

Reduction of serum cholesterol in hypercholesterolemic rats by Guar gum

Saeed Samarghandian¹, Mosa-Al-Reza Hadjzadeh^{1,*}, Atiyeh Sadat Davari¹, Marziyeh Abachi²

Abstract

Objective: Several diseases are reported to be uncommon in those parts of the world where dietary fiber intakes are high, therefore, in this study; we evaluated the hypocholesterolemic effects of a dietary fiber (guar gum) in hypercholesteromic rats.

Materials and Methods: Rats were fed high-fat or a normal fed diet for 12-week then treated with 5% guar gum in their regime during a 28 days period.

Results: Total cholesterol was significantly increased in high-fat diet rats, while administration of guar gum significantly lowered it. Body weight was significantly increased in high-fat diet rats while, at the end of 4-weeks treatment of guar gum, body weight of treated rats was significantly decreased.

Conclusion: These results suggested that guar gum may be effective as hypocholesterolemic agent and may prevent hypercholesteromia in hypercholesteromic rats. The results also suggested that guar gum may be important for reducing body weight in hyperlipidemic rats.

Keyword: Dietary fiber , Guar gum, Hypercholesteromic, Lipid profile, Rat

1- Department of Physiology, School of Medicine, Mashhad University Medical Sciences, Mashhad, I. R. Iran

2- Department of Biology, School of Sciences, Islamic Azad University, Mashhad Branch, I. R. Iran

*Corresponding author: Tel: +985118002221; Fax: +98 511 8828564
E-mail: Hajzadehmr@mums.ac.ir.

Introduction

Arterial disease is reported to be uncommon in those parts of the world where dietary fiber intakes are high (Kan *et al.*, 2007). Cholesterol level are probably one of most metabolic risk factor for cardiovascular disease. Various diets rich in certain types of dietary fiber (although not wheat bran (Truswell *et al.*, 1976)) or containing purified dietary fiber preparations have been shown to lower the serum cholesterol levels in normal individuals (Kan *et al.*, 2007), but a report on the cholesterol lowering effect of lignin in a hyperlipidemic group (Hillman *et al.*, 1985) was not confirmed subsequently (Linder and Moller, 1974). Recently, search for new drugs for regulating and reducing serum total cholesterol level has been the focus of attraction with numerous reports showing remarkable activities of natural agents. The products of plant are reported as less toxic as and with fewer side effects than synthetic agents. Dietary fiber has become more and more important since the work of Burkitt *et al.*, (Burkitt, 1988), Burkitt (Burkitt, 1984) and Trowell (Trowell, 1986), who found a direct relationship between fiber deficient diets and the development of certain chronic and degenerative diseases such as ischemic stroke myocardial infarction, closely related to atherosclerosis which were more common in industrialized countries. Dietary fiber has been classified into two parts, the insoluble part containing mainly some hemicelluloses, lignin and cellulose; the soluble part is comprised of mainly some hemicelluloses, pectins and finally gums. Dietary fiber, specially the insoluble part, act a physical action on the intestine, increasing peristaltic movement, stimulating intestinal food transit, elevating feces volume and weight and improving feces consistency. Guar, *Cyamopsis tetragonoloba* (L.) Taub. or cluster bean, is a member of the Leguminosae (Fabaceae) family and is a galactomannan storage polysaccharide

which is grown in India and the United States and also is economically the most important of the four species in the genus. Currently, the major use of the crop is for the galactomannan gum extracted from the endosperm of the seed. About 42% of the guar seed is endosperm of which the predominant portion is mucilage or gum (guar gum). As a soluble dietary fiber (SDF), guar gum is part of the total dietary fiber (TDF) fraction of the seed. Approximately 80–85% of the gum is a galactomannan, which is comprised of a (1–4)-b-D-mannopyranosyl backbone with branch-points from the six-position linked to single a-D-galactopyranosyl residues. There are typically 1.5–2.0 mannose residues for every galactose. Guar gum galactomannans form water dispersible hydrocolloids, which thicken when dissolved in water leading to their use as emulsifying, thickening or stabilizing agents for a wide range of processed foods. Lower-grade guar gum has numerous uses in industrial applications and as a friction-reducing agent (Zhang *et al.*, 2008).

