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BIOLOGICAL EFFECT OF HIGH DIETARY FATS AND SUCROSE LEVEL ON LIVER FUNCTIONS AND LIPIDS PROFILE IN THE EXPERIMENTAL RATS

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ABSTRACT

The effect of a diet containing 25% edible fats (balady butter,balady samna, and hydrogenated fat); edible oils (corn oil, sunflower oil and mixed oil) and a diet containing 45% sucrose on body weight gain; organs weight (liver, kidney and splelen); liver enzymes (ALT and AST); lipid profile (Triglycerides, Total cholesterol (T.ch.), High density lipoprotein cholesterol (HDL-Ch), Low density lipoprotein(LDL-ch) and Total protein (TP). The risk ratio is the result of T.ch divided by HDL-ch were studied in the experimental rats. The feeding experimental was carried out during 45 days and the results were compared with control group of rats fed a balanced diet. The results showed that groups of rats fed on diet containing (25% edible fat and/or 45% sucrose) caused significant increase in body weight gain, organs weight, level of liver enzymes and lipid profiles of serum and liver extract, while slightly decreased in total protein was observed when compared with control. On the other side, data showed that no changes were observed for groups of rats fed on 25% edible oils on body weight gain, organs weight, liver enzymes, lipids profile and total protein comparing with control . While, the low-fat (5%) group in rats diet yielded a significant decrease in the all previously parameters than control, this is due to the low fat content in the feeding diets of rats. In conclusion, although 25% edible oils was high fat diet, but it was less harmful effect on the liver functions and lipids profile than that recorded for the 25% edible fats (Saturated fatty acids) and thus it can be represented the 25% edible oils (unsaturated fatty acids) was healthy diet for the experimental rats.

Keywords : Lipid profile, High fat diet, High sucrose diet, Liver enzymes, AST and ALT.

INTRODUCTION

The food balance sheets of several countries including Egypt, revealed a progressive increase in the consumption of saturated fats and refined sugar (Ministry of Agriculture, Egypt, 1986). This stimulated us to carry out an experimental study on the effect of high level of saturated fats and sucrose on liver content of different lipid fractions and proteins. This study may clarify the hazards that might be caused by such dietary style.

The effect of the levels and types of dietary fats and oil with carbohydrate on lipid metabolism received much attention of several workrs (Pan *et al.*.,1994, Rothwell & Stock 1987, and Mona, M. *et al.*., 1989), since they play an important role in hyperlipemia, atherosclerosis as well as coronary heart diseases (Haqvin (1964) , Kritchevsky *et al.*,(1984) and Fitzgereld *et al.*, 2001). This increases in the prevalence of obesity has been attributed to an increased fat intake and a decreased physical activity (Schrouwen and Westerterp 2000).

High-fat diets, due to their high energy density, stimulate voluntary energy intake. An increased fat intake does not stimulate its own oxidation but increase its stored in the human body, fat oxidation only slowly increases resulting in positive fat balances on the short term. In conclusion, the increased intake of dietary fat and a decreasing physical activity, level are the most important environmental factors, explaining the increased prevalence of obesity in westernized societies (Schrouwen and Westerterp 2000;and Popp.tt *et al.*, 2002).

The intake of animal fats rich in saturated fatty acids, compared with the intake of vegetable oils rich in monoenoic or polyenoic fatty acids was the high effect. Considerable evidence has accumulated to show that the quantity, quality, processing and composition of fat might be important factors in this respect.

Therefore the present study was conducted to elucidate the effect of feeding animal on milk fats (butter, samna); hydrogenated fat and some edible oil (Corn oil, sun flower oil, mixed oil) widely consumed by Egyptians on liver function and lipids profiles of experimental animal.

MATERIALS AND METHODS

A - Dietary fats and oil :-

- Milk fats : Balady butter and Samna were obtained from Diary Egypt Co. Cairo.
- Hydrogenated fat from local Market.
- Edible oils : Corn oil, sunflower oil and mixed oil (sunflower oil : soya oil 1:1) were obtained from Soap and Oil, Co. Cairo Egypt.

