INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 08 Issue 05 May 2025

DOI: 10.47191/ijmra/v8-i05-19, Impact Factor: 8.266

Page No. 2437-2441

Effect of gum Arabic (GA) on Lipid Profile in Sudanese Patients with Type 2 Diabetes Mellitus

Awad R Eltayar[1], Awad M Ahmed[1], Tariq E Elmissbah[2], Mohammed A. Hanif[1]

[1]College of Medicine - Najran University- Najran, Kingdom of Saudi Arabia

[2]Department of Clinical Laboratory Sciences - College of Applied Medical Sciences - Taif University, Taif, Kingdom of Saudi Arabia

ABSTRACT

Background: Diabetes mellitus an endocrine disease characterized by sustained high blood sugar levels. Gum arabic (GA) is one of the oldest and greatest natural gums and a valuable natural product generated by Acacia Senegal trees. GA is a cash crop in Sudan.

Aim. The main aim of this study was to assess the effect of GA on lipid levels (cholesterol, triglycerides, high-density lipoproteins, and low-density lipoproteins) on diabetic patients.

Methods. This was a cross-sectional study conducted among Sudanese volunteers with type 2 diabetes mellitus. Thirty samples were collected from diabetic patients. The same patients served as controls via measurements made before the use of GA.

Results. The results showed that the serum total cholesterol and (LDL) levels were significantly ($P<0.05$) decreased following using of gum Arabic by diabetic patients. In addition, the level of serum total cholesterol decreased significantly after the administration of gum Arabic compared to the all subject on the same group before using. The level of plasma LDL decreased significantly ($P<0.05$) after the administration of GA.

Conclusions. In prediabetic and diabetic patients, adding GA to food supplements lowers the levels of cholesterol, triglycerides, high density lipoproteins, and low-density lipoproteins.

KEYWORDS: Diabetes mellitus, Lipid Porfile, Sudanese patients

INTRODUCTION

Diabetes mellitus is a metabolic disorder that manifests as chronic hyperglycemia. Diabetes mellitus is mostly caused by inadequate insulin production, resistance to the hormone's effects, or both. Insulin is one of the hormones that the body uses to control the metabolism of proteins, lipids, and carbohydrates. [(2)] An autoimmune deficit of the pancreatic beta cells results in insufficient quantities of insulin. People with diabetes have abnormal glucose, lipid, and protein metabolism because insulin has a restricted effect on target organs. Poor insulin action and insufficient insulin production are the most frequent primary causes of hyperglycemia. Determining which aberration is the main offender is often difficult.[(4)]

Severe hyperglycemia results in polyuria, polydipsia, weight loss, occasionally polyphagia, and blurred vision. Hyperglycemia can also damage the immune system, and diabetic patients are prone to infection. The impact of acute uncontrolled diabetes are hyperglycemia with ketoacidosis or hyperglycemic hyperosmolar syndrome.[(4)] Anecdotal evidence from traditional medicine suggests that ingesting GA orally has positive impacts on various aspects of health including kidney function.[(5)] Here, we evaluated improvements in the biochemical profiles of end-stage renal failure patients receiving hemodialysis after adding 50 g of GA daily to their diet.

MATERIALS AND METHODS

The purpose of this cross-sectional prospective study was to evaluate the impact of GA on patients with renal failure who were diabetic. Triacylglycerides (TAG), total cholesterol (TC), high-density lipoproteins (HDL), and low-density lipoprotein levels (LDL) were the outcome metrics.

Subjects

Patients with diabetes who were experiencing renal failure provided thirty samples. For ninety days, these received 25 grams of GA. After the first month, samples were tested again and then again after the second and third months.

The patients were initially given the GA as controls. Beginning at 10:00 p.m. the night before the trial, patients were instructed to fast. The following day, at 8:00 am, venipuncture was performed to collect blood samples aseptically into tubes coated with EDTA. The tubes were then rapidly centrifuged to extract the plasma. We measured serum creatinine levels to assess the effect of GA on renal function. A colorimetric approach was used to calculate LDL, HDL, TC, and TAG.