A great deal of work has been articulated since then showing the valuable effects of guar gum against a variety of disease. Short term effects of dietary fiber like guar gum exerts a physical action on the intestine, stimulating peristaltic movements. The long term effects of guar gum have not yet to be examined. Therefore, this paper reports the effects of a potent hypocholesterolemic fiber preparation, guar gum on the serum lipids of rats with hyperlipoproteinemia. Guar gum is a galactomannan storage polysaccharide obtained from the cluster bean (*Cyamopsis tetragonoloba*) which is grown in India and the United States (Wang *et al.*, 2009). When added to aqueous solutions at low concentrations guar gum causes large increases in viscosity having 5 to 8 times the thickening power of starch (Burkitt, 1988) (a 1% aqueous solution has a viscosity of 42 centipoises after hydration at 25 C for 24 hr (Burkitt, 1984).

Hypocholesterolemic effects of guar gum

Materials and methods

Materials

Total cholesterol kit was purchased from Pars Azmoon (Tehran, Iran). Guar gum was purchased from Alibaba Company. The seed of plant were dried and powdered. All powdered samples were then pooled for making rat's diet chow with the percentage of Guar gum (5 %). The composition of Guar gum is shown in Table 1.

Table 1. The composition of Guar gum.

Components	Percent*
Moisture	9.55
Protein (N _ 6.25)	2.16
Total lipids	0.78
Ash	0.54
Insoluble fiber	7.60
Soluble fiber	75.00
Non fiber carbohydrates	4.37

*Mean values of three determinations.

Animals

Male Wistar rats weighing (270 ± 10) g were purchased from Medical faculty of Mashhad (Mashhad, Iran) were kept in their own cages at constant room temperature (21 ± 2 °) under a normal 12 hr light: 12 hr dark regime with free access to food (as follows) and water.

Induction of hypercholesteromic and Experimental procedure

The rats were fed a standard diet or chow supplemented with 18% corn oil (high fat diet) for 12-week prior to the study for induction of normal and hyperlipidemia rat respectively (Pratchayasakul et al., 2011, Guo et al., 2011, Bajerska et al., 2011, Suanarunsawat et al., 2010, Zhao et al., 2011). Then the rats that received 12-week to high fat diet significantly increased serum total cholesterol versus to the normal rats that received 12-week to standard diet (Esteves et al., 2011, Berrougui et al., 2003, Ahmed et al., 2001, Bajerska et al., 2011, Reena et al., 2011). At the end of 12-week diet period the hypercholesterolemic and normal rats each were randomly

assigned to one of the two following treatment groups, treatment 1,2 for 28 days based on chow contained guar gum 0%, 5%, respectively (n=7). The chemical composition of diets is shown in Table 2.

Table 2. The chemical composition of diets.

Compenets of diets (g/kg)	Normochol esterolemic groups	Hypercholesteromic groups	
	Normal	Control	Treatment
Casein.	20.0	20.0	20.0
DL-Methionine	0.3	0.3	0.3
Corn starch	51.8	35.8	30.8
Corn oil	2.5	18.5	18.5
Sucrose	15.4	15.4	15.4
Cellulose	5.0	5.0	5.0
Mineral mix	3.5	3.5	3.5
Vitamin mix	1.5	1.5	1.5
Guar gum	0.0	0.0	5.0

During the treatment period, at day first (T0), at day 14 (T14) and at the end of period (T28) the rats were subjected to measure body weight and also to collect blood sample. Before blood sampling, all rats were fasted for 12h, blood sample were collected from the orbital venous plexus (Makni et al., 2000).

Analysis of cholesterol in plasma

Plasma cholesterol level was determined by enzymatic colorimetric methods, using commercial kits from Pars Azmoon (Tehran, Iran) (Bhandari et al., 1998). Briefly, Blood samples transferred directly into centrifuge tubes, allowed to clot at room temperature for 20 min, and centrifuged for 20 min at 2000 rpm. The supernatant obtained was transferred into test tubes for lipid analysis.

Analysis of body weight during treatment period

Body weight was recorded in both the hypercholesterolemic and normal rats groups at the end of 12-week diet period and also during the treatment period, at day first (T0), at day 14 (T14) and at the end of period (T28).

Statistical analysis

The data were analyzed using statistical package program stat view software. Data are given as mean±SEM statically significant between cholesterol level in each group and during treatment period was performed with one-way ANOVA followed by Tukeys test. P values less than 0.05 were considered statistically significant.

Results

Laboratory, testing

Feeding rats with a high fat diet for hypercholesterolemic rats, as evidenced by high serum total cholesterol was significantly elevated in comparison with normal rats received standard chow diet during the period (Figure 1).

