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Impact of some commonly used egyptian diets on plasma lipids profils of rats

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Einfluß einiger üblicher ägyptischer Kostformen auf Plasmalipidprofile bei der Ratte

Summary: Seven types of diets commonly consumed in Egypt were studied in hyperlipemic rats. Each of the seven diets were fed to a group of hyperlipemic rats. The diets contain white beans and whole wheat bread (Diet 1); cabbage and peas (2); spinach and carrots (3); whole wheat bread and bean sprouts (4); whole wheat bread, white beans and peas (5); white beans and carrots (6) and the last diet contains peas and carrots (7). The experiment continued for 5 weeks, at the end of which different plasma lipids and biological parameters were compared to hyperlipemic rats fed the control diet for 5 weeks.

Results showed that plasma total cholesterol of rats of all groups showed significant decrease, except in rats fed diet 6 in which no significant change was noticed. Plasma total lipids of rats fed diet 5 decreased significantly. Plasma phospholipids of rats fed diets 3 and 7 increased significantly. Rats fed diet 3 showed decreased levels of plasma high density lipoprotein-cholesterol. Body weight gain of rats fed diets 1, 2 and 3 decreased significantly. Total food intake was noticed to decrease on feeding diets 1 and 6. Significant decrease was produced in food efficiency ratio of rats fed diets 1, 5 and 6. Feeding any type of the previous seven diets produced significant increase of feces weight.

Zusammenfassung: An hyperlipämischen Ratten wurde der Einfluß von 7 üblichen ägyptischen Kostformen geprüft. Die Ernährung bestand aus weißen Bohnen und Weizenvollkornbrot (Diät 1), Kohl und Erbsen (2), Spinat und Karotten (3), Weizenvollkornbrot und Bohnensprossen (4), Weizenvollkornbrot, weißen Bohnen und Erbsen (5), weißen Bohnen und Karotten (6) und schließlich Erbsen und Karotten (7). Die Versuche dauerten 5 Wochen, danach wurden verschiedene Plasmalipide und biologische Parameter mit hyperlipämischen Kontrolltieren verglichen. Das Gesamtplasmacholesterol war in allen Versuchsgruppen erniedrigt; eine Ausnahme machte Diät 6, hier gab es keine Senkung. Erniedrigt waren die Gesamtplasmalipide in Gruppe 5. Plasmaphospholipide stiegen an in den Gruppen 3 und 7. In Gruppe 3 war das HDL-Cholesterol erniedrigt. Die Gewichtszunahmen in den Gruppen 1, 2 und 3 waren reduziert. Ein verminderter Futterverzehr wurde in den Gruppen 1 und 6 beobachtet. Die Futterverwertung sank in den Gruppen 1, 5 und 6. In allen 7 Gruppen war das Gewicht der Faeces erhöht.

Key words: Fibers – rats – plasma lipids

Schlüsselwörter: Ratten – Plasmalipide

Introduction

Epidemiological studies suggested that dietary fiber lowers blood cholesterol and prevents cardiovascular problems in man (1). However when experiments were conducted in rats and man, inconsistent effects of dietary fibers on cholesterol levels were obtained (2, 3). Kritchevsky et al. (4) postulated that other diet ingredients such as type and quantity of protein and fats proved to play a prominent role in modifying plasma lipids. Nomani et al. (5) suggested a correlation between energy intake and different plasma lipids changes.

Since food habits vary from one country to the other, it seems to be more logical to deal with the whole diet as a factor for modifying plasma lipids. The aim of the present work is to study the role of some diets more commonly consumed in Egypt in modifying plasma lipid profile in patients cases suffering from hyperlipidemia.

Materials and methods

Experimental design

Seven diets commonly consumed by Egyptian populations have been prepared and fed to groups of animals which were rendered hyperlipemic through feeding a diet containing 15 % butter fat and 60 % sucrose (6).

Diets

The ingredients and the chemical composition of the hyperlipemic diet, the test diets, and the control diets are shown in Table 1. The test diets, composed mainly of some vegetables, cereals and legumes, were prepared as needed.