Biological assay :-

Seventy two adult female albino rats weighing 85±10 were obtained from NODCAR farm, Cairo Egypt. They were divided into nine groups of 8 rats each, and housed individually in stainless steel cages at room temperature of 25°C and a relative humidity of about 55% for 45 days.
The experimental diets used are shown in Table (1). Food and water were allowed and libitum. (AOAC 1995).

Body weight changes and food consumed were recorded weakly.

Table (1) Composition of diets (g. per 100 g).

Ingredients	Basal Diet	Free Fat diet	High Fat diet	High sucrose diet
Maize starch	45	45	35	25
Sucrose	25	30	20	45
Casein	10	10	10	10
Fat*	10	5	25	10
Salt mixture	4.0	4.0	4.0	4.0
Vitamin mixture	1.0	1.0	1.0	1.0
Celleouse	5.0	5.0	5.0	5.0
Total	100	100	100	100

***The dietary fats and oils used : Balady butter, milk fat (samna), hydrogenated fat, corn oil, sun flower oil and mixed oil (sunflower + soya oil, 1:1).**

The feeding animal groups were: standard diet (basal diet) low fat 5%, sucrose 45%and six groups were feeding on different kinds of fat and oils at ratio 25% replacement from basal diet as shown in table (1) .

At the end of experimental period, rats were fasted overnight for 16-18 hrs, blood samples were withdrown, the animals were killed by decapitation, then the organs (Liver, heart,spleen, kedny) were dissected out and weighed.

Separated serum samples and liver extracted according to (Mona *et al.*, 1989) were subjected to the biochemical analysis including: Total cholesterol (Finley 1 978) H DL-cholesterol (Wieland a nd S eidel 1 981), L DL-cholesterol (Freidwald *et al.*,1972); triglycerides (Fossati and Principe 1982), AST and ALT (Reitman and Frankel, 1957) and total protein (Doumas 1975). The risk ratio is the result of total cholesterol divided by HDL-cholesterol.

Statistical analysis :-

The obtained results were statistically analyzed by using analysis of variana and least Significant Difference (L.S.D) at 0.05% level of probability as reported by Snedecor and Cohran (1980).

RESULTS AND DISCUSSON

I - Biological effect of feeding high-fat and high Sucrose diets on normal experimental rats.

In view of the importance of dairy products and sugar especially sucrose in the Egyptian diet it seemed desirable to discuss the effect of balady butter and milk-fat (samna) produced from milk; hydrogenated fat and sucrose on normal experimental rats for feeding period 45 days, compared with control (basal diet).

A: Effect on body weight :-

Result i n t able (2) s how t hat r ats f eeding o n f orms o f h igh f at a nd high sucrose diet containing 25% and 45% respectively caused an increases body weights comparing with control.

Table (2): The effect of feeding with high fat and high sucrose diet on body weight of experimental rats. (N=8 rats and mean ± SD)

Feeding groups	Initial body weight gm.	Final body weight gm.	Gain in body weight gm.	Percentage increase in body weight gm.
Pre feeding groups	84.25 ± 9.38 ^{b}	102.62 ± 4.88 ^{ab}	18.37 ± 0.87 ^{d}	21.8 ± 1.03 ^{d}
Control group	88.25 ± 3.81 ^{a}	128.50 ± 4.21 ^{b}	40.25 ± 1.32 ^{e}	45.61 ± 1.49 ^{e}
Free-fat group	85.13 ± 6.64 ^{ab}	96.60 ± 7.52 ^{bc}	11.47 ± 0.89 ^{c}	13.47 ± 1.05 ^{da}
Balady butter group	85.62 ± 2.72 ^{ab}	141.15 ± 44.8 ^{c}	55.53 ± 1.76 ^{dc}	64.85 ± 2.05 ^{a}
Milk fat (samna) group	83.37 ± 5.93 ^{c}	143.70 ± 10.22 ^{c}	60.33 ± 4.29 ^{de}	72.36 ± 5.14 ^{ac}
Hydrogenated fat group	81.95 ± 4.60 ^{c}	143.45 ± 7.90 ^{c}	61.50 ± 3.32 ^{de}	75.04 ± 4.05 ^{ac}
Corn-Oil group	88.25 ± 6.30 ^{a}	132.89 ± 9.48 ^{ab}	44.64 ± 3.19 ^{a}	50.58 ± 3.62 ^{ac}
Sunflower oil group	82.37 ± 4.66 ^{c}	128.88 ± 7.29 ^{ab}	46.52 ± 2.63 ^{a}	56.47 ± 3.19 ^{ac}
Mixed oil group (Sunflower oil .soya oil 1:1)	81.82 ± 2.28 ^{c}	126.97 ± 3.54 ^{ab}	45.15 ± 1.25 ^{a}	55.18 ± 1.53 ^{ac}
Sucrose group.	86.63 ± 2.43 ^{ab}	136.63 ± 4.00 ^{cd}	50.00 ± 1.46 ^{ab}	57.71 ±1.67 ^{ab}

