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**THE EFFECT OF FEEDING GUM ARABIC ON SERUM
TOTAL AND LIPOPROTEINS CHOLESTEROL IN
HYPERCHOLESTEROLEMIC RATS
(WITH ONE TABLE)
(With One Table)**

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**تأثير إطعام الصمغ العربي على الكوليستيرول الكلي واللايپوبروتينات في فئران
عالية الكوليستيرول في الدم**

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تماشياً مع الاهتمام المتزايد بالطب البديل (الطب الشعبي) في علاج الامراض المختلفة بما فيها ارتفاع مستوى الكوليستيرول في الدم، هدفت هذه الدراسة الي تقويم تأثير الصمغ العربي المخلوط مع الطعام على مستوى الكوليستيرول الكلي وكوليستيرول اللايپوبروتين (الدهن البروتيني) ذو الكثافة المنخفضة جداً واللايپوبروتين منخفض الكثافة واللايپوبروتين عالي الكثافة والجليسريدات الثلاثية في دم الفئران المغذاه اضافياً بالكوليستيرول. أجريت التجربة علي خمسة وعشرون فأراً تم تقسيمهم الي خمس مجموعات أ، ب، ج، د و هـ، بكل منها خمسة فئران. كانت المجموعة (أ) هي مجموعة مقارنة وأعطيت الوجبة الاساسية فقط، المجموعة (ب) أعطيت الوجبة الاساسية + ١% كوليستيرول، المجموعة (ج) أعطيت وجبة المجموعة (ب) مضافا اليها بدرجة الصمغ العربي بنسبة ١٠%، المجموعة (د) أعطيت الوجبة الاساسية بإضافة ١% كوليستيرول وبدرجة الصمغ العربي بنسبة ٢٠%، اما المجموعة الأخيرة (هـ) فأعطيت الوجبة الاساسية بإضافة ١% كوليستيرول وبدرجة الصمغ العربي بنسبة ٣٠% وذلك لمدة ٣٠ يوماً. أخذت عينات من الدم من جميع المجموعات عند نهاية فترة الدراسة وذلك لإجراء التحليل. خلصت النتائج الي انخفاض مستوي الكوليستيرول الكلي في المجموعات (ج)، (د) و (هـ) مقارنة بالمجموعة (ب) لكنه لم يكن معنوياً. مستوى كوليستيرول اللايپوبروتين منخفض الكثافة انخفض معنوياً في المجموعات (ج)، (د)، و (هـ) مقارنة بالمجموعة (ب). مستوى كوليستيرول اللايپوبروتين عالي الكثافة زاد معنوياً في المجموعات (ج)، (د) و (هـ) مقارنة بالمجموعة (ب). انخفض مستوى الجليسريدات الثلاثية وكوليستيرول اللايپوبروتين ذو الكثافة المنخفضة جداً على نحو تدريجي في المجموعات (ج)، (د) و (هـ) مقارنة بالمجموعة (ب)، كان هذا الانخفاض معنوياً في المجموعتين (د) و (هـ) فقط. مما سبق، خلصت الدراسة

الي أن اضافة الصمغ العربي الي طعام الفئران أظهر تأثير ايجابي علي مستوي الكولسترول والجليسريدات الثلاثية في الدم.

SUMMARY

Parallel with the recent increasing interest in alternative/herbal medicine for the prevention and treatment of various diseases including hypercholesterolemia, in addition to the increasing uses of Gum Arabic (GA) as one option. The objective of this study was to evaluate the effect of Gum Arabic mixed diet on serum concentration of total cholesterol (TC), very low density lipoprotein cholesterol (VLDL-c), low density lipoprotein cholesterol (LDL-c), high density lipoprotein cholesterol (HDL-c), and triacylglycerol (TAG) in rats fed diet supplemented with cholesterol. Twenty five Wistar albino rats were divided into five groups named A, B, C, D, and E, each of five rats. Group A was fed on basal diet and served as control, group B received the basal diet mixed with 1% cholesterol powder. Gum Arabic (GA) was added to the basal diet with 1% cholesterol powder at the rate of 10%, 20% and 30% in groups C, D and E, respectively. After 30 days, blood samples were collected from all groups for analysis. There was non-significant reduction on TC in groups C, D and E compared to group B. The level of LDL-c was found to be significantly ($P<0.05$) decreased in groups C, D and E compared to group B. In groups C, D and E HDL-c level was significantly ($P<0.05$) increased compared to group B. Serum TAG and VLDL-c were reduced in dose response manner of Gum Arabic in groups C, D and E compared to group B, although the decrease was only significant ($P<0.05$) in groups D and E. The present study concluded that the addition of Gum Arabic to rat's diet has positive effect in lowering serum cholesterol and triacylglycerol levels.