Table 1. Composition of test diets

Ingredients Type	Composition %	Protein	Fat	Carbohydrate	Crude fiber:	HC[1]	C[2]	L[3]
Hyperlipemic diet								
Casein	20	20	15	60.5				
Butter fat	15							
Sucrose	60.5							
Vitamin mixture (7)	1.0							
Salt mixture (8)	3.5							
Diet No. 1								
Rice	30	2.0		27.00	0.7			
Whole wheat bread	25	2.9		18.60	3.5			
White beans	25	4.9		12.24	7.9			
Casein	5	5.0						
Butter fat	15		15					
Total	100	14.8	15	57.84	12.1	9.37	1.634	0.4
Diet No. 2								
Rice	30	2.0		27.00	0.7			
Cabbage	25	4.9		14.80	5.0			
Peas	25	7.0		10.85	7.0			
Casein	5	5.0						
Butter fat	15		15					
Total	100	18.9	15	52.65	12.7	4.2	6.3	1.5

Ingredients Type	Composition %	Protein	Fat	Carbohydrate	Crude fiber:	HC[1]	C[2]	L[3]
Diet No. 3								
Rice	30	2.0		27.00	0.7			
Spinach	25	8.9		11.10	5.0			
Carrot	25	2.2		16.75	6.0			
Casein	5	5.0						
Butter fat	15		15					
Total	100	18.1	15	54.85	11.7	2.6	6.0	2.5
Diet No. 4								
Rice	30	2.0		27.00	0.70			
Whole wheat bread	10	1.2		7.424	1.41			
Bean sprout	40	9.6		19.80	10.60			
Casein	5	5.0						
Butter fat	15		15					
Total	100	17.8	15	54.224	12.71	4.0	6.3	5.4
Diet No. 5								
Rice	30	2.000		27.000	0.70			
Whole wheat bread	10	1.164		7.424	1.41			
White beans	15	2.930		7.330	4.80			
Peas	25	7.000		19.850	7.00			
Casein	5	5.000						
Butter fat	15		15					
Total	100	18.094	15	52.604	13.91	8.55	3.85	0.8
Diet No. 6								
Rice	30	2.0		27.00	0.7			
White beans	25	4.9		12.21	7.9			
Carrots	25	2.2		16.70	6.1			
Casein	5	5.0						
Butter fat	15		15					
Total	100	14.1	15	55.91	14.7	7.6	4.7	1.6
Diet No. 7								
Rice	30	2.0		27.00	0.7			
Peas	25	7.0		10.85	7.0			
Carrots	25	2.2		16.75	6.1			
Casein	5	5.0						
Butter fat	15		15					
Total	100	16.2	15	54.60	13.8	4.6	6.4	2.0
Control diet								
Rice	30	2.0		27.0	0.7			
White bread	25	3.5		21.0	0.5			
Cracked beans	25	8.1		16.4	0.5			
Casein	5	5.0						
Butter fat	15		15					
Total	100	18.6	15	64.4	1.7			

HC: Hemicellulose; C: Cellulose; L: Lignin

Preparation of diets' ingredients

White beans and peas were soaked in tap water for 3 h, cooked, then dried.

Rice was cooked in tap water. Cabbage, spinach, and carrots were cut into small pieces and cooked in tap water. All the cooked ingredients were dried in a drying oven.

The dried ingredients were analyzed for protein and curde fiber (9). Formulation of the diets was carried out by mixing the dried ingredients and addition of fat and casein to raise its levels to that of the control diet.

The values of the different types of fiber (cellulose, hemicellulose and lignin) were provided from two sources (10, 11).

Animals

Fourty-eight male albino rats weighing 85–120 g were first maintained on a hyperlipemic diet (Table 1) for 40 days; later they were divided into eight groups of six rats each. Each group was fed one of the test diets; an additional group was fed the control diet. The food and water were given ad lib. for a period of 5 weeks.

During the feeding experiment, food consumption, body weight gain, and fecal weights were measured. At the end of the experiment blood samples were taken and plasma was separated for chemical analysis of total lipids (12), phospholipids (13), triglycerides (14), total cholesterol (15), and high-density lipoprotein-cholesterol (16). The data of the rats fed the test diets were compared with those of the control group. Statistical analysis by Student's *t*-test was performed.

