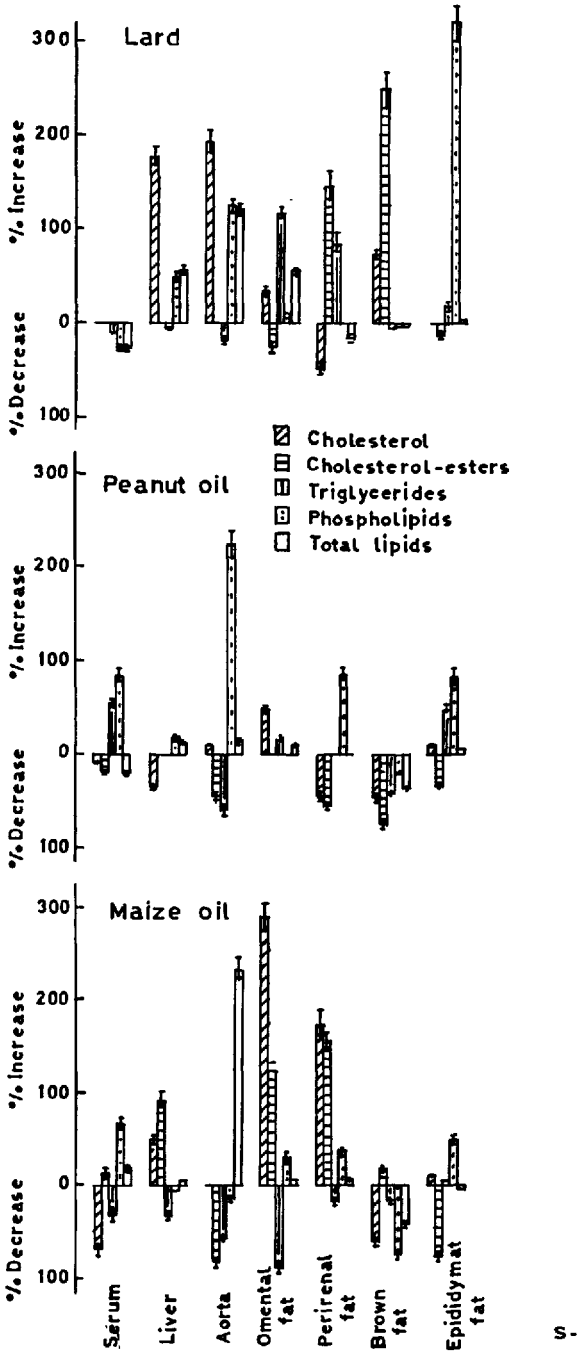

Fig. 1. Percent change in serum and tissues lipid components in response to hypercaloric diets containing lard peanut and maize (male rats.)