RESULTS

45 Sudanese patients with type 2 diabetes were included in this study. There were 21 females (47%), and 24 males (53%) in all. With a range of 45-70 years, the average age of all the patients was 53.5 ± 10.8 years. 29% of the patients were between the ages of 45 and 50. The patients were categorized based on age groupings in bins of five years. The distribution of people between the ages of 51 and 55 and 56 and 60 was comparable, at 15.0% and 22.0%, respectively. The smallest fractions were the extremely young and the extremely old.

(Table 1 and **Table 2)**. For every patient, the average blood glucose level was 9.32 ± 3.27 mmol/l. Patients with diabetes who had a higher BMI (≥ 30) had higher blood glucose levels.

With a mean blood glucose level of 11.9 ± 2.1 mmol/l, several study participants (47.7%) had blood glucose levels outside of the normal range and hence had poor glycemic control. To be more precise, 42.3% of the female individuals (6.38 ±1.51 mmol/l) and 52.3% of the male subjects (6.54 ±1.26 mmol/l) had blood glucose levels within the reference limit. For the diabetic patients in-group (A), the mean cholesterol level was 179.38±34.63 mmol/l, or 4.603 ± 1.1 gm/dl. The cholesterol levels of the diabetics were considerably higher ($p < 0.05$). **(Table 4)**.

Table 1. Age distribution in the study group.

Age group	**Result**	
	Number	***Percent***
45-50	10	33.4%
51-55	5	16.7%
56-60	7	23.3%
61-65	5	16.6%
> 65	3	10.1%
Total	**30**	**100**

Table 2. Gender distribution in the study group.

Gender	**Result**	
	Number	***Percent***
Male	17	56.7%
Female	13	43.3%
Total	30	100%

Table 3. Duration of diabetes in years.

Duration of diabetes years		
	Number	***Percent***
1-5	4	13.4%
6-10	6	20.0%
11-15	5	16.6%
16-20	2	6.7%
20	13	43.3%
Total	30	100%

We found that 13.4% had diabetes for less than 5 years followed by 36.6% who had diabetes for 6–15 years; 50% of the patients had had diabetes for more than 20 years.

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

Table 4. The impact of GA on serum total cholesterol, HDL, LDL, and TAG levels in diabetic patients before and after use of GA (15).

Parameters / Groups	TC (mmol/l)	HDL (mmol/l)	LDL (mmol/l)	TAG (mmol/l)
Baseline	4.6327 ± .89544[a]	4.6327 ± .46373[a]	2.9327± .86667[a]	1.9440 ± .92622[a]
After one month	4.2267 ± .84321[b]	1.3593 ± .35951[b]	2.7347 ± .84168[b]	1.7660 ± .72886[b]
After two months	4.1353 ± .81602[b]	1.2167 ± .34597[b]	2.5420 ± .80534[b]	1.7167 ± .68454[b]
After three months	4.2287 ± .54954[b]	1.0400 ± .21902b	2.2140 ± .68878b	1.5313 ± .67231b

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

DISCUSSION

In all people, diabetic patients the blood lipids play important role as a risk factor, as the result of the impaired action of insulin, there is an increase in triglyceride hydrolysis and the release of non- esterified fatty acids (NEFAs).

This condition is more likely to contribute to the increased risk of CAD and CHD among diabetic patients. [12]

The results showed that the serum total cholesterol and (LDL) levels were significantly (P<0.05) decreased following administration of 25g of GApowder in group B compared to same group before using GA(self-control).But serum (HDL) level was significantly (P< 0.05) decreased. These results were in agreement with the study of Son. [16], who reported that administration of (25g) of GA powder resulted in adecrease in TC and (LDL), but the (HDL) was reported to be decreased. Also the results were in line with the results obtained from other studies that administration of (25g) of GA powder or other high fat diet resulted in adecrease in TC as well as LDL, but decreased HDL level. [6] Also the results were in line with the results obtained from other studies that administration of (25g) of GA powder or other high fat diet resulted in adecrease in TC as well as LDL, but decreased HDL level. [9]In this study, levels of cholesterol were higher among those who were overweight or obese compared to those of normal weight (4.69mmol/l compared to 4.51 mmol/l). This also applies for triacylglyceride (1.61mmol/l compared to 1.54mmol/l).