Results and discussion

It is clear from the results (Table 2) that plasma total cholesterol (T.ch) decreased significantly when feeding any type of the test diets except diet 6. Diet 5 produced the best result in reducing plasma cholesterol level (27 %). The least decrease of total cholesterol was produced by diet 1 (9 %). High-density lipoprotein cholesterol (HDL-ch) showed significant decrease when diet 3 was fed to the rats. HDL-ch/T.ch ratio increased significantly when rats were fed any type of the test diets, except diets 3 and 6. Once again, diet 5 produced the best effect in elevating the HDL-ch/T.ch ratio. On the other hand, diet 6, which contained white beans and carrots, produced a significant reduction of HDL-ch/T.ch ratio, which is really a bad effect. It is now well documented that the decrease in HDL-ch/T.ch ratio is one of the best indicators of coronary artery disease and that elevating this ratio may improve the situation (17).

Feeding any of the test diets did not modify the plasma triglyceride levels. The plasma phospholipids of rats fed diet 3 and 7 increased significantly by 11 % and 10 %, respectively. The only significant decrease of plasma total lipids (29 % reduction) was noticed on feeding diet 5.

Some authors (18, 19) reported that dietary cellulose did not decrease plasma cholesterol. Shurpalekar et al. (20) proved that 20 % cellulose in the diet decreased plasma cholesterol in Indian children. Kiriyama et al. (21) stated that carboxymethyl cellulose decreased plasma cholesterol in rats. Natural sources of dietary fiber such as soyfiber and guar gum reduced plasma cholesterol (22, 23). Thiffault et al. (24) used a preparation of cellulose in the treatment of a type II hypercholesterolemic patient. Such treatment produced a significant decrease of plasma cholosterol; however, lignin failed to lower plasma cholesterol. Kritchevsky (4) reported that lignin reduced serum and liver lipids and the deposit of fat in the liver cells (25), whereas cellulose supplementation had no reducing effect on serum and liver total lipids levels and DID not decrease the

Table 2. Plasma lipids of the rats of different dietary groups: Total lipids (T.L), phospholipids (P.L), triglycerides (T.G), total cholesterol (T.ch), and high-density lipoprotein-cholesterol (HDL-ch) in mg/100 ml and HDL-ch/T.ch ratio

Diet No.		T.L	P.L	T.G	T.ch	HDL-ch	HDL-ch / T.ch
Control rats	mean	350.800	141.667	85.263	97.463	69.53	0.717
	± SE	15.262	3.420	5.416	3.927	1.80	0.028
1	mean	386.000	147.600	93.000	88.600^{a}	71.40	0.805^{b}
	± SE	14.646	3.657	3.791	1.998	2.73	0.019
2	mean	331.000	152.400	83.200	74.500^{e}	65.60	0.880^{e}
	± SE	8.969	9.891	2.434	1.537	1.45	0.007
3	mean	341.000	157.500^{b}	86.900	81.600^{d}	55.10^{d}	0.674
	± SE	7.503	5.747	3.753	3.109	3.21	0.019
4	mean	330.000	147.900	81.000	78.200^{c}	65.40	0.836^{d}
	± SE	21.220	7.591	3.011	4.778	4.03	0.010
5	mean	248.000^{e}	145.700	84.400	71.300^{e}	65.10	0.913^{e}
	± SE	11.310	10.383	4.090	1.470	1.69	0.008
6	mean	340.000	132.400	79.200	101.200	63.10	0.626^{a}
	± SE	21.160	8.899	1.406	4.700	3.55	0.034
7	mean	327.000	155.200^{b}	77.000	82.000^{d}	67.30	0.821^{d}
	± SE	13.212	4.274	1.679	2.458	2.57	0.011

Values significantly differ from the control:
a) $p < 0.05$; b) $p < 0.025$; c) $p < 0.01$;
d) $p < 0.005$; e) $p < 0.0005$

deposit of fat in the liver cells (3). Some authors (26–28) proved that different types of fibers did not affect serum triglycerides and HDL-ch, while others (26) reported that pectin increased serum HDL-ch.

