Plasma lipids and prothrombin time in rats fed palm oil and other commonly used fats in Egypt

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RESUMEN

Lípidos en plasma y tiempo de protrombina en ratas alimentadas con aceite de palma y otras grasas frecuentemente utilizadas en Egipto.

Ratas Sprague-Dawley fueron alimentadas durante un periodo total de 8 semanas con seis dietas diferentes en su contenido graso. El contenido graso fue proporcionado por aceite de palma u oleína de palma o aceite de maíz o grasa hidrogenada o aceite de palma de fritura y mezcla de aceite de maíz + grasa hidrogenada en la relación (1:1). El último fue dado al grupo de control.

Los animales alimentados con las diferentes dietas experimentales mostraron diferencias significativas estadísticamente en el contenido en colesterol y triglicéridos en suero entre todos los grupos. El aumento en contenido HDL-colesterol fue evidente en animales alimentados con oleína de palma y aceite de palma. El grupo alimentado con aceite de fritura mostró el más bajo contenido en HDL-colesterol. En estos experimentos, los animales alimentados con oleína de palma mostraron la mayor relación de HDL-colesterol a colesterol total, mientras que la relación más baja fue mostrada en ratas alimentadas con aceite de fritura. El tiempo de protrombina (PT) y tromboplastina parcialmente activada (PTT) mostró valores elevados en dietas de aceite de palma, oleína de palma y aceite de maíz al comparar estos grupos con los demás.

PALABRAS-CLAVE: Dieta grasa - Lípidos en plasma - Rata - Tiempo de protrombina.

SUMMARY

Plasma lipids and prothrombin time in rats fed palm oil and other commonly used fats in Egypt.

Sprague-Dawley rats were fed for a total period of 8 weeks on six diets that were different in the source of their fat content. The fat content was provided either, palm oil or palm olein or corn oil or hydrogenated fat, or frying palm oil and mixture of corn oil + hydrogenated fat in the ratio (1:1). The latter was given to the control group. Animals fed these various experimental diets showed statistically significant differences in serum cholesterol and serum triglycerides content among all group. Increased HDL-cholesterol content was evident in animals fed on palm-olein and palm oil. The frying oil fed group showed lowest HDL-cholesterol content. In these experiments palm olein fed animals showed highest ratio of HDL-cholesterol to total cholesterol while the lowest ratio was shown in rats fed on frying oil. Prothrombin (PT) and activated partial thromboplastin time (PTT) showed higher values in palm oil, palm olein and corn oil diets as compared to all groups with each other.

KEY-WORDS: Fatty diet- Plasma lipids - Prothrombin time - Rat.

1. INTRODUCTION

The consumption of palm oil has increased significantly in Egypt during the last few years as compared with other edible oils. It has been used for several purposes such as cooking, frying and in several food industries.

The use of palm oil in food products has recently been called into questions about its effect on health aspects. Several controversial reports have been published that compare palm oil with soy oil (1). At the same time, palm oil has a very low ratio of polyunsaturated to saturated fatty acids (2). It is well established that diets high in saturated fatty acids represent a major factor in the induction of plasma hyperlipidemia and exerts its effects in the process of atherogenesis and coronary heart diseases (3), (4).

Sundram et al (5) studied the effect of dietary palm oil and its fraction on rat blood lipids using semisynthetic purified diet containing 20% fat for 15 weeks. The dietary fats were corn oil, soybean oil, palm oil, palm olein, and palm stearin. No significant difference in the body and organs weights of rats fed the various diets were evident. Plasma cholesterol levels of rats fed soybean oil were significantly lower than those of rats fed corn oil, palm oil, palm olein or palm stearin.

Frying is one of the most commonly used procedures for the preparations of foods with desirable texture and flavor, various vegetable oils are used for frying of food products (6).

Various chemical changes such as hydrolysis, oxidation and polymerization occur in the frying oil as consequence of the frying process (high temperature, the presence of water vapour content of the oil surface with air, the presence of fried product particles in the system) (7). Overused or highly a bused frying oils contain oxidized and polymerized materials that might be harmful to human health (8).

The aim of the present work is to evaluate palm oil compared with other commonly used fats and oils available in our market. These are corn oil, hydrogenated fat, palm olein and frying palm oil. To fulfill these objectives feeding experiments were carried out and serum lipids, prothrombin time (PT) and activated partial thromboplastin time (PTT) were determined.

