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Original Article

VEGETABLE OILS AND DYSLIPIDEMIA

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ABSTRACT

Objective: Vegetable oils are now routinely recommended for cholesterol lowering diet regimens but their differential effects on lipid fractions are not well-understood. This study was conducted to compare the effects of corn oil, olive oil and rapeseed oil on plasma lipids.

Setting: Department of Pathology, Postgraduate Medical Institute, Lahore.

Methods: Forty-eight Albino rats were divided into four groups of twelve rats each. Animals in each group were fed a diet containing only one type of vegetable oil for twelve weeks. Lipid profiles at 0 week and 12 weeks were compared.

Results: Control group showed non-significant (P>0.05) change. Rapeseed oil group showed non-significant (P>0.05) change in TC, LDL-c and HDL-c and significant (P<0.05) rise in TAG and TL. In corn oil group, all lipid fractions decreased significantly (P<0.05); LDL-c highly significantly (P<0.001) decreased (36.6±5.1 to 25.0±3.7mg/dl) and HDL-c significantly (P<0.05) decreased (34.8±2.3 to 31.2±2.5) at 12 weeks. In olive oil group, there was significant (P<0.05) decrease in TC, TAG and TL; highly significant (P<0.001) decrease in LDL-c (35.6±7.3 to 27.0±6.8 mg/dl) at 12 weeks. Significant (P<0.05) rise in HDL-c (33.6±3.3 to 36.5±3.6 mg/dl) at 12 weeks was unique to the olive oil group.

Conclusion: Olive oil may be considered a better dietary fat in dyslipidemia as compared with corn oil and rapeseed oil.

KEY WORDS: - Hyperlipidemia, vegetable oils, plasma lipid fractions, Albino rats.

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INTRODUCTION

Lipoprotein disorders or dyslipidemias are among the most common metabolic diseases seen in clinical practice. They are important because they may lead to a number of sequelae including coronary heart disease (CHD)[1]. Excessive levels of blood cholesterol accelerate atherogenesis[2] and lowering high blood cholesterol reduces the incidence of CHD[3,4]. Knowledge about the levels of cholesterol subfractions is more meaningful than simple plasma cholesterol level. The higher the level of LDL cholesterol, the greater the risk of atherosclerotic heart disease; conversely, the higher the level of HDL cholesterol, the lower the risk of coronary heart disease. This is true in men and women, in different racial and ethnic groups and at all adult ages[5-7].

Hyperlipidemia may be a primary anomaly,

which cannot be linked to an identifiable underlying disease or it can be a secondary manifestation of some other condition e.g., Diabetes Mellitus, Hypothyroidism or chronic renal failure[8]. Different types of dietary lipids have been shown to affect lipid metabolism and hence serum lipid profile, differently[9,10]. Plasma cholesterol levels are moderately decreased when low cholesterol diets are used. So it is useful to identify diets containing cholesterol and affecting serum lipid profile. Foods from animal sources have cholesterol, while foods from plant sources e.g., vegetable oils have no cholesterol[11]. So, vegetable oils replace the animal fat in the cholesterol lowering diet regimens. It is now generally believed that vegetable oils decrease plasma cholesterol levels although they differ in their cholesterol lowering capacity. It was further revealed that the effect of dietary cholesterol on plasma cholesterol is less important than the amount and types of fatty acids consumed. So the interest shifted from the cholesterol content of dietary fat towards the fatty acid composition of fats and oils. Fatty acids may be saturated, polyunsaturated or monounsaturated. Fats from animal sources contain a higher proportion of saturated fatty acids while fats from plant sources e.g. vegetable oils contain more unsaturated fatty acids[11]. So vegetable oils still retain their validity as cholesterol lowering agents. The question now arises about their relative potency and, as our understanding about plasma cholesterol sub fractions have increased, about their effects on plasma cholesterol sub fractions. These issues are to be resolved, so we selected three vegetable oils for this study i.e. corn oil, rapeseed oil and olive oil. All the three are locally produced abundantly. Olive oil is extracted from the ripe fruit of olive plant[12] and is used in Pakistan because of its religious value. Olive oil is highly appreciated by the Holy Prophet Muhammad (may peace be upon him). He said, "Eat olive oil and massage it, as it is from a sacred tree."[13] To observe the effects of these oils on plasma lipids, we designed a study model using Albino rats as experimental animals.

MATERIALS AND METHODS

This study was carried out in the Department of Pathology, Postgraduate Medical Institute (PGMI), Lahore.