Reported elevated levels for total cholesterol, triacylglyceride among patients with poor glycemic control (6.11± 1.5 mmol/L , 2.13± 0.7 mmol/L) compared to those with satisfactory levels (5.59 ± 0.89 mmol/L , 1.59±0.38 mmol/L), respectively. Thus glycemic control improves diabetes related dyslipidemia and is expected to reduce risk of atherosclerosis. [14] The level of serum total cholesterol decreasedsignificantly after the administration of 25gof GA compared to the all subject on the same groupbefore using GA. This result was in line with the result obtained by. [3] who reported that, administration of GA 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.[15]

GA reduces serum cholesterol in rats, by suggesting that gum interferes with dietary cholesterol absorption, reported by. [17] in chicken, Reported that GA in the basal laying hen diet significantly reduced serum cholesterol in a gradual manner. But these results disagree with showed that plasma cholesterol concentration was unaffected by feeding GA, [2]

GA (soluble dietary fiber) was observed to be effective in lowering the total plasma cholesterol level compared with insoluble fiber (cellulose) when rats were fed by diets supplemented with 1% cholesterol. [12]

According to the above mentioned results the hypocholesterolemic effect of GA may be due to its interference with dietary cholesterol absorption as suggested by. [17]The level of plasma LDL decreased significantly (P<0.05) after the administration of 25%GA. These results were in line with the results stated by. [6],reported reduction of serum cholesterol when human subjects received GA, and that the decrease was confined to (LDL) and (VLDL) cholesterol.[16]

The results were also in agreement with that obtained by who reported thatadministration of GA in usual beverages ofhypercholesterolemia males daily for 4 weeks showed no change in any plasma lipid parameters.[2]

The major physiological role of (LDL) is to deliver cholesterol for cellular membrane repair and for synthesis of vitamins and other biological materials. Small (LDL) particles become more common as triglyceride levels increase above (1.5 mmol/l). [11] A high concentration of small dense LDL particle, is associated with a three-to seven-fold increased risk of CHD irrespective of total

circulating LDL concentration, and thus, although LDL concentration may be normal in type 2 DM, its abnormal composition may render it more atherogenic. [10]

The (VLDL1) (a subspecies of VLDL) is the precursor of the small dense LDL particles. It is the major components of (triacylglyceride rich lipoproteins (TRLs) in diabetic dyslipidemia, so their long existence time in blood favours the excess core lipid exchange of triacylglycerides and cholesterol esters between (TRLs) and (LDL) (via action of cholesterol ester transfer protein) and thus enriching (LDL) with triacylglycerides en route. Since hepatic lipase activity is increased in type 2 DM there is increased hydrolysis of triacylglyceride rich (LDL) particles to form small dense (LDL). Because of the longstanding increase of its level, and because of its small size, the small dense (LDL) can easily penetrate into sub endothelial tissues where it contributes to the formation of atherogenic plaques. In addition they are more prone to oxidation and they are also associated with impaired endothelium - dependent vasodilatation in patients with type 2 DM.[16], thus patients with high (LDL) are particularly considered to pose a risk of (CHD) and atherosclerosis

DM patients whose (LDL) level is poorly controlled are usually those with poorly controlled glucose and high blood pressure or active smoking. [10]

Although glycemic control can reduce hypertriglyceridemia, it usually has a relatively modest effect on elevated (LDL) levels. [14]However, some studies suggest that (LDL) levels can decrease with short term tight glycemic control. [16]HDL one of the most important lipoprotein that plays an important role in manifestation of dyslipidemia.In this study the mean level was (0.95±0.16) mmol/l. Females had a significantly higher level than males (0.92 ±0.14) mmol/l and 0.92±0.04 mmol/l) respectively. These levels are similar to those reported by. [5],for Sudanese diabetic patients where he reported a level of (0.95mmol/l) for females but lower than that for males which was (1.01 mmol/l), but there were no significant differences between the two sexes. The levels are below those reported for non-diabetic Sudanese.

