The Effect of Flaxseed Oil (Linum usitatissimum) on Lipid Metabolism of Cholesterol Fed Rats

Suaad M. J. Al-Hadrawy, Ikhlass A. Al-Hilaly and Haider A. Thanwan Al-Kafajy
College of Science, University of Kufa.

Abstract
This research designed to study the effects of flaxseed oil (0.25 ml) orally given for 28 days on the total cholesterol concentration and on lipid lipoprotein in the blood of cholesterol fed rats. Methods: Randomly 12 adult female rats were divided into 4 groups (3 animals for each group). The control group (group I) were fed with standard pellet diet, the second group (group II) were fed with 1% cholesterol diet, the third group (group III) were daily administered (0.25 ml) of the flaxseed oil along with high cholesterol diet, and the fourth group (group IV) received daily (0.25 ml) of flaxseed oil. Results: The results showed a disturbance state in blood lipids in the animals that fed with diet contain cholesterol characterized with significant increase in total cholesterol (TC) and the concentration of low density lipoprotein (LDL-C) and triglyceride (TG) and in the very low density lipoprotein (VLDL-C) in the serum and a significant decrease in the level of high density lipoprotein (HDL-C) concentration. Also the result showed that flaxseed oil administration has no protective effects against this lipid disturbance which induced by cholesterol use. Conclusion: The treatment with flaxseed oil didn’t cause significant decrease in total cholesterol level and didn't cause increase the level of High density lipoprotein in the plasma of treated rats.

Keywords: flaxseed oil; cholesterol; triglycerides; HDL-C; LDL-C.

Introduction
The use of flaxseed as a dietary supplement is increasing in parallel with the research on its multitudinous effects on human health (1). Flaxseed contains putative health promoting factors like nutritional fiber, the phytoestrogen lignan precursors secoisolariciresinol and matairecinol and flaxseed oil with its high concentration of α-linolenic acid (2).

Flaxseeds contain 35-45 % oil. Flaxseed oil has an exceptional fatty acid composition: depending on the strain 45-60 % of it is alpha-linolenic acid (ALA) and 15-18 % is linoleic acid (LA). ALA and LA fatty acids are essential i.e. they must be included in the diet (1).

ALA shows cancer-preventive effects (3,4), an inverse association with risk of coronary heart disease (5) and beneficial effects on hemostatic factors (6). ALA is involved also in inflammatory diseases by decreasing leukotriene β4 concentration (7) and in atopic disease (8). ALA seems to have a beneficial role also on brain function (9).

In laboratory and animal studies, flaxseed and flaxseed oil are reported to lower blood cholesterol levels. Effects on blood triglyceride levels in animals are unclear, with increased levels in some research and decreased levels in other research. Human studies in this area report mixed results, with decreased blood levels of total cholesterol and low-density lipoprotein (bad cholesterol) in some studies, but no effect in other studies (10,11,12).

Atherosclerosis is the leading cause of cardiovascular morbidity and mortality (13). Atherosclerosis induces two significant pathological processes: an ischemic event due to blood flow obstruction and vascular contractile dysfunction. It is well known that atherosclerosis is associated with elevated circulating cholesterol levels (14,15).

Therefore, this study was designed to investigate the effect of the flaxseed oil on lipid profile system in cholesterol fed rats.

Materials and Methods
Numbers of mature female rats were housed under standard condition and freely access to water and standard diet along the experiment except when indicated, high cholesterol diet were prepared daily by addition of 1% cholesterol to the standard diet (16). Flaxseed oil were obtained from Mehta
Twelve adult female albino rats (220-250 gm) were randomly divided into four groups (each of 3 animals). Group I (control) received standard pellet diet, group II received high cholesterol diet, group III were administered (0.25 ml) of the flaxseed oil along with high cholesterol diet, and; group IV received (0.25 ml) of flaxseed oil, at the end of experiment, fasting blood samples was drawn at 28 days of treatments by cardiac puncture technique, where plasma was immediately separated and stored at -20 ºC until assayed of TC, TGs, HDL-C and VLDL-C concentrations using a standard enzymatic assay (Biomériux Vitek. Inc. USA, Linear chemicals kit, Spain, respectively). Serum LDL-C was calculated by subtracting the sum of HDL-C and VLDL-C from total cholesterol (17).