Animals: Forty-eight Albino rats of eight weeks age were collected from the Nutrition Department of Agriculture University, Faisalabad. They were randomly distributed into four groups of twelve rats each for giving different oil diets. Each group had equal number of male and female rats. The animals were numbered and kept as pairs of same sex in iron cages at Postgraduate Medical Institute, Lahore. Optimum hygienic atmosphere was provided to keep the animals during the study period. Food and water was provided to the animals at all times of day. Four types of synthetic diets given orally were used in the study. Each group of animals was fed only one type of diet throughout the twelve weeks of study. According to the type of diet fed, animals were grouped as under:-

Group A	(n=12)	=	Control Group; 5% vegetable oil fat.
Group B	(n=12)	=	Corn oil Group; 20% corn oil fat.
Group C	(n=12)	=	Olive oil Group; 20% olive oil fat.
Group D	(n=12)	=	Rapeseed oil Group; 20% Rapeseed oil fat.

Diets: One control diet and three experimental diets were used in the study. Control diet was a low fat diet containing only 5% vegetable oil fat. Experimental diets were having 20% fat as Corn oil, olive oil and rapeseed oil. Vegetable oils were purchased from the local market and the same stock was used throughout the study. Rat diets were prepared at two weeks intervals and stored at 0-5°C in closed containers. The diets were well tolerated by the animals. Composition of different diets is shown in Table-I.

Table-I : Composition of Different Diets

Ingredients	*Group A*	*Group B*	*Group C*	*Group D*
Fats	5% (Veg.oil)*	20% (Corn oil)	20% (Olive oil)	20% (Rapeseed oil)
Maize Starch	60%	45%	45%	45%
Casein	20%	20%	20%	20%
Cane Sugar	10%	10%	10%	10%
Choline & Methnionine	0.5%	0.5%	0.5%	0.5%
Mineral Mixture	3.5%	3.5%	3.5%	3.5%
Vitamin Mixture	1.0%	1.0%	1.0%	1.0%
Total	100%	100%	100%	100%

* Veg. oil = vegetable oil

Dietary Fat Analysis: The dietary fats used in this study were analyzed for percent composition of fatty acids by Gas-liquid chromatography. First, methyl esters of the fatty acids in the dietary fat were prepared by the method of Kumar and Tsunoda (1978)[14]. The methyl esters were chromatographed on a "Pye-Unicom 204 series chromatograph." Pye-glass column used was of 1.5 meters length with 4 millimeter internal diameter. The stationary phase was 10% Polyethylene glycol succinate (PEGS) coated on diatomite (80-100 mush) support. Both the materials were of Pye-Unicom origin. Nitrogen was used as a carrier gas at the rate of flow of 40ml/min. Injection temperature, column temperature and detector temperature, all were 220°C. Fatty acid compositions were computed from the peak areas corresponding to the respective fatty acids. Results of the analysis are given in Table-II.

Methods: The animals were fed the control diet for one week prior to the start of the experimental period to make the animals acclimatized to the environment and to bring the plasma lipids to a baseline.

After this initial period of adaptation to the environment & control diet[15], the first blood sample (0 week sample) was collected and analyzed and the experimental diets were started. After the completion of 12 weeks study period, another blood sample (12 weeks sample) was collected and analyzed. Results of the two samples were compared.

Before collection of blood samples, the animals were kept on an overnight fast (12-14 hours). In the next morning, animal was given ether anesthesia and 2ml blood was drawn with the help of a 5ml syringe through a heart puncture. Blood was then transferred to the labeled centrifuge tube and allowed to clot at room temperature for one hour and then centrifuged for ten minutes at a speed of 3000 rpm. Serum was separated and used afresh for estimations. If required, the serum was stored at -20°C. Total cholesterol (TC), HDL-cholesterol (HDL-c), LDL-cholesterol (LDL-c), triacylglycerols (TAG) and total lipids (TL) were estimated from the serum so collected.

Total cholesterol (TC) and serum TAG were determined after enzymatic hydrolysis and oxidation (Varley 1980)[16] ; HDL-c was determined enzymatically by CHOD-PAP method mentioned by Richmond (1973)[17] ; LDL-c was also determined enzymatically by CHOD-PAP method used by Levy (1981)[18], total lipids were estimated by sulphophospho vanillin reaction described by Zolliner, Kirsch and Gesamate (1962)[19].

Comparison of results obtained for various groups was done by utilizing student's t-test.