Reported a higher level of (HDL)with a mean of (1.05mmol/l) for men and (1.17mmol/l) for women.[3] There are reported significant difference between men and women (0.9mmol/l) versus (1.22 mmol/l), reported by [4] But other studies showed no significant difference between males and females as reported by. [1] In some studies addition of 10%, 20% and 30% GAto the basal diet of induced hypocholesterolemic Wistar albino rats resulted in a significant increase of serum HDL. The findings in the present study are consistent with that reported by AL Othman. [9], who stated that supplementing GA to diet with (1% cholesterol resulted in a significantly higher HDL content.

It's reported that the administration of the soluble dietary fiber (SDF) fraction of *Trigonella foenumgraecum* to rats orally twice a day for 28 days increased the serum (HDL) level. But the present study is not in agreement with 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 fiber supplement containing GA and Pectin in apple juice did not change HDL-c in hypercholesterolemia men and women.[10]

According to the above mentioned findings the elevated level of (HDL) is attributed to the soluble fiber nature of GA which led to decrease (LDL) and increase (HDL) production.

There is strong evidence that (HDL) is a powerful inverse predictor of premature CHD and maintaining high levels of it may guard against atherosclerosis. In this study (75.4%) of the study group had triacylglyceride levels above the favorable levels (above 1.7mmol/l).

In the one study addition of (25%) GA to thebasal diet of induced hypocholesterolemicWister albino rats resulted in a significant decrease in serum triacylglycerol level, although (10%) of GA resulted in non-significant decrease. These findings were in line withthe result obtained by. [11]

The percentage of patients with elevated triglyceride level differed among various studies. Perusicova (2001) found that (31%) of the study population had elevated triacylglyceride level, (27%) were reported by. [2] Lower percentages were found among Ethiopian patients.

More than half of the patients had blood triacylglyceride levels above the optimal in an American study population. [1]

Mengasha (2006) Reported that (38.9%) had serum triacylglyceride levels higher than (1.82 mmol/l).[15], found that 4% and 15% of their African American study group had high or border line risk - respectively- compared to 16% and 34% of Caucasians with same risk lines.

Among our all study subject, the level of total triacylglyceride increased with age until 60-69 years after which it started to decline. In the UKDPS (1997) the levels of triglyceride tended to decrease after the age of 50 years for males but females had a trend of higher levels and reached a plateau after the age of 50 years.

In the study the highest percentage of patients (43%) with elevated triacylglyceride was in the age group of (50-59) years followed by (40-49) (39%). In a study among a Kuwaiti population the highest percentage (34%) were among those older than 60 years and the number of patients increased with age. [3]

These results are also in agreement with the results obtained by Topping *et al*. (1985) who showed that, in rats fed GA plasma triacylglycerol were significantly lower than in controls. McNaughton (1978) observed that plasma triacylglycerol decreased as dietary fiber level increased in diet fed to laying hens.

But these results disagree with. [(2).] Who reported that consumption of GA for 4 weeks by hypocholesterolemic subjects had no significant effect on plasma lipids, and. [(7),] who reported that GA fed to rats replacing cellulose in purified diets supplemented with cholesterol and cholic acid resulted in lower triacylglycerol.

CONCLUSION

In prediabetic and diabetic patients, adding GA to food supplements lowers the levels TC, TAG, HDL, and LDL.

Acknowledgement

The authors would like to acknowledge everyone who contributed to the completion of this work.

Competing Interests

The authors declare that they have no competing interests.