A,b,c,d and e indicate significant difference (P.< 0.05) within column.

The percent increase in body weight gain were 64.85% for balady butter, 72.86% for milk fat (samna); 75.04% for hydrogenated fat and 56.71% for sucrose, while control was 45.61% . Such increases in body weight as a result of feeding on a diet containing 25% fat and/or 45% sucrose. On the other hand the percentage increasing in prefeeding and low-fat groups were 21.80% and 13.47% respectively, this is due to the low content of fat and sucrose in their diets. (Mona *et al* , 1989) and Loh *et al.* (1998).

B- Effect on organs weight :

Our results showed that the picture was almost the same either in case of high fat or high sucrose diet (Table 3) indicates that a slight difference increase in organs weight among groups and between each group compared with control. This increased in body weights and organs weight of experimental rats due to the high content of fat and sugar in producing diets by 25% and 45% respectivily when compared with control (basal diet) and low-fat group (Abd-El-Tawab *et al* .,1990, and Mona *et al.,* 1989).

Table (3): The effect of feeding with high fat and high sucrose diet on organs weight of experimental rats. (n=8 rats & mean ± SD)

Feeding groups	Liver weight gm.	Kideny weight gm.	Heart weight gm.	Spleen weight gm.
Pre feeding groups	3.50 ± 0.46	0.99 ± 0.19	0.65 ± 0.12	0.55 ± 0.16
Control (st. diet)	3.70 ± 0.18	1.02 ± 0.17	0.68 ± 0.16	0.58 ± 0.16
Low-fat- group	3.21± 0.29	0.83 ± 0.18	0.55 ± 0.11	0.47 ± 0.12
Balady butter group	4.04 ± 0.61	1.16 ± 0.20	0.69 ± 0.18	0.60 ± 0.13
Milk fat (samna) group	4.08 ± 0.28	1.18 ± 0.25	0.70 ± 0.20	0.65 ± 0.15
Hydrogenated fat group	4.13 ± 0.20	1.14 ± 0.12	0.66 ± 0.15	0.67 ± 0.14
Corn-Oil group	3.27 ± 0.29	0.75 ± 0.14	0.62 ± 0.14	0.49 ± 0.10
Sunflower oil group	3.47 ± 0.63	0.89 ± 0.21	0.60 ± 0.13	0.50 ± 0.19
Mixed oil group (Sunflower oil+soya oil 1:1)	3.35 ± 0.31	0.85 ± 0.16	0.64 ± 0.11	0.52 ± 0.20
Sucrose group.	4.15 ± 0.57	1.12 ± 0.17	0.69 ± 0.17	0.62 ±0.17