RESULTS

Results of the chemical analysis of the vegetable oils studied are shown in Table-II. In

Table-II : Fatty acid Composition of Dietary Fats

Fats	*Saturated fatty acids (Chain length & %)*	*Unsaturated fatty acids (Chain length, No. of double bonds & %)*
Corn oil (PUFA)	C 16 = 12.0*	C 18 : 1 = 24.4
	C 18 = 2.8	C 18 : 2 = 58.6 (Linoleic acid)
		C 18 : 3 = 1.2
	Total = 14.8%	Total = 84.2%
Olive oil (MUFA)	C 16 = 12.6	C 16 : 1 = 1.0
	C 18 = 1.4	C 18 : 1 = 76.0 (Oleic acid)
		C 18 : 2 = 8.0**
	Total = 14.0%	Total = 85.0%
Rapeseed oil (MUFA)	C 16 = 3.5	C 18 : 1 = 17.0
	C 18 = 1.5	C 18 : 2 = 17.6
		C 18 : 3 = 10.2
		C 22 : 1 = 50.5 (Erucic Acid)
	Total = 5.0%	Total = 95.3%

Explanation:- * C 16 = 12.0 means saturated fatty acids of 16 carbon chain length present in 12% amount.

** C 18 : 2 = 8.0 means unsaturated fatty acids of 18 carbon chain length with two unsaturated bonds present in 8.0% amount.

corn oil group, there were 14.8% saturated fatty acids and 84.2% unsaturated fatty acids. The most abundant (58%) fatty acid in corn oil was linoleic acid (C18:2), a polyunsaturated fatty acid or PUFA. Olive oil had 14.0% saturated fatty acids and 85.0% unsaturated fatty acids, 76% was oleic acid (C18:1). In rapeseed oil 5% were saturated fatty acids, 95.3% unsaturated fatty acids, erucic acid (C22:1) was 50.5% in amount. Oleic acid and erucic acid are monounsaturated fatty acids/or MUFA

Results of the study are shown in Table-III. This table shows that in the control group, there was non-significant ($p>0.05$) change between 0 and 12 weeks' values of all the serum lipid fractions. In rapeseed oil group, there was non-significant ($p>0.05$) change in 0 and 12 weeks values of TC, HDL-c and LDL-c while there was significant ($p<0.05$) rise in serum TAG and TL at 12 weeks.

In the corn oil group, all the lipid fractions were significantly ($p<0.05$) decreased at 12 weeks; LDL-c rather highly significantly ($p<0.001$) decreased (36.6±5.1 to 25.0±3.7 mg/dl) at 12 weeks. In this group, HDL-c was significantly ($p<0.05$) decreased (34.8±2.3 to 31.2 ±2.5 mg/dl) at twelve weeks. In the olive oil group, there was significant ($p<0.05$) decrease in TC, TAG and TL and highly significant ($p<0.001$) decrease in LDL-c from 35.6±7.3 to 27.0±6.8 mg/dl at twelve weeks. The significant ($p<0.05$) rise in HDL-c from 33.6±3.3 to 36.5±3.6 mg/dl at twelve weeks was unique to the olive oil group.

All the lipid fractions were decreased to a greater extent in the corn oil group as compared with the olive oil group except for the reverse situation in case of HDL-c which was increased in the olive oil group at twelve weeks. Rapeseed oil group showed increase in all lipid fractions at twelve weeks as compared with the other two groups.

Table -III: Comparison of serum lipid fractions in various groups at 0 and 12 weeks

Lipid fractions →	*Total Cholesterol (TC)*		*HDL-C*		*LDL-C*		*Triacylglycerols (TAG)*		*Total Lipids (TL)*	
Groups ↓	*0 Week*	*12 Weeks*	*0 Week*	*12 Weeks*	*0 Week*	*12 Weeks*	*0 Week*	*12 Weeks*	*0 Week*	*12 Weeks*
Control Group (5% fat)	87.0±6.7	↓82.4±7.0 *	31.9±2.9	↓30.1±2.4 *	34.7±6.1	↓30.7±6.4 *	94.6±10.8	↑101.7±9.1 *	469.1±13.2	↑478.8±13.4 *
Olive oil Group (20% fat)	89.6±8.1	↓79.2±8.0 **	33.6±3.3	↑36.5±3.6 **	35.6±7.3	↓27.0±6.8 ***	93.7±7.6	↓84.2±6.7 **	469.0±11.8	↓437.9±10.5 **
Corn oil Group (20% fat)	89.2±6.6	↓72.3±6.0 **	34.8±2.3	↓31.2±2.5 **	36.6±5.1	↓25.0±3.7 ***	94.3±7.7	↓79.9±6.0 **	469.1±13.2	↓428.7±14.4 **
Rape seed oil Group (20% fat)	87.2±7.2	↑92.0±7.7 **	32.8±4.1	↑34.4±3.9 *	34.1±4.6	↑37.1±5.3 *	94.8±7.5	↑105.5±6.9 **	470.0±12.7	↑487.5±12.3 **