REFERENCES

1) American Diabetes Association (A.D.A.). Diagnosis and classification of diabetes mellitus. Diabetes Care. 2009;32(1):s62-s67.
2) Fowler PW, Graham GC, Vasudevan DA. Type 2 Diabetes Mellitus: Managing Hemoglobin A(1c) and Beyond. South Med J. 2010;103(9):911-6.
3) Watkins PJ, Amiel AA, Howell SL, Turner E. Diabetes and its Management. 6th ed. Blackwell Publishing Ltd. UK; 2003.
4) Jaafar NS. Clinical Effects of Arabic Gum (*Acacia*): A Mini Review. Iraqi J Pharm Sciences. 2019;28(2):9-16.
5) Rad ZP, Mokhtari J, Abbasi M. Preparation and characterization of *Calendula offcinalis*-loaded PCL/gum arabic nanocomposite scaffolds for wound healing applications. Iranian Polymer Journal. 2019;28(1):51-63.
6) Eghbalifam N, Shojaosadati SA, Hashemi-Najafabadi S, et al. Synthesis and Characterization of Antimicrobial Wound Dressing Material based on Silver Nanoparticles Loaded Gum Arabic Nanofibers. Int J Biological Macromolecules. 2020;155:119-130.
7) Brownlee M. The Pathobiology of Diabetic Complications: A Unifying Mechanism. Diabetes. 2005;54(6):1615-1625.
8) Musa H, Ahmed A, Fedail J, et al. Gum Arabic Attenuates the Development of Nephropathy in type 1 Diabetes Rat. Gums and Stabilisers for the Food Industry 18. RSC Publishing; 2016:245-255.
9) Ibekwe CA, Oyatogun GM, Esan TA, et al. Synthesis and Characterization of Chitosan/Gum Arabic Nanoparticles for Bone Regeneration. Am J Mater Sci and Eng. 2017;5(1):28-36.
10) Rad ZP, Mokhtari J, Abbasi M. Preparation and Characterization of *Calendula officinalis*-Loaded PCL/Gum Arabic Nanocomposite Scaffolds for Wound Healing Applications. Iranian Polymer Journal. 2019;28(1):51-63.
11) Singh B, Sharma S, Dhiman A. Acacia Gum Polysaccharide based Hydrogel Wound Dressings: Synthesis, Characterization, Drug Delivery and Biomedical Properties. Carbohydrate Polymers. 2017;165:294-303.
12) Rodrigues MLC, Motta MEFA. Mechanisms and Factors Associated with Gastrointestinal Symptoms in Patients with Diabetes Mellitus. Journal de Pediatrics. 2012;88(1):17-24.
13) Babiker R, Elmusharaf K, Keogh MB, et al. Effect of Gum Arabic (*Acacia Senegal*) Supplementation on Visceral Adiposity Index (VAI) and Blood Pressure in Patients with Type 2 Diabetes Mellitus as Indicators of Cardiovascular Disease (CVD): A Randomized and Placebo-Controlled Clinical Trial. Lipids in Health and Disease. 2018;17(1):56.
14) Siham A, Khadiga A, Huwaida E, et al. Effect of Dietary Inclusion of Gum Arabic (*Acacia senegal*) on Performance and Blood Chemistry of Broiler Chicks. Wayamba J Animal Science. 2015;3(2):305-310.
15) Ali AA, Ali KE, Fadlalla AE, Khalid KE. The Effects of Gum Arabic Oral Treatment on the Metabolic Profile of Chronic Renal Failure Patients Under Regular Haemodialysis in Central Sudan. Nat Prod Res. 2008;22(1):12-21. doi:10.1080/14786410500463544 PMid:17999333
16) Mohammed ME, Abbas AM, Badi RM, et al. Effect of Acacia Senegal on TGF-β1 and Vascular Mediators in a Rat Model of Diabetic Nephropathy. Arch Physiol Biochem. 2022;128(6):1548-58. doi:10.1080/13813455.2020.1781901 PMid:32574082
17) Ali BH, Ziada A, Al Husseni I, Beegam S, Nemmar A. Motor and Behavioral Changes in Rats with Adenine-Induced Chronic Renal Failure: Influence of Acacia Gum Treatment. Exp Biol Med (Maywood). 2011;236(1):107-12.