Data are expressed as means ± SE. Statistical comparisons were made using one-way ANOVA, followed by least significant difference test. Differences between means were considered significant when p<0.05.

The Results

Effect of flaxseed oil on plasma TC and TGs of cholesterol fed rats

Table (1) showed a significant increase (195.6± 4.05, 191.6± 4.40) (p<0.05) in the total cholesterol concentration in the serum of group II and III in comparison with the control group,(68±1.527) while in group IV the total cholesterol concentration decreased insignificantly (59.3±2.333) (p>0.05) in comparison with the control which was (59.3 mg/dl).

The results also showed in Table (1) a significant increase (85.33±3.179, 80±2.516) in II and III groups when compared with the control group (49.33±5.06), while in IV group TGs concentration decrease significantly (25.33±6.741) (p<0.05) in comparison with the control.

Effect of flaxseed oil on plasma lipid profile of cholesterol fed rats

Table (2) showed a significant decrease (43.66±4.484, 50.66±1.201)(p<0.05) in HDL-C concentration in group II and III in comparison with the control group (62.833±1.666) and IV group (60±2.516), while in group IV there was no significant changes (p>0.05) in HDL-C in comparison with the control group.

The results showed in Table (2) a significant increase (18.1 0.665, 17.3±0.405) (p<0.05) in VLDL-C and LDL-C (133.9±7.15, 123±5.9) in group II and group III when compared with the control group (7.63±2.543), also the results showed Table (1) a significant decrease (5.06±1.348) (p<0.05) in VLDL in IV group in comparison with the control (12.8±0.953), but the LDL-C in IV group didn’t show any significant difference (5.73±0.94) (p>0.05) from the control (7.63±2.543).
Table (1)

Total serum cholesterol and triglycerides (mg/dl) in cholesterol fed rats treated with flaxseed oil for 28 Days.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Total cholesterol</th>
<th>Triglycerides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (group I)</td>
<td>68 ±1.527</td>
<td>49.33 ±5.206</td>
</tr>
<tr>
<td>Cholesterol fed (group II)</td>
<td>195.6 ±4.05</td>
<td>a 85.33 ±3.179</td>
</tr>
<tr>
<td>Cholesterol + flaxseed oil (group III)</td>
<td>191.6 ±4.40</td>
<td>a 80 ±2.516</td>
</tr>
<tr>
<td>Flaxseed oil (group IV)</td>
<td>59.3 ±2.333</td>
<td>a 25.33 ±6.741</td>
</tr>
</tbody>
</table>

LSD 10.775 15.382

Values are expressed as mean ± S.E., n.=3/group.

a significant difference (p<0.05) from control group.
b significant difference (p<0.05) from other groups.

Discussion

This study showed that a high-cholesterol diet produced an increase in serum TC, TGs, LDL-C and VLDL-C and decrease in serum HDL-C concentration. Cholesterol in consider as a major contributing factor responsible for the modification of the rate of the hepatic lipoprotein synthesis leading to an increase in plasma VLDL-C and LDL-C concentration in normal and hypercholesterolemic subjects. (18,19). Furthermore, it has been shown that changes (increased in LDL-C and VLDL-C) may be at least in part, due to changes in the hepatic expression of genes such as lipoprotein receptors, apolipoprotein β and the microsomal TG transfer protein (20).

The increase in serum TGs level in animals received high cholesterol diet may be due to an increase in serum VLDL-C level which act carrier for the TGs in the serum (21). Serum HDL-C level have been reported to be inversely correlated with serum VLDL-TGs levels both in normolipidemic and hyperlipidemic subjects (22).

