Glances of Dietetic Oral Guar Gum: Reducing Cholesterol in Human Scenario

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Abstract
Dietary oral guar gum (fiber) has various effects on cholesterol metabolism, pancreatic functions and intestinal physiological mechanisms. The hypocholesteromic effects of this fiber are well known by studies on intestinal cholesterol absorption, fecal sterol and bile acid loss from various animal models and human clinical investigations. Apart from altering the normal physiological processes, it also affects the molecular expression of various genes as published by few workers but further investigation is needed in this area. This dietary fiber has been known to lower plasma LDL cholesterol concentrations. Fiber also elevates several enzymatic activity and intestinal response. The ability of guar gum to induce weight loss enables it to be used as weapon against patients suffering from obesity and elevated cholesterol levels.

Abbreviations: SCAP: Sterol Cleavage Activating Protein

Introduction

Preface of Guar Gum
The world agriculture produces enough food to meet the energy need of population of around 6 billion people and in pace with population growth. But worldwide the demand of adequate diet rich in nutrients especially protein is increasing with time. Guar Gum is among the nutritional substitute for protein and fibers. Guar or cluster bean (Cyamopsis tetragonoloba (L) Taub), (Fam. Leguminosae) is a drought tolerant annual leguminous plant, consisting of high molecular weight (50,000-8,000,000) polysaccharides composed of galactomannans; mannose:galactose in ratio 2:1. Chemically, guar gum is a polysaccharide composed of the sugars galactose and mannose. The backbone is a linear chain of β 1, 4-linked mannose residues to which galactose residues are 1, 6-linked at every second mannose, forming short side-branches. It is primarily grown in arid and semi arid regions of Indian Subcontinent. India production contribute to 80% of the world’s total production [1,2] (up to 6 million tons per year) and net export of guar seeds and guar gum (over 117000 tons) bring in over 187,380,000 US Dollars annually. In India, the tender pod of guar crop is consumed largely as a vegetable in human diet while the whole plant is good for cattle feed and as a nitrogen rich green manure. The seeds are dehusked, milled and screened to obtain the ground endosperm (native guar gum) [1]. The gum may be washed with ethanol or isopropanol to control the microbiological load (washed guar gum). It also contribute commercially in food(ice-creams, cheese, puddings), pharmaceuticals (tablet binder and disintegrating agent and in micro-encapsulation of drugs), cosmetics (emulsifier, thicker, and stabilizer in creams and skin care products, tooth pastes, shampoos, conditioners, and shaving gels/creams), and industrial applications (cloth and paper manufacture, paints, mosquito repellant coils, oil well drilling mud [3], explosives, ore flotation). Guar meal (germ and hull) is commonly used as fodder for cattle and poultry. In the U.S., differing percentages are set for its allowable concentration in various food applications [4]. In Europe; guar gum has EU food additive code E412.

Structural Formula Representation of Guar Gum
(Figure 1)

Effect of Dietary Fiber on Cholesterol Metabolism
The regulation of cholesterol metabolism by guar gum concludes that it is having hypocholesterolmic effect and serves as protective role for cardiac disorders as indicated by various clinical trial in humans. Although a number of pharmaceutical products are available to cure the risk factors [5] involved in the pathology of atherosclerotic vascular diseases [6-8], but the clinical trials of natural fibers curing these cardiac disorders...
are emerging as a landmark in the field of food nutrition and healthcare. Published data on the animal feeding studies [9,10] and meta analysis reports [11,12] categorize this soluble fiber as beneficial dietary supplement. Many published reports also state the regulatory role of this soluble fiber in cholesterol metabolism and reduction in circulating cholesterol concentrations [13]. Consumption of these water soluble, viscous forming fibers such as guar gum, pectin, and psyllium has consistently been shown to reduce plasma cholesterol in humans [14-17].

**How Dietary Fiber Alters the Cholesterol Level?**

It is well known that soluble fibers act in the intestine to promote secondary responses in the liver and peripheral circulation from direct effects within the intestinal lumen [16,18]. The fiber also reduces the dietary fat and cholesterol uptake and also decreases the cholesterol level in the intestine [19]. The dietary fiber interferes with the solubilization and digestion of cholesterol. In small intestine the fiber along with the cholesterol as a result of intestinal losses migrates in the large intestine, in which the dietary fiber undergo the process of fermentation and facilitates the production of short chain fatty acids. These short chain fatty acids might be involved in the regulation of cholesterol homeostasis. The altered chylomicron composition due to interference with the dietary fiber may also be involved in the defective metabolism of cholesterol. Flowchart representation of the regulation of the cholesterol regulation by dietary fiber is shown in the Figure 2.