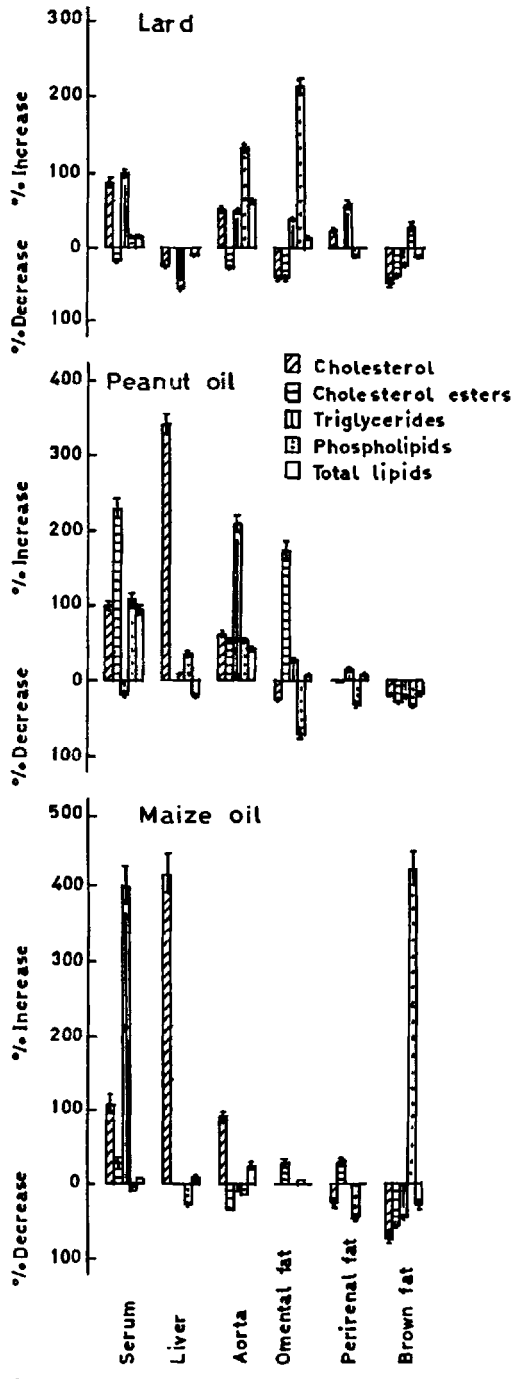

Fig. 2. Percent change in serum and tissues lipid components in response to hypercaloric diets containing lard, peanut and maize (female rats)

Gas chromatographic analysis of fats used revealed that lard contains 39.39% saturated fatty acids, peanut oil 28.4% and maize oil 14.3% (table 2).

Saturated dietary fats caused a decrease in total serum lipids in male rats while peanut oil increased serum total lipids in females. This may be through a decrease of lipolytic activity in blood and tissues, since in case of lard total lipid content increased in liver, aorta and omental in male rats. This finding resembles what has been reported by *Manning* and *Clarkson* (1972) (11) in monkeys using 25% lard and cholesterol, they demonstrated an initial rise in serum cholesterol which was not detected in this experiment. This difference may be due to the absence of cholesterol in the diets used, or because serum cholesterol was not followed throughout the experimental period.

Serum cholesterol in male rats were decreased by unsaturated dietary fat (maize oil). This finding agrees with what has been stated by *Soukupova* (1966) (14), that serum cholesterol level in man is increased by saturated fatty acids and reduced by unsaturated ones. In female rats there was no correlation between the type of fat and serum cholesterol level, as seen from results (fig. 2) however, increasing dietary fat content to 20% caused an increase in serum cholesterol level no matter the fat was.

Aortic total lipids were increased in male rats by lard and maize oil, while in females all fats caused such increase. What has been found in male rats, agrees with the finding of *Vles* and *Kloeze* (1967) (17) who found that feeding rabbits with 1:1 coconut oil and maize oil caused less atheroma than feeding the two oils successively for a period of 10 weeks each.

In female rats free cholesterol was increased by all fats, while cholesterol esters were increased only by peanut oil and was decreased by lard and maize oil. *Swell* et al. (1960, 1962) (15, 16) and *Moore* (13) reported that the majority of cholesterol esters in aortic plaques to be oleic acid esters, this could explain the increase in cholesterolesters in females by peanut oil, since it contains 70.6% oleic acid.

Table 2. Gas Liquid Chromatography (GLC) of the fats used in the diets.

	Maize oil %	Peanuts oil %	Lard %
C 14:0			1.15
C 16:0	11.8	11.4	21.80
C 18:0	2.5	10.9	16.40
C 16:1			2.30
C 18:1	25.6	70.6	46.00
C 18:2	59.5		10.70
C 18:3	0.6		1.60
C 20:0		1.6	
C 20:4		1.0	
C 22:0		2.1	
C 24:0		1.9	
C 24 br		0.5	

N.B. = The first number indicates chain length, the second indicates the number of double bonds. br = branched.

One can conclude from the results presented in this study that synthetic diets using 56.9% of total caloric requirements as sucrose and 20% as saturated fat in male rats might be atherogenic. On the other hand, in female rats using the same dietary formula no matter the ratio of saturated fatty acids to unsaturated may lead to the same picture.

Summary

Three fats were used in a synthetic dietary formula containing 20% of its composition as fat from either lard, peanut oil or maize oil.

Twelve groups of rats were included in this study, six groups served as controls; 3 from each sex. Control groups recieved the same dietary formula except fat content was 10%.

Saturated dietary fats in male rats seems to be atherogenic while in females, increasing dietary fat to 20% gave atherogenic picture.

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