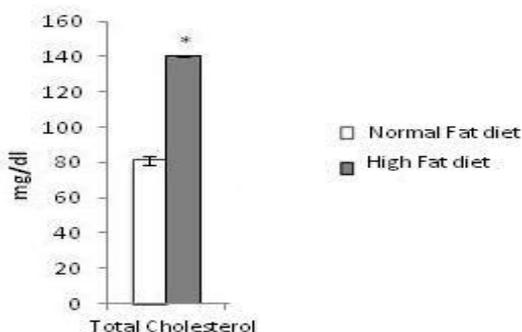


Figure 1. Feeding rats with a high fat diet for 12-week resulted in hypercholesteromic rats, as evidenced by high serum Total Cholesterol which were significantly elevated in comparison with normal rats received standard chow diet during the period.

Hypocholesterolemic effects of Guar gum

Effect of Guar gum on serum total cholesterol in rats fed with high fat diet.

Change of diet from normal fat diet to high fat diet caused significant rise in total cholesterol level. Elevated serum total cholesterol level in hypercholesterolemic rats at T14 and T28 by treatment of 5%, Guar gum in their regimes ($p < 0.001$)(Figure 2).

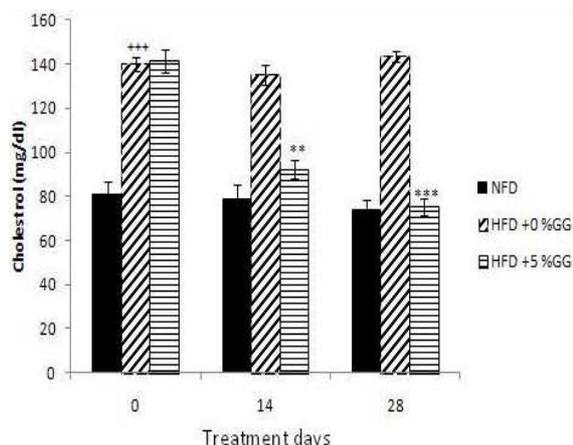


Figure 2. Elevated serum Total Cholesterol level in hypercholesteromic rats were lowered at T14 and T28 by treatment of 5%, Guar gum in their regimes ($p < 0.001$).

Effect of Guar gum on Body weight

Effect of Guar gum on body weight in rats fed with normal fat diet

We only showed non-significant decrease in body weight in normal rats treated with 5% percentage of Guar gum at T14 and T28.

Effect of Guar gum on body weight in rats fed with high fat diet

Shifting of diet from normal fat diet to high fat diet showed remarkable incline body weight. Upon treatment of rats with Guar gum (5%) for 14 and 28 days, there was significant decrease in body weight compared to high fat diet control (Figure 3).

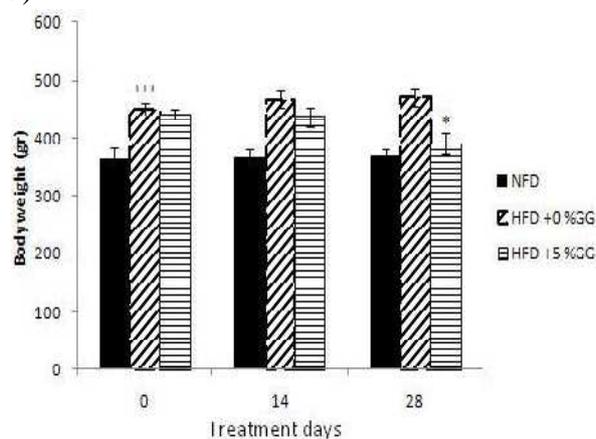


Figure 3. Upon treatment of rats with Guar gum (5%) for only at T28 days, there was significant rise in body weight compared to high fat diet control

Discussion

High dose of fat in dietary have been showed to lead to the hyperlipidemia in rats which is the most firmly-constructed and best-known risk factors for atherosclerosis (Ghasi et al., 2005). Therefore, in the present study hypercholesteromic was induced in rats which raise the serum total cholesterol level following in an increased risk for the expansion of atherosclerosis. Regulating the serum lipid profile is critical in atherosclerosis prohibition, as it has been demonstrated that atherosclerosis could be reduced by controlling the level of serum lipids particularly serum cholesterol. Recently, there has been direct attention on the cholesterol-lowering effects of dietary plants, and different plants are shown to be useful in reducing plasma lipid levels particularly cholesterol level. (Choudhary et al., 2005; Kannel et al., 1997, Moriceau et al., 2000). The current study was down with the objective to identify the hypolipidemic potential of *Cyamopsis tetraglobolus* seed (Guar gum) on serum lipid profiles of hypercholesteromic and normal fat diet rat. An elevated cholesterol concentration in the plasma may bring coronary atherosclerosis to develop. (Dongowski et al., 2000). Guar gum and other types of gel-forming dietary fiber have already been shown to lower the serum cholesterol level in normal man. This is the first report of a significant hypocholesteremic action of a gel-forming dietary fiber in a group of hypercholesteromic rats. The marked effect of guar in reducing serum cholesterol in the individuals who were already taking cholestyramine may be of clinical importance, for although it may be due to greater patient compliance with therapy it also highlights the fact that the modes of action of these agents may be different and complimentary. Cholestyramine is thought to reduce serum cholesterol by inducing a bile acid loss (Moriceau et al., 2000) whereas the increase in bile acid