Key words: Gum Arabic, Hyper-cholesterolaemia, Rats.

INTRODUCTION

Coronary heart disease (CHD) is a global health problem. High intake of fats and dyslipidemia are risk factors for its development. Certain food items which are rich in dietary fiber in association with exercise may be protective (Buriro and Tayyab, 2007). The association of raised serum cholesterol with Coronary heart disease is well known; some studies suggest that the increase of serum triacylglycerol may also be a hazard (Sharma *et al.*, 1996).

There are many chemical drugs that lower cholesterol level in the body such as: statins, fibrates, ezetimibe and nicotinic acid, but most of them are expensive and have undesirable effect (Thomas, 2003). So there are increasing interest in alternative/herbal medicine for the prevention and treatment of hypercholesterolemia.

Gum Arabic (GA) is a dried exudates obtained from the branches and stems of *Acacia senegal* and closely related species (FAO, 1999). It is a complex polysaccharide of high molecular weight which contains neutral sugars as rhamnose, arabinose, and galactose; acids such as glucuronic acid; minerals such as calcium, magnesium, potassium, sodium, and phosphorous (Leung, 1980). Gum Arabic has wide industrial uses as a stabilizer, thickening agent and emulsifier, mainly in the food industry also in the textile, pottery, lithography, cosmetics and pharmaceutical industries (Verbeken *et al.*, 2003).

In folk medicine, GA has been reported to be used internally for the treatment of inflammation of the intestinal mucosa, and externally to cover inflamed surfaces (Gamal el-din *et al.*, 2003). Some recent reports have claimed that GA possesses anti-oxidant, nephro-protectant and other effects (Rehman *et al.*, 2001; Gamal el-din *et al.*, 2003; Ali *et al.*, 2008).

Clinically, GA has been tried in patients with chronic renal failure, and it was claimed that it helps to reduce urea and creatinine plasma concentrations and reduces the need for dialysis from 3 to 2 times per week (Suliman *et al.*, 2000).

Ross *et al.* (1983) and Sharma (1985) reported reductions of total serum cholesterol by 6% and 10.4%, respectively when human subjects received 25 g/day and 30 g/day of GA for periods of 21 and 30 days. The decrease was confined to LDL and VLDL cholesterol only, with no effect on HDL and triacylglycerol. In contrast, consumption of GA at a dose of 15 g/day for 4 weeks by healthy human subjects or hypercholesterolemic subjects had no significant effect on plasma lipids (Haskell *et al.*, 1992; Jensen *et al.*, 1993).

In rats, the results were contradictory. Topping *et al.* (1985) showed that plasma cholesterol concentrations were unaffected by feeding GA, but plasma triacylglycerols were significantly lower than in controls.

In another study, GA was fed to rats replacing cellulose in purified diets supplemented with cholesterol and cholic acid, no significant effects of increasing concentrations of GA were found on the concentrations of plasma cholesterol when compared to levels found in rats that consumed control diet containing cellulose alone. Plasma triacylglycerol concentrations were, however, higher in rats fed GA (Annison *et al.*,

1995). These findings are not universally accepted and their confirmation, validity, reliability and mode of action await further studies.

The aim of this study is to evaluate the effect of feeding Gum Arabic mixed diet on the level of serum total and lipoproteins cholesterol in induced hypercholesterolemic Wistar albino rats.

MATERIALS and METHODS

Experimental animals: Twenty five Wistar albino rats obtained from the National Center for Research, Khartoum were used in this study. The rats were housed identically in stainless steel cages in an air room under suitable conditions. All of the rats were initially fed a standard laboratory diet for 7 days as adaptation period. Tap water was freely available.