C- Effect on blood serum and liver extracts parameters :-

The blood serum and liver extracts of the tested rats were analyzed for triglycerides, total cholesterol, HDL-ch., LDL-ch (Lipid profile), liver enzymes (AST, ALT) and total proteins as presented in tables (4&5). The obtained results showed that the effect of feeding high fat and high sucrose diets on serum and liver extract of lipid profile ; liver enzymes and T. proteins were produced significant elevation when compared with the control (Table 4,5). While no change were observed between each groups. The obtained results for lipids profile, liver enzymes and total proteins for serum and liver extracted of rats feeding on balady butter, samna, hydrogenated fat and sucrose were 135.32mg%, 139.35mg% ,141.03mg% and 123.31mg%. for triglycerides (i.e) compared with 118.33mg% for control and 99.49 mg % for low-fat group. This increasing might be due to the high content of saturated fatty acids in these fats. This observation was shown by Haqvin (1964) who reported that in order to prevent hypercholesterolima which is the main risk factor in C.H.D.(coronary heart disease), butter and related products most be completely omitted from the diet and exchanged by vegetable oils. Also

the effects of a high fat or a high-sucrose diet were similar as recorded by Xue, *et al* .(2001).

These findings go paralled with the of Al-Okbi 1984 which proved that both high fat or high sucrose diets produced significant increased of serum low density lipoprotein, Moreover high sucrose diets produced significant increase total cholesterol, and triglycerides serum.

The work mechanism by which triglycerides (TAG) metabolism is affected by a high-fat or a high-sucrose diet differed; a high-fat diet increased plasma TAG level by lowering removal of TAG without increase in h epatic TAG secretion in normal rats. A high-sucrose diet, in contrast, induced much high plasma TAG levels by both increased hepatic TAG secretion and decreased removal of TAG as mentioned by Xue *et al.* (2001).

II. Biological effect of feeding some edible oils (Cornoil, sunflower oil and mixed oil on normal experimental rats.

A-Effect on body weight:-

From the reported results in Table (2), it was observed that the body weight gain of rats fed on a diet containing 25% from some edible oils (Corn oil, sunflower oil and mixed oil (sunflower oil + soya oil 1:1) were slightly increased than control, but no changes were noticed between groups fed on the latter oils, the body weight gain of rats fed on corn oil, sunflower oil and mixed oil is 44.64 gm 46.52 gm and 45.15 gm respectively compared with control which is 40.25 gm.

However, the percentage increase in body weight gain of the former oils and control are 50.58%, 56.47%,55.18% and 45.61% respectivily. Such increase in body weight as a result of feeding on a diet containing 25% edible oils (Loh *et al* .,1998).

B - Effect on organs weight :-

Results in Table (3), showed a slight difference increase between groups which feeding on a diet containing 25% edible oils (corn-oil , sunflower-oil and mixed oils) in liver, kidney, heart and splean weights compared with low-fat and control groups, this due to the feeding on high edible oils, However no change are noticed between groups feeding on the latter oils. These results a greed with the work of some authors (Mona et al 1989, Masi *et al.*, 1986).

The slight difference increase in organs weights of rats fed on 25% edible oils were low than the organs weight of rats fed on milk-fat and sucrose diets Table (3) this is due to the latter-fat containing a high saturated fatty acid (Abd El Tawab *et al.* , (1990).

C – Effect on blood serum and liver extract :-

From the obtained results in Table (4 and 5). It was observed that the lipids profile (Triglycerides, total-cholesterol, HDL-ch, LDL-Ch); Liver enzymes (AST,ALT)) and total proteins of rats fed on a diet containing 25% edible oils, caused a slight increase in both lipids profil and liver enzymes while no change in total proteins when compared with control , from the other hand the feeding on high-fat diet or hig-sucrose diet caused higher significant increase in lipid profile and liver enzymes of rats feeding it than feeding on edible oils.

Table (4): The effect of feeding with high fat and high sucrose diets on lipid profile, Liver enzymes and total protein of rats serum (n=8 rats & mean ± SD)