output on guar is known to be small by comparison. It has, however, a marked effect in reducing postprandial glycemia and also a marked effect on the postprandial chylomicronemia. These actions may be of importance in regulating fat metabolism. Other factors such as decreased calorie intake on guar might have facilitated the fall seen in serum cholesterol.

Thus, decreasing lipid profiles in serum particularly serum total cholesterol level is important for decreasing the risk of atherosclerosis. In the current study, the hypercholesteremic rats produced by high fat diet for 12 weeks demonstrated high serum levels of total cholesterol level but application of 5 % Guar gum in rats food at T14 and T28 reduced high total cholesterol level. A proposed mechanism by which guar gum may lower plasma cholesterol is by increasing the fecal excretion of bile acids and cholesterol. In other studies, pectin or wheat bran did not alter small intestinal bile acid levels either. Perhaps the main effect of dietary fibers on bile acids in the small intestine is to decrease the efficiency of the enter hepatic circulation resulting in a greater fecal excretion. Probably guar gum with increasing viscosity in digestive system is able to decrease uptake rate of substances and disturbance in reuptake of bile acids, and can therefore have positive effect on decrease of glucose, cholesterol, triglyceride and Low - density lipoprotein cholesterol (LDL-C) of blood, but the mechanism is not known and clear. (Dongowski et al., 2004) Galactomannans, of which guar gum is an example, are the principal form of dietary fiber in leguminous seeds. Beans and other legumes are one of the richest sources of dietary fiber available for human consumption, containing two to three times as much dietary fiber as whole cereals (Kan et al., 2007). Guar gum is already used in the food industry as a thickener and emulsion stabiliser and if

high concentrations can be incorporated into a variety of foods these might prove to be acceptable vehicles for the gum. Drug preparations often have only limited patient acceptability and it may be that agents that can be incorporated into foods will be more acceptable. Alternatively the addition of guar gum to a therapeutic regime containing a relatively unpalatable agent such as cholestyramine may allow the dose of the latter to be reduced while achieving the same therapeutic objective. Our results demonstrated that Guar gum decreased serum cholesterol concentration when compared with hyperlipidemic control rats. Therefore, our results suggest that Guar gum is an effective lipid lowering agent in both hypercholesteremic rats but may act more protect against cardiovascular disease in hyperlipidemia than normal rats. Guar gum and possibly other similar types of dietary fiber, merits further study as a potential hypocholesterolemic agent.

Acknowledgements

The authors would like to thank Research Affairs of Mashhad University of Medical Sciences for financially supporting this work and Mr. Joharchi for his assistance (botanists) in a herbarium of Ferdosy University. We also wish to thank from Javaneh Khorasan Company for making different concentration of Guar gum food for rats.