2. EXPERIMENTAL

2.1. Material and Methods

The dietary test fats used in the present investigation were selected on basis of wide consumption by Egyptian population. These include: Palm oil and palm olein which are products of Misr Gulf Oil Processing Co. These fats were delivered by the company without storing in the local market. The frying oil sample was drawn from a closed system from Egypt Trade Chipsy Co. at a temperature of nearly 180 °C. Also, the turnover rate (the rate at which fresh oil is added to the fryer to replace oil lost from the system), affects to a great extent the keeping quality of the oil. Corn oil and hydrogenated fat were brought from local market. The hydrogenated fat was used to make of blend of hydrogenated corn oil to give fat of iodine value (65.7). Time of hydrogenation 20 minutes, used Ni as a catalyst, at 180 °C at atmospheric pressure. The source of corn oil is byproduct of starch industry.

Nutritional studies were carried out in sprague Dawley albino rats that weighed 100 ± 10g.

The animals were divided into six groups, 6 rats in each group, the animals were kept individually in wire bottomed cages at 25 ± 2 °C and relative humidity 55%. Food and water were given ad libitum. Six isocaloric diets were prepared as shown in Table I.

Table I
Composition of the experimental diets (g/100g)

INGREDIENTS	DIET %
Casein	15.0
Fat (*)	15.0
Sucrose	22
Starch	43
Salt mixture (9)	4
Vitamin mixture (10)	1
TOTAL	**100**

(*) The dietary fats used are: palm oil, palm olein, frying oil, corn oil, hydrogenated fat and a mixture of corn oil hydrogenated fat (1:1) W/W as control group.

The feeding experiments tested for 8 weeks. During the experimental feeding period the animals were carefully monitored and checked for food consumption and change in body weight.

On the last day, animals were fasted overnight, the animals were sacrificed. Blood was collected and sera was separated.

Serum samples were analyzed for total lipid (11), serum total cholesterol (12), triglycerides (13), high density lipoprotein cholesterol (phosphotungstate magnesium precipitation method) (14), phospholipids (15).

One ml of blood was taken on sodium citrate as anticoagulant for determination of prothrombin time (PT) and activated partial thromboplastin time (PTT) (16).

2.2. Statistical Technique

The standard deviation (SD) was used to measure the variation of a particular determination or parameter. Where appropriate the one-way analysis of variance (ANOVA) was used to compute for differences in total lipid, phospholipids, cholesterol, triglycerides, HDL-cholesterol., PT and PTT, among the various experimental groups, using F: 0.05 as the level of significance (17).

3. RESULTS AND DISCUSSION

The results shown in tables II, III and IV revealed that there are significant differences between the all groups as regards serum total lipids decreased in groups fed corn oil and frying oil. These findings contradict with those reported by seham and Maher who noticed that serum lipids pattern of rats fed the heated oil was increased. The discrepancy might be due to the relatively lower food intake in the present study. This is may be attributed to loss of appetite of rats due to the formation of harmful products such as peroxides and thermalpolymers which were formed during the frying process (18).

Table II
Comparison of lipids in different experimental groups (mg/dL)

GROUP		T.L.	T.ch.	T.G.	Ph.L.	HDL.ch.
Corn oil	Mean	471.75	68.5	64.63	77.36	25.52
	S.D ±	27.14	2.86	2.78	5.51	2.97
Palm olein	Mean	530.66	68.52	141.72	80.05	28.33
	S.D ±	10.01	4.25	6.09	2.76	2.06
Palm oil	Mean	527.84	84.28	90.01	82.95	30.18
	S.D ±	13.40	1.93	8.47	10.56	3.18
Control	Mean	551.74	76.20	115.00	82.22	23.33
	S.D ±	13.82	9.36	8.92	3.52	1.86
Hydrogenated	Mean	622.33	72.48	163.66	82.16	22.08
fat	S.D ±	20.76	6.03	6.65	5.19	1.20
Frying oil	Mean	462.31	71.26	98.50	78.93	19.15
	S.D ±	30.73	4.61	14.78	6.21	1.44
	F.	.0000	0.0001	.0000	0.584	0.000

- Mean of 6 rats per experimental groups least significant difference by one-way ANOVA for $\alpha = 0.05$ significant.