A compensatory increase in the expression of hepatic HMG–CoA reductase, the rate limiting enzyme in cholesterol biosynthesis, is thought to account for the reduction in the hepatic free cholesterol pool following the consumption of guar gum [20]. The production of short chain fatty acids by bacterial fermentation of the fiber in the large intestine is thought to have multiple health benefits and may be involved in mediating the hypocholesterolemic effects of dietary fiber [21].

**Figure 1:** Structural formula representation of guar gum.

**Figure 2:** Flowchart representation of probable cholesterol regulation by dietary soluble fiber.

**Regulation of Gene Expression by Dietary Fiber**

The hypocholesterolemic effect of guar gum encounters the regulation of the mRNA and protein expression of hepatic LDLr, SR-B1, and SREBP2 associated with the antherogenic diet. In response to guar gum consumption, mRNA and protein expression of the hepatic LDLr were increased [22]. Nonsterol...
transcriptional regulation of the LDLr involves transcription factor early growth response in association with the sterol independent regulatory elements [23], estrodial stimulated expression through the estrogen response element [24], and insulin stimulated expression through SREBP1a [25]. Sterol dependent transcription of the LDLr is regulated through SREBP2 [26] and more recently with the liver X receptors [27]. Few studies suggested that covertase subtilisin/kexin type 9, a proteinase regulated by SREBP2 enhances the degradation of the LDLr protein [28]. The SREBP2 regulates hepatic cholesterol metabolism by binding sterol response elements in the promoter region of a target genes [26]. Under normal physiological level of the cholesterol the SREBP2 precursor protein is found to be associated with the sterol cleavage activating protein (SCAP) in the endoplasmic reticulum. As per requirement of the cholesterol the SREBP-SCAP complex translocates to the Golgi apparatus where the transcriptionally active amino terminal domain is released by the proteolytic cleavage [29]. By the assistance of a protein factor importin β [30], the amino terminal domain enters the nucleus and upregulates the transcription of target genes, including LDLr. Several published reports demonstrate the mechanisms associated with the hypocholesterolemic effects of dietary fibers that have pertained to the hepatic mRNA expression of HMG-CoAr and CYP7 A1 [31]. There is also increase in hepatic ATP-binding cassette transporter G5/G8 mRNA and protein expression and biliary cholesterol concentration.

**Intestinal and Enzymatic Response to Dietary Guar Gum Fiber**

The guar gum is rich in galactomannans and form probably a viscous gel like entity in the lumen of the intestine, stomach. When dietary fiber is consumed, on reaching to the stomach it resides in the lumen and forms an increased feeling of satiety and reduction of the appetite [32,33] as it has slow rate of absorption from the lumen of intestine, these attributes could be due to the bulkiness of the guar diet. The fiber also effect on the pancreatic enzymatic activities, as its consumption elevates the total activities of amylase, lipase and protease [34]. Similar effects on food intake and body weight gain have been observed in hepatic ATP-binding cassette transporter G5/G8 mRNA and protein expression and biliary cholesterol concentration.

**Future the Rapeutic Potential of the Guar Gum**

The future relevance of the functional fiber based foods will depend on the integrated approach of public health, researchers and doctors. Due to unique features associated with the dietary fibers such as guar gum, it serves as tool for the patients suffering from the several cardiac problems especially with atherosclerotic patients. The hypocholesterolemic effects related with soluble fiber consumption are clear and supported by several esteemed publications around the globe. It also eradicates the obesity, which is a major problem of the developed world and arising problem of the developing world. Ahead of the physiological approach many genetic approaches have also been studied which state its role in the regulation of the gene expression engaged in the lipid metabolism. Detailed knowledge of the mechanism of lowering the plasma cholesterol level by fiber is paramount to developing novel fiber based diet that target the cholesterol reductions. It’s now turn of researchers and mankind servants to contribute in this marathon and provide a precious and healthy gift to mankind.

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