References

- Adeneye AA, Adeyemi OO, Agbaje EO. 2010. Anti-obesity and antihyperlipidaemic effect of *Hunteria umbellata* seed extract in experimental hyperlipidaemia. *J Ethnopharmacol*, 130(2): 307-14.
- Ahmed I., Lakhani M.S., Gillett M., John A., Raza H. 2001. Hypotriglyceridemic and hypocholesterolemic effects of anti-diabetic *Momordica charantia* (karela) fruit extract in streptozotocin-induced diabetic rats. *Diabetes Res Clin Pract*. 51(3):155-61.
- Bajerska J, Wozniewicz M, Jeszka J, Drzymala-Czyz S, Walkowiak J. 2011. Green tea aqueous extract reduces visceral fat and decreases protein availability in rats fed with a high-fat diet. *Nutr Res*. 31(2):157-64.
- Berrougui H, Ettaib A, Herrera Gonzalez MD, Alvarez de M Sotomayor, Bennani-Kabchi N, Hmamouchi M. 2003. Hypolipidemic and hypocholesterolemic effect of argan oil (*Argania spinosa* L.) in *Meriones shawi* rats. *J Ethnopharmacol*, 89: 15–18.
- Bhandari U, Sharma JN, Zafar R. 1998. The protective action of ethanolic ginger (*Zingiber officinale*) extract in cholesterol fed rabbits. *J. Ethnopharmacol*, 61:167-71.
- Burkitt DP. 1988. Dietary fiber and cancer. *J Nutr*, 118(4): 531-3.
- Burkitt D. 1984. Fiber as protective against gastrointestinal diseases. *Am J Gastroenterol*, 79(4): 249-52.
- Choudhary MI, Naheed S, Jalil S, Alam JM, Atta-ur-Rahman. 2005. Effects of ethanolic extract of *Iris germanica* on lipid profile of rats fed on a high-fat diet. *J. Ethnopharmacol*, 98: 217-20.
- Dongowski G, and Lorenz A. 2004. Intestinal steroids in rats are influenced by the structural parameters of pectin. *J Nutr Biochem*, 15:196-205.
- Esteves EA, Bressan J, Costa NM, Martino HS, Donkin SS, Story JA. 2011. Modified Soybean Affects Cholesterol Metabolism in Rats Similarly to a Commercial Cultivar. *J Med Food*.
- Ghasi S, Nwobodo E, Ofili JO. 2000. Hypocholesterolemic effects of crude extract of leaf of *Moringa oleifera* Lam in high-fat diet fed Wistar rats. *J. Ethnopharmacol*, 69: 21-5.
- Guo F, Li Y, Sun C, Niu Y, Feng R. 2011. Effects of high-fat diet on blood lipids in rats. *Wei Sheng Yan Jiu*. 40(1):40-2.
- Hillman LC, Peters SG, Fisher CA, Pomare EW. 1985. The effects of the fiber components pectin, cellulose and lignin on serum cholesterol levels. *Am J Clin Nutr*, 42(2): 207-13.
- Ji G, Zhao X, Leng L, Liu P, Jiang Z. 2011. Comparison of dietary control and atorvastatin on high fat diet induced hepatic steatosis and hyperlipidemia in rats. *Lipids Health Dis*. 26; 10-23.

Hypocholesterolemic effects of guar gum

- Kannel WB, Castelli WP, Gordon T. 1997. Cholesterol in the prediction of atherosclerotic disease. New perspectives based on the Framingham study. *Ann. Intern. Med.*, 90: 85-91.
- Kan H, Stevens J, Heiss G, Klein R, Rose KM, London SJ. 2007. Dietary fiber intake and retinal vascular caliber in the Atherosclerosis Risk in Communities Study. *Am J Clin Nutr.*, 86(6):1626-32.
- Linder P, and Lignin M. 1974. A cholesterol-lowering agent? *Lancet*, 2: 1259.
- Makni M, Fetoui H, Gargouri NK, Garoui EM, Zeghal N. 2010. Antidiabetic effect of flax and pumpkin seed mixture powder: effect on hyperlipidemia and antioxidant status in alloxan diabetic rats. *J Diabetes Complications*, Nov 22. [Epub ahead of print]
- Moriceau S, Besson C, Levrat MA, Moundras C, Rémésy C, Morand C. 2000. Cholesterol-lowering effects of guar gum: changes in bile acid pools and intestinal reabsorption. *Lipids*, 35: 437-44.
- Prachayasakul W, Kerdphoo S, Petsophonakul P, Pongchaidecha A, Chattipakorn N, Chattipakorn SC. 2011. Effects of high-fat diet on insulin receptor function in rat hippocampus and the level of neuronal corticosterone. *Life* 88(13-14): 619-27.
- Reena MB, Gowda LR, Lokesh BR. 2011. Enhanced hypocholesterolemic effects of interesterified oils are mediated by upregulating LDL receptor and cholesterol 7- α -hydroxylase gene expression in rats. *J Nutr.* 141(1):24-30.
- Suanarunsawat T, Boonnak T, Na Ayutthaya WD, Thirawarapan S. 2010. Anti-hyperlipidemic and cardioprotective effects of *Ocimum sanctum* L. fixed oil in rats fed a high fat diet. *J Basic Clin Physiol Pharmacol.* 21 (4):387-400.
- Trowell H, Burkitt D. 1986. Physiological role of dietary fiber: a ten-year review. *Bol Asoc Med*, 78(12): 541-4.
- Truswell, A. S., and Kay R M. 1976. Brian and blood lipids, *Lancet*, 1: 367.
- Wang X, Wang J, Zhang J, Zhao B, Yao J, Wang Y. 2009. Structure-antioxidant relationships of sulfated galactomannan from guar gum. *Int J Biol Macromol*, 46(1): 59-66.
- Zhang J, Wang ZW, Shi XM. 2010. *Canna edulis* Ker By-product: Chemical Composition and Characteristics of the Dietary Fiber. *Food Sci Technol Int*, 16(4): 305-13.