Experimental design: The animals were divided into five groups each of five animals. These groups were named as A, B, C, D, and E. Group A was fed on basal diet and served as control, group B received the basal diet mixed with 1% cholesterol powder. Gum Arabic (GA) was added to the basal diet with 1% cholesterol powder at the rate of 10%, 20% and 30% in groups C, D and E, respectively. Blood samples were collected at the end of the experiment for the determination of lipid fractions concentration.

The composition of rat basal diet: The rats were given a basal diet which fulfilled their requirements, as follows:

Wheat flour	657g
Dry meat	220g
Sodium chloride	3g
Oil	120g

Gum Arabic: Gum Arabic powder was purchased from (the Gum Arabic Company limited, Khartoum), which is pre-identified, and then added to the rats diet according to the different groups.

Cholesterol supplementation in the diet: Cholesterol powder (Lab Tech Chemicals) was supplemented to the basal diet of the rats so as to induce hypercholesterolemia in all groups except the control one according to Son *et al.* (2003).

Blood sampling: following 30 days, blood was collected from the rat's orbital plexus (1.5 ml) after an overnight fasting by capillary tubes and then transferred into test tubes; the blood was centrifuged at 5000 rpm for 10 minutes. Then the serum was placed into plain containers and used immediately.

Analytical methods: All lipid fractions were estimated in the Research and Laboratory Unit, Khartoum Teaching Hospital, using Roche diagnostic Hitachi 902 analyzer, Germany, which is fully automated and computerized machine to report test results on various body fluid samples for wide range of analysis. It uses spectrophotometric principle.

Calculation of Very low density lipoprotein-cholesterol (VLDL-c): Very low density lipoprotein-cholesterol (VLDL-c) in samples was calculated according to the formula of Friedewald, *et al.* (1972) which state that: $VLDL-c = TG/5$

Statistical analysis: Data are expressed as the means \pm SE. The effect of Gum Arabic was determined by the one-way analysis of variance (ANOVA) procedure, using SPSS version 17 software. Differences were considered significant at $P < 0.05$.

RESULTS

The induction of hypercholesterolemia: Table (1) Shows significant increase ($P < 0.05$) in the total cholesterol level as well as LDL-c, and a significant decrease ($P < 0.05$) in HDL-c in group B compared to group A (control).

The effect of feeding Gum Arabic mixed diet on serum total cholesterol level: Table (1) show the results of serum total cholesterol of groups A, B, C, D and E. The level of serum total cholesterol in group B is significantly ($P < 0.05$) higher than the level of serum total cholesterol in group A, but there is non-significant ($P > 0.05$) difference between groups B, C, D and E.

The effect of feeding Gum Arabic mixed diet on serum LDL-c level: Table (1) Show the results of serum LDL-c of groups A, B, C, D and E. The level of serum LDL-c in group B is significantly ($P < 0.05$) higher than the level of serum LDL-c in groups A, C, D and E. In group C the level of serum LDL-c is significantly ($P < 0.05$) different compared to the level of serum LDL-c of group A. However, there is non-significant difference between groups A, D and E.

The effect of feeding Gum Arabic mixed diet on serum HDL-c level: as we could observe in Table (1), the level of serum HDL-c in group B is significantly ($P < 0.05$) lower than the level of serum HDL-c in groups A, C, D and E. In group C the level of serum HDL-c is non-significantly ($P > 0.05$) different compared to the level of serum HDL-c of group A, but the level of serum HDL-c of group D and E is significantly ($P < 0.05$) higher than that of group A (the control group).

The effect of feeding Gum Arabic mixed diet on serum triacylglycerol and VLDL-c level: Table (1) Show the results of serum triacylglycerol (TAG) and VLDL-c level of groups A, B, C, D and E. Since they are dependent (VLDL-c equal 20% of TAG), the level of serum TAG and VLDL-c in group B are non-significantly higher than that of groups A and C, but significantly ($P < 0.05$) higher than those of groups D and E. Serum TAG and VLDL-c in group D and E are significantly ($P < 0.05$) lower than that of group A (control group).