Key: ↑= Increased; ↓ = decreased; * = P>0.05 (non-significant); ** = P<0.05 (significant); *** = P<0.001 (highly significant)

Values in mg/dl show mean ± SD.

HDL-c = high density lipoprotein cholesterol; LDL-c = low density lipoprotein cholesterol.

DISCUSSION

With the exceptions of coconut oil and palm oil all vegetable oils are liquid at room temperature, they are virtually cholesterol-free and they all contain unsaturated fatty acids predominantly.[11] So, they have hypocholesterolemic effect and are recommended for cholesterol lowering diets in atherosclerotic vascular diseases. In this study, we compared the differential effects of three vegetable oils on serum lipids and lipid fractions. These oils had different fatty acid composition and desaturation. Analysis showed that the olive oil contained oleic acid, corn oil contained linoleic acid and rapeseed oil contained erucic acid predominantly (Table-I). The percentage compositions of the fatty acids found in our study sample of corn oil, olive oil and rapeseed oil, was slightly different from Khan et al.(1989)[20]. This difference was possibly due to the territory and species difference of the respective plants.

We found that the corn oil diet decreased the total lipids, and other lipid fractions including HDL-c at 12 weeks. The same effect of corn oil was shown by many workers.[21-23] In the rapeseed oil group, it was seen that all serum lipids were increased. Our findings about rapeseed oil differ from its effects mentioned in the literature[7,8] which showed a plasma lipid lowering effects of rapeseed oil. Findings of Carrol (1962)[24] were similar as found in our study. Edible form of rapeseed oil is Canola oil. Because erucic acid (C 22: 1) has been linked to cardiac muscle damage, edible Canola oil products are prepared from low erucic acid varieties of rapeseed plants.[25]

Olive oil diet decreased all serum lipids except HDL-c which was actually increased at 12 weeks. Findings of Garg et al. (1988)[26] and Jacottot et al (1988)[27] were also similar to our findings but other literature[7,8] did not mention the HDL-c raising capacity of olive oil. Ours is an experimental animal study but observations by various workers[28-30] revealed similar effects

of these vegetable oils in humans.

It is now clear that lowering plasma cholesterol by diet and drugs slows and may even reverse the progression of atherosclerotic vascular lesions and the complications they cause[31]. In general for each 1 mg/dl decrease in plasma LDL-c, there is about two percent decrease in mortality from atheroscleerotic heart disease[32]. When the decision is made to treat the hyperlipoproteinemia, dietary measures are always initiated first and these only may obviate the need for drugs. In fact, most patients with elevated LDL-c can be managed appropriately with diet in which monounsaturated fats should predominate.[29] Our findings may have following clinical implications:-

(i) Primary Prevention of CHD:- In case of males, both corn oil and olive oil may be equally beneficial. In case of females, in which a low HDL-c is a more important risk factor for coronary heart disease than a high LDL-c[7], olive oil may be recommended because of its HDL-c raising effect. In females taking contraceptive pills or estrogen replacement therapy, olive oil is better.

(ii) Secondary prevention of CHD:- Dietary reductions in calories and saturated fats decreases LDL-c, but reductions in HDL-c are also observed. Polyunsaturated fats also have the same effect. The inclusion of monounsaturated fats (olive oil) in the diet, as naturally occurs in the Mediterranean diet, prevents the decrease in HDL-c[33].

(iii) In diabetic patients, patients of hypothyroidism and in patients using beta-blockers (except Pindolol and acebutolol), there is high total cholesterol with low HDL-c[8] and in obesity where HDL-c is usually low[30], olive oil may be the safe dietary fat.

CONCLUSION

Previously it was thought that the polyunsaturated fats are the most beneficial, but recent studies suggest that monounsaturated fats such as olive oil, may be the most healthful[34]. In Pakistan where over 7.3 million people have elevated blood cholesterol levels[35] and where the use of foods containing monounsaturated fat is rare[36], it is recommended that the use of olive oil in diet may be encouraged.

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