Feeding group	Lipids profile				Risk ratio T.ch/DHL-ch. mg%	Liver enzymes		T.protein gm%
	Triglycerids mg%	T.cholesterol mg%	HDL-ch. mg%	LDL-ch. mg%		AST U/L	ALT U/L	
Prefeeding group	115.13±2.73[b]	62.71±1.46	22.85±0.53	16.09±0.43	2.74±0.06	76.13±4.45	23.75±1.67	5.71±0.07
Control group	118.33±2.23	62.84±1.27	22.55±0.41	16.62±0.30	2.78±0.02	86.75±3.85	26.50±2.73	6.94±0.09
Low-fat-group	99.49±2.51	58.46±2.27	20.30±0.37	18.26±0.33	2.87±0.05	74.75±2.38	24.00±2.88	5.54±0.09
Balady butter group	135.32±1.44	72.80±1.64	25.4±0.39	20.34±0.31	2.86±0.04	94.63±2.45	34.12±2.90	5.28±0.10
Milk fat group(samna)	139.35±1.82	74.35±2.04	26.18±0.27	20.30±0.21	2.83±0.03	96.00±2.62	40.87±2.03	5.49±0.08
Hydrogenated-fat group	141.03±1.21	70.27±1.31	27.88±0.33	14.19±0.16	2.52±0.03	92.12±1.81	36.62±3.11	5.15±0.07
Corn-oil group	112.34±3.77	53.30±1.80	18.70±0.35	12.13±0.18	2.85±0.05	88.00±1.85	18.13±2.90	5.61±0.49
Sun flower group	116.71±2.22	54.43±1.56	17.35±0.19	13.74±0.11	2.96±0.03	85.87±2.9	16.50±2.45	5.47±0.15
Mixed oil group (sunflower oil + soy oil 1:1)	114.45±1.84	55.23±1.20	16.47±0.18	15.87±0.23	3.81±0.04	85.75±2.25	21.37±1.92	5.92±0.17
Sucrose group	123.31±2.50*	48.09±1.59*	12.28±0.15	12.14±0.22	3.99±0.07	82.13±1.81	15.62±1.92*	5.74±0.20

a,b,c,d and e indicate significant difference (0.05) within column

Table (5): The effect of feeding with high fat and high sucrose diet on lipids profile, Liver enzymes and total protein of rats liver exctract (n=8 rats and mean ± SD)

Feeding group	Lipids profile				Risk ratio T.ch/HDL-ch. mg/gm	Liver enzymes		T.protein gm%
	Triglycerides mg/gm	T.cholesterol mg/gm	HDL-ch. mg/gm	LDL-ch. mg/gm		AST ul/dl	ALT ul.dl	
Prefeeding group pre-g.l	8.18±0.24	5.46±0.13	3.40±0.01	0.43±0.01	1.61±0.03	7.85±0.24	3.02±0.18	4.67±0.39
Control group	8.70±0.19	5.82±0.15	3.50±0.09	0.58±0.01	1.66±0.04	8.21±0.18	3.38±0.24	4.62±0.10
Low-fat-group	6.13±0.25	4.63±0.21	2.85±0.13	0.55±0.02	1.62±0.07	6.35±0.24	2.73±0.19	4.50±0.19
Balady butter group	8.99±0.11	6.41±0.26	3.88±0.16	0.73±0.03	1.65±0.06	9.60±0.13	4.44±0.26	4.20±0.76
Milk fat group(samna) G	9.02±0.13	6.48±0.20	3.95±0.12	0.72±0.02	1.64±0.05	9.63±0.14	4.72±0.21	4.35±0.12
Hydrogenatedn group	8.95±0.25	6.50±0.23	3.90±0.14	0. 66±0.02	1.62±0.06	9.58±0.20	4.31±0.24	4.46±0.10
Corn-oil group	7.52±0.10	5.79±0.17	3.65±0.11	0.63±0.02	1.58±0.04	8.05±0.18	3.28±0.21	4.77±0.12
Sun flower oil group	7.46±0.11	5.65±0.18	3.59±0.11	0.56±0.02	1.57±0.05	8.07±0.19	3.11±0.22	4.67±0.14
Mixed oil group (sunflower oil+Soya oil 1:1	7.59±0.13	5.73±0.29	3.60±0.18	0.61±0.03	1.59±0.08	8.11±0.21	3.16±0.29	4.54±0.40
Sucrose group	8.47±0.20	5.58±0.26	3.38±0.15	0.51±0.02	1.56±0.06	8.19±0.23	3.31±0.27	5.28±0.40

a,b,c,d and e indicate significant difference (0.05) within column

These findings were confirmed by Carrol (1971) when he noticed that serum cholesterol decreased in rabbits fed commercial diet containg 15% by weight cotton seed oil. Masi *et al.*,(1986) found that corn oil is the most effective dietary fat in reducing cholesterolemia and lower levels of blood lipids in hyperlipaemic patients and rabbits.