Table 1: The effect of feeding Gum Arabic mixed diet on serum total cholesterol, LDL-c, HDL-c, VLDL-c and triacylglycerol (TAG) level in induced hypercholesterolemic Wistar albino rats

Parameters	TC (mg/ dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	VLDL-c(mg/dl)	TAG(mg/dl)
Groups					
A	87.40± 7.1 ^a	53.60 ± 6.2 ^a	18.20 ± 9.9 ^a	15.40±10.3 ^a	78.00± 6.5 ^a
B	122.2 ± 10.4 ^b	38.20 ± 9.7 ^b	68.36 ± 8.6 ^b	16.21 ± 9.7 ^a	81.20 ± 10.3 ^a
C	120.20 ± 6.4 ^b	67.20 ± 7.5 ^a	43.92 ± 8.7 ^c	13.08 ± 11.4 ^a	65.40 ± 10.2 ^a
D	116.0 ± 9.9 ^b	77.20 ± 7.2 ^c	28.76 ± 08 ^a	10.04 ± 4.5 ^b	50.20 ± 6.5 ^b
E	107.20 ± 9.5 ^b	80.80 ± 5.9 ^c	18.12 ± 6.1 ^a	8.28 ± 8.5 ^b	41.40 ± 5.1 ^b

* Means ± SE within the same column having different superscript small letters are significantly different at ($P < 0.05$) based on t- test.

DISCUSSION

The objective of this study was to evaluate the effect of feeding Gum Arabic mixed diet on serum levels of total cholesterol (TC), VLDL-c, LDL-c, HDL-c and triacylglycerol (TAG) in induced hypercholesterolemic Wistar albino rats.

Induction of hypercholesterolemia: The results showed that the serum total cholesterol and LDL-c levels were significantly ($P < 0.05$) increased following administration of 1% cholesterol powder mixed with the basal diet in group B compared to group A (control), but serum HDL-c level was significantly ($P < 0.05$) decreased. These results were in agreement with the study of Son *et al.* (2003), who reported that administration of 1% cholesterol powder resulted in an increase in TC and LDL-c, but the HDL-c was reported to be decreased. Also the results were in line with the results obtained from other studies that administration of cholesterol powder or other high fat diet resulted in an increase in TC as well as LDL-

c, but decreased HDL-c level (Chithra and leelaman, 1997; Hwang *et al.*, 2001)

The effect of feeding Gum Arabic on serum total cholesterol level: The level of serum total cholesterol was decreased, but non-significantly after the administration of 10%, 20% and 30% Gum Arabic compared to the hypercholesterolemic group (group B). This result was in line with the result obtained by Ross *et al.* (1983) who reported that, administration of Gum Arabic to men for 3 weeks result in modest fall in serum cholesterol, and he reported that the mechanism of the decrease in cholesterol with GA is not by adsorption of cholesterol metabolites as the fecal bile acids and neutral sterols did not increase. The findings in the present study are also consistent with those reported by Kelley and Tsai (1978), they noticed that Gum Arabic reduces serum cholesterol in rats, suggesting that gum interferes with dietary cholesterol absorption. In chicken, El-kheir *et al.* (2009) reported that Gum Arabic in the basal laying hen diet significantly reduced serum cholesterol in a gradual manner.

On the other hand, these results disagreed with Topping *et al.* (1985) who showed that plasma cholesterol concentration was unaffected by feeding GA, and Annison *et al.* (1995) who reported that GA fed to rats replacing cellulose in purified diets supplemented with cholesterol and cholic acid, has no significant affect on plasma cholesterol when compared to levels found in rats that consumed control diet containing cellulose alone. It is also not in agreement with the work of Tageldin *et al.* (2006) who reported increase on cholesterol level in rabbits fed GA, and that GA associated with an increase in total cholesterol biosynthesis.

Al-Othman *et al.* (1998) reported that, the soluble fraction of various dietary fiber sources, as found in oat bran and barley, seem to have the potential for lowering plasma total and LDL cholesterol levels, and Gel-forming soluble fibers, such as pectin and guar gum, have also been observed to be effective hypocholesterolemic agents, on the other hand, insoluble fibers, such as cellulose or wheat bran, have to be relatively ineffective in lowering serum cholesterol levels.