There are complicated sequences of physiological events for fat absorption in the small intestine when an emulsion of dietary lipids comes into contact with the bile containing a micellar solution of bile acid conjugates with cholesterol and phospholipids. Some authors (4, 29) reported that the dietary fiber, when fed to animals or man, generally increased excretion of bile acids and that fiber binds bile acids and bile salts in vitro, and that the extent of this binding is characteristic for each type of fiber and each substrate. Kritchevsky (30) proved that fecal excretion of cholesterol was high in animals fed high-fiber diets. These authors also suggested that the mechanism of fiber action involved the inhibition of cholesterol absorption and bile acid conjugates. The effect of fiber and its mode of action on the enzymes responsible for digestion of dietary fats cannot be ignored; George and Barbara (31) showed that feeding cellulose to rats decreased digestive enzyme activity, lipase, trypsin and chymotrypsin in the small intestine. Kritchevsky (32) reported that dietary fiber produced inhibition of cholesterol absorption and synthesis, inhibition of bile acid reabsorption, and an increase of cholesterol catabolism. Some authors (33) reported that dietary fiber decreased the reabsorption of bile salts, increased fecal excretion, and reduced hyperlipemia. Also, the fiber chelates bile acids and hinders cholesterol synthesis. Vahouny et al. (34) proved that cellulose produced a reduction of lymphatic absorption of cholesterol and increased hepatic phospholipids. Story et al. (35) proved that additon of 5 % lignin reduced the accumulation of liver cholesterol when the diet contained 0.5 % cholesterol. Absorption of cholesterol was reduced when unripe banana was given. Unripe banana had more hemicellulose but less cellulose, lignin and cutin than ripe banana (2).

Concerning the nutritional parameters (Table 3), feeding rats diets 1, 5 and 6 produced a significant reduction in body weight gain by 164 %, 80 %, and 162 %, respectively. Total food intake decreased significantly when rats were fed diets 1 and 6. Food efficiency ratio decreased significantly when diets 1, 5, and 6 were fed. Feeding any type of the test diets produced significant increase in feces weight which agreed with the work of some authors (36, 37).

Table 3. Body weight gain, total food consumption, food efficiency ratio, and feces weight in grams of rats fed the different diets

Diet No.		Body weight gain	Total food consumption	Food efficiency ratio	Feces weight
Control rats	mean	38.5	408.0	0.089	22.17
	± SE	9.432	28.25	0.020	1.87
1	mean	–24.7[d]	285.3[d]	–0.094[d]	57.20[e]
	± SE	11.9	12.7	0.047	1.70
2	mean	36.0	423.7	0.082	131.30[e]
	± SE	8.82	19.2	0.020	8.40
3	mean	23.8	397.7	0.056	186.50[e]
	± SE	7.7	19.03	0.020	10.50
4	mean	30.2	412.7	0.072	65.30[e]
	± SE	5.5	27.5	0.010	3.20
5	mean	7.8[b]	350.0	0.022[b]	88.50[e]
	± SE	6.7	15.6	0.020	9.70
6	mean	–23.7[e]	308.8[c]	–0.080[e]	95.00[e]
	± SE	9.5	17.6	0.030	8.04
7	mean	21.3	385.5	0.056	104.30[e]
	± SE	1.6	20.3	0.004	7.15

Values significantly differ from the control:
a) $p < 0.05$; b) $p < 0.025$; c) $p < 0.01$;
d) $p < 0.005$; e) $p < 0.0005$

Ten percent cellulose intake produced no change in food intake and food efficiency (38). Wilson et al. (39) showed that pectin reduced the body weight gain. Muller et al. (28) reported that feeding cellulose or lignin produced reduction in body weight gain when compared with those receiving either hemicellulose or pectin. Adding 4 % cellulose to a diet contaning 60 % corn starch produced no change in body weight gain (40). Rats fed cellulose or lignin gained significantly less weight than rats fed hemicellulose (29). Cumming et al. (41) reported an increase of fecal fat when feeding dietary fiber. These findings emphasize the role of fiber in decreasing body weight gain.

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