The decrease in serum HDL-C was observed in the current study is associated with increase in serum VLDL-C and TGs levels in cholesterol fed rats (Table 1 and 2). Intervention of the flaxseed oil along with cholesterol didn't reduce the levels of serum TC, TGs, LDL-C and VLDL-C and didn't increase the levels of serum HDL-C concentration.

Flaxseed oil is rich in an essential fatty acid called alph-linolenic acid (ALA), used as a source of energy by the body. It also serves as the parent substance to compounds that regulate blood pressure, blood clotting, heart rate, blood vessel dilation, the immune response, and the breakdown of fats (6).

Flaxseed contain 35% of its mass as oil, of which 55% is ALA (ω-3 fatty acid) and 15% to 18% is LA (23, 24). It is a rich source of ω-3 fatty acid and the richest source of plant
lignans (25). Flaxseed has been shown to be effective in reducing hypercholesterolemic atherosclerosis by 46% without lowering serum cholesterol (12). Crop Development Center (CDC)-flaxseed, which has an oil content (35% of total mass) and concentration of Lignan secoisolariciresinol diglucoside (SDG)(16.4mg/g versus 15.4 mg/g defatted meal) similar to those of ordinary flaxseed but has only 2% to 3% of α-linolenic acid content, reduced the development of hypercholesterolemic atherosclerosis by 69% and reduced serum cholesterol and LDL-C ≈ 31% to 32% (26). These results suggest that the hypocholesterolemic activity of flaxseed is not due to ALA but may suggest that the hypocholesterolemic activity of flaxseed is not due to ALA but may be to the lignan component of the meal. (27).

In conclusion, flaxseed oil has not shown any hypolipidemic effect.

References

الخلاصة

هدف البحث:
صمم هذا البحث لدراسة تأثير زيت بذور الكتان (0.25 مل) عن طريق الفم لمدة 28 يوما على تركيز الكولسترول الكلي وعلى حالة الدهون والشحوم البروتينية للدم في الجرذان المغذى على الكولسترول.

طريقة البحث:
تم عشوائيا تقسيم نساء الجرذان البالغة إلى اربع مجموعات تمثل كل مجموعة، المجموعة الأولى(سيطرة) اعطيت العلف العادي، ثم تغذية حيوانات المجموعة الثانية بزيت بذور الكتان، ثم تغذية حيوانات المجموعة الثالثة على علبة حاوية على 1% كولسترول في حين اعطيت حيوانات المجموعة الرابعة عليقة تحتوي على 1% كولسترول، وجربت يوميا بذور فاصوليا (0.25 مل) واما المجموعة الرابعة فقد جربت يوميا بذور فاصوليا (0.25 مل).

النتائج:
أشارت النتائج إلى حدوث حالة اضطراب دهون الدم في الجرذان المغذى على عليقة حاوية على الكولسترول تميزت بزيادة معنوية في تركيز كل من الكولسترول الكلي (TC) والكليسترول الدهني (TGs) والكوليسترول الثلاثي TC (TGs) والكوليسترول الثلاثي TC (VLDL-C) في الشحوم البروتينية ذات الكثافة الوراثية جدا والكلسترول الثلاثي TC (HDL-C) في الشحوم البروتينية ذات الكثافة الوراثية جدا.

الاستنتاج:
أظهرت نتائج هذه الدراسة بأن إعطاء زيت بذور الكتان ليس له تأثيرات وقائية ضد حالة اضطراب الدهون المحتملة بسبب استخدام الكولسترول حيث لم تؤدي المعاملة بزيت بذور الكتان إلى حدوث انخفاض معنوي في مستوي الكولسترول الكلي ولم تسجل ارتفاع تركيز الشحوم البروتينية ذات الكثافة الوراثية العليا في_blazma.D لجرذان المعاملة.