F: F. Prob
T.L.: Total lipid.
T.ch.: Total cholesterol
T.G.: Triglycerides
HDL.ch.: HDL-cholesterol
Ph.L.: Phospholipids

Table III
The atherogenic potency of dietary fats (the ratio of HDL-cholesterol to total cholesterol)

RATIO	Control	Palm olein	Palm oil	Frying oil	Corn oil	Hydrogenated fat
$\frac{\text{HDL-cholesterol}}{\text{Total cholesterol}}$	0.306	0.413	0.360	0.268	0.368	0.305

Table IV
Comparison of Thromboplastin (PT) Partial Thromboplastin time (PTT) different experimental groups

GROUP		Thromboplastin time (PT)	Partial thromboplastin time (PTT)
Corn oil	Mean	19	37.66
	S.D ±	1.44	2.58
Palm olein	Mean	17.16	35.83
	S.D ±	1.94	1.53
Palm oil	Mean	15.66	43.11
	S.D ±	0.95	3.9
Control	Mean	13.66	32.5
	S.D ±	1.03	3.83
Hydrogenated fat	Mean	14.25	25.83
	S.D ±	1.29	3.06
Frying oil	Mean	14.08	27.91
	S.D ±	1.02	7.22
	F.	.000	.000

- Mean of 6 rats per experimental groups least significant difference by one-way ANOVA for $\alpha = 0.05$ significant.
F: F. Prob.

The data from the present work show that serum triglycerides are the main serum lipid fraction, and can be modified in response to different diets.

Triglycerides are lowest in the corn oil diet, followed by palm oil, frying oil, palm olein and hydrogenated fat respectively. These results are in agreement with Majumdar *et al* (19), who recorded lower values of plasma triglycerides in case of palm oil diet.

The same finding was observed by, Habidah Abdul Hamid *et al* (20) revealed the same observation as regards the lowering action of palm oil on plasma triglycerides. Contrary to this, some workers observed elevated levels of plasma triglycerides in rats fed on palm oil (21) (22) (23).

It should be mentioned that Tony *et al* (24) could not record significant changes for serum triglycerides throughout their study on rats fed palm olein, corn oil and coconut oil. Also Murakumi *et al* (25) found no significant differences in the concentration of triglycerides in serum among rats fed palm oil, palm olein or soybean oil. These discrepancies might be due to the difference in diet composition concerning the serum phospholipids, all the groups showed a nonsignificant change when compared with each either.

The corn oil fed rats having the lowest value while palm oil fed rats had the highest value. Some workers (4) (5) (23) found that serum phospholipids content was increased in palm oil group when compared to corn oil group which is in agreement with our results.

Plasma total cholesterol show statistically significant differences between all groups receiving different oils and fats including the different palm oil constituents which show a tendency for higher cholesterol level. It is generally believed that saturated fat from animal and vegetable sources in human diets tend to cause an elevation of serum cholesterol concentration (26). Hornstra *et al* (27) found that palm oil is an exception in having a lipid lowering effect despite its high concentration of saturated fatty acid (50% palmitic acid). These results agreed with Qureshi *et al* (28) who found that total serum cholesterol was reduced on feeding palm oil diet when compared to corn oil diet. Some authors (29) demonstrated the hypocholesterolemic effect of palm oil and corn oil, too.

A possible explanation for this apparently paradoxical action the high content of tocotrienols present in palm oil (780-1080 μg/g). Recently, Sugano and Imaizumi (30) reported that palm oil is hypercholesterolemic when compared with polyunsaturated fatty acid rich diet. They stated that such specific effect appear to attributed to the fatty acid profile of different fats and oils.

With respect to HDL-cholesterol, all the groups showed significant changes when compared with each other. The palm oil group showed an increase in HDL-cholesterol. These results agree with those found by some investigators (31) who recorded in a human study, a highest level of HDL-cholesterol in the group consuming palm oil diet (P/s 0.2) with respect to other fats having different P/s ratios.

The ratio of HDL-cholesterol to total lipid cholesterol was calculated in table III. It was suggested to give an indication of the atherogenis potency of a dietary fat. An increased ratio to indicates less potency of the dietary fat (4).

To measure the arterial thrombus tendency we recourse to the prothrombin time (PT) and partial thromboplastin time (PTT) which were found to be higher in palm oil, palm olein and corn oil.

Animal studies carried out by Hornstra *et al* and Rand *et al* (32) (33) suggested that palm oil had desirable influences on thrombotic tendency, blood platelet aggregation and eicosanoid biosynthesis.

The results reported suggested that palm oil was considerably less effective in promoting clotting than would have been anticipated on the basis of its fatty acid composition. Rand *et al* (33) suggested that the discrepancy between the predicted effect on clot formation and that observed in the experiment could be accounted for by reference to the tocopherols and tocotrienols contents in the oil, suggesting that among these component lies the ingredients reponsible for the anomalous behaviour.

Therefore, further studies especially designed to investigate the effect of dietary palm oil and palm olein based nutritional products on plasma lipoproteins and prostaglandin metabolism are needed.

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