Gum Arabic (soluble dietary fiber) was observed to be effective in lowering the total plasma cholesterol level compared with insoluble fiber (cellulose) when rats were fed diets supplemented with 1% cholesterol (Al-Othman *et al.* 1998).

According to the above mentioned results the hypocholesterolaemic effect of GA may be due to its interference with dietary cholesterol absorption as suggested by Kelley and Tsai (1978).

The effect of feeding Gum Arabic on serum LDL-c: The level of Plasma LDL-c decreased significantly ($P < 0.05$) after the administration of 10%,

20% and 30% Gum Arabic. These results were in line with the results stated by Ross *et al.* (1983) and Sharma (1985) who reported reduction of serum cholesterol when human subjects received GA, and that the decrease was confined to LDL and VLDL cholesterol. The results were also in agreement with that obtained by Al-Othman *et al.* (1998), but it disagreed with Jensen *et al.* (1993) who found that administration of GA in usual beverages of hypercholesterolemic males daily for 4 weeks showed no change in any plasma lipid parameters.

Hwang *et al.* (2001), reported that feeding of 5% *Allium sativum* whole fruits to rats after high fat diet decreased LDL-c level significantly, and that was due to the fiber content of the fruit, that increases LDL-c receptor activity.

The effect of feeding Gum Arabic on serum HDL-c: In the present study addition of 10%, 20% and 30% Gum Arabic to the basal diet of induced hypercholesterolemic Wistar albino rats resulted in a significant increase of serum HDL-c. A finding that is in consistent with that reported by Al-Othman *et al.* (1998), who stated that supplementing Gum Arabic to diet with 1% cholesterol resulted in a significantly higher HDL-c content.

Hannan *et al.* (2003) reported that the administration of the soluble dietary fiber (SDF) fraction of *Trigonella foenum graecum* to rats orally twice a day for 28 days increased the serum HDL-c level. The present study is not in agreement with Ross *et al.* (1983) and Sharma (1985) who reported no effect on HDL when human subjects received 25 g/day and 30 g/day of GA for periods of 21 and 30 days, respectively, it is also disagreed with that of Davidson *et al.* (1998) who stated that soluble dietary fiber supplement containing Gum Arabic and Pectin in apple juice did not change HDL-c in hypercholesterolemic men and women.

According to the above mentioned findings the elevated level of HDL-c may be attributed to the soluble fiber nature of GA which led to decrease LDL-c and increase HDL-c production.

The effect of feeding Gum Arabic on serum triacylglycerol and VLDL-c: In the present study addition of 20% and 30% Gum Arabic to the basal diet of induced hypercholesterolemic Wistar albino rats resulted in a significant decrease in serum triacylglycerol level, but the level of 10% GA resulted in non-significant decrease. These findings were in line with the result obtained by Ross *et al.* (1983) and Sharma (1985). These results are also in agreement with the results obtained by Topping *et al.* (1985) who showed that, in rats fed GA plasma triacylglycerols were significantly lower than in controls. On the same line, McNaughton (1978) observed that plasma triacylglycerol decreased as dietary fiber level increased in diet fed to laying hens.

However, these results disagree with Jensen *et al.* (1993) who reported that consumption of GA for 4 weeks by hypercholesterolemic subjects had no significant effect on plasma lipids, and Annison *et al.* (1995) who reported that GA fed to rats replacing cellulose in purified diets supplemented with cholesterol and cholic acid resulted in higher triacylglycerol.

CONCLUSION

Soluble fraction of various dietary fiber sources seem to have the potential for lowering plasma total and LDL cholesterol levels, and observed to be effective hypocholesterolemic agents.

From the present results and previous findings, mixing of Gum Arabic with diet has diverse effects on atherogenic lipids among animal species including human, with most studies concluded that Gum Arabic has positive effect in lowering serum cholesterol.

Accordingly further studies are needed to specify the effective dose and the treatment period of GA that exerts protective and/or curative response to human. Further studies are also needed to target other lipid classes, and other biochemical parameters, with more focusing on how Gum Arabic exert its mechanism in lowering or increasing certain biochemical parameters.

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