The results in table (4&5) indicate that the high fat, diet (Milk fat, butter-fat), and hydrogenated fat containing 25% and sucrose diet containing 45% were caused significant at 0.05% level increased in lipids profile and liver enzymes than feeding on a diet containing 25% vegetable oil, these results were agreement to Al-Okbi (1984) and Grando *et al* .(1972).

Conbination of these data with those from our study leads us to conclude that the intake of the animal fat (butter and Samna) and hydrogenated fat rich in saturated fatty acid compared with the vegetable oils diet rich in unsaturated fatty acids, increase body weight, organs weight and in different parameters of blood serum and liver extract of rats feed on high-fat and high socrose diets, while there are no change when rats fed on edible oils compared with control and low-fat group.

In conclusion , the above mentioned findings seem to indicate that corn oil,, sun-flower oil and mixed oil can be a useful dietary and avoid the diet containing high animal fat or high sucrose diet.

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التأثير البيولوجى للأغذية المرتفعة فى نسبة الدهون والزيوت وكذلك مستوى السكروز على بعض الوظائف الحيويه لحيوانات التجارب

شوقى يعقوب ، وجيه احمد المالكى

اجرى هذا البحث بغرض دراسة تأثير الأغذية المرتفعة فى نسبة الدهون الحيوانيه او النباتيه وكذلك السكريات على مستوى دهنيات الدم ومستخلص الكبد فى حيوانات التجارب وذلك لمدة ٤٥ يوم بالمقارنة بالغذاء القياسى والمجموعة المغذاه على غذاء منخفض فى نسبة الدهون والسكريات وكانت النتائج كالأتى :-

أولا :- المجموعات من حيوانات التجارب المغذاه على غذاء يحتوى على نسبة ٢٥% دهون حيوانية (زبده وسمن بلدى) وكذلك السمن الصناعى اعطت زيادة معنوية فى وزن الجسم والأعضاء وكذلك فى مجموعة دهنيات الدم كالجلسريدات الثلاثية والكوليستيرول الكلى والأعلى والأقل كثافة وأيضا انزيمات الكبد فى سيرم ومستخلص الكبد لحيوانات التجارب بالمقارنة بالمجموعة القياسيه والمجموعة المنخفضة فى الدهون والسكريات بنسبة ٥%، ٢٥% على التوالى. ايضا المجموعة المغذاه على نسبة٤٥% سكروز أظهرت زيادة معنوية لنفس القياسات السابقة بالمقارنة بالكنترول .

ثانيا:- المجموعات من حيوانات التجارب المغذاه على زيوت نباتيه بنسبة ٢٥% (زيت الذرة - زيت عباد الشمس - الزيت المخلوط من عباد الشمس مع زيت الصويا بنسبة ١:١) أظهرت نقصا معنويا فى جميع القياسات من وزن الجسم والأعضاء (كبد - كلى- طحال - قلب) وايضا مستوى دهنيات سيرم ومستخلص الكبد لحيوانات التجارب شملت الدهون الثلاثية والكوليستيرول الكلى والعالى والمنخفض الكثافة وانزيمات الكبد ونسبة البروتين.

مما سبق نستنتج ان التغذية على الزيوت النباتية ولو كانت بنفس النسبة فى مقارنة بالدهون الحيوانية والزيوت المهدرجة وجدت أنها لم تحدث أى زيادات معنوية فى جميع القياسات بعكس الدهون الحيوانية والمهدرجة والمستوى العالى من السكروز .

لذلك نوصى بتجنب إستخدام الأغذية العالية فى محتواها من الدهون الحيوانية او السكريات ويفضل استخدام الاغذية المصنعة او المحتويه على الزيوت النباتية من الناحية الصحية .