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Role of guar fiber in appetite control

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HIGHLIGHTS

- Appetite control could be a logical approach for proper weight management.
- Guar fiber reduced the colonic mobility and increased the release of CCK.
- Guar fiber provided both acute and sustained perceivable satiety effects.
- The acute perception of satiety was observed with intake of 5 g guar fiber.
- Regular intake of guar fiber (2 g/day) reduced 20% daily energy intake via snacking.
- Guar fiber at reasonable dosage levels provide appetite control.

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ABSTRACT

Appetite control and reduction of additional calorie intake may be a logical approach for proper weight management. Viscous dietary fibers are effective in appetite control but difficult to apply in normal serving sizes in foods and nutritional supplements due to their viscosity and required high doses. Guar fiber popularly known as partially hydrolyzed guar gum (PHGG) is near non-viscous soluble fiber that has been proven effective in providing many physiological benefits. Guar fiber has also been identified as potential natural food and nutritional supplement ingredient for appetite control. The aim of this review is to summarize all the clinical studies pertinent to its effects on appetite control in normal subjects and postulate the mechanism of action. Guar fiber exhibited appetite control via delaying the colonic transit time of digested food, stimulation of satiety hormone cholecystokinin (CCK) and induction of prolonged perception of post-meal satiation and satiety effects. Regular intake of guar fiber at a dose of 2 g/serving provided significant sustained post-meal satiation effects and minimized the inter-meal calorie intake by about 20% in normal subjects. The intake of guar fiber alone at a dose >5 g/serving or its combination with protein (2.6 g guar fiber + 8 g protein/serving) showed acute satiety effects in normal subjects. Guar fiber containing >85% dietary fiber, with clear solubility and negligible taste impact, may be an ideal natural dietary fiber for use in food and supplement applications at low dosage levels for appetite control.

Contents

Abbreviations: CCK, cholecystokinin; CCT, colonic transit time; GLP1, glucagon-like peptide-1; PHGG, partially hydrolyzed guar gum; PYY, polypeptide YY; SCFA, short chain fatty acids; VAS, Visual Analog Scale.

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1. Introduction

In these modern days, abundant food, frequent snacking habits and sedentary work are a few of the causes for the rise of obesity in both developing and developed countries. Frequent snacking of high fat and high sugar products is evidently a key factor leading obesity [4,5,38]. Addressing appetite control is a logical option to limit food intake. Although appetite is dependent on several factors, the post meal satiation (fullness) and perception of satiety period (feeling of fullness) after a meal may be important to suppress intermittent appetite, which could have an influence on inter-meal snacking and subsequent meal intake. Several hormones such as Ghrelin, CCK, glucagon-like peptide-1 (GLP1) and polypeptide YY (PYY) were identified as biomarkers of hunger and satiety [12,28]. Recently, the measurement of hunger and appetite on visual analog scale is considered as a valid tool in assessing the perception of satiety period for comparison with control or other food materials [15,62].

Foods rich in proteins [14,23,26], thickening agents like guar gum [18,40,43], gel-forming dietary fibers such as pectin [84] and nuts rich in fat, protein and fibers [79] are known to provide good perceivable satiation. Among the fibers, the viscosity was considered as an important factor in gastric emptying and thereby appetite control [41,50]. However, a recent study suggests that the non-viscous soluble fibers like resistant dextrin, resistant starch, poly dextrose and soluble corn fiber [53] at doses of >20 g could also increase the perception of fullness and reduce hunger ratings. In other study, the regular intake of 16 g of oligofructose [9] per day for two weeks also exhibited satiety effects. Resistant maltodextrin [88] at a dosage of 10 g delayed the feeling of hunger and increased satiety by 1.5 and 2 h, respectively. Recently, guar fiber a near non-viscous soluble fiber popularly known as partially hydrolyzed guar gum (PHGG; Sunfiber®) showed significant satiety effects at very low doses (≤5 g), which is an ideal dose to incorporate in single serving of foods such as yogurt, nutritional/protein bars and beverages and nutritional supplements to keep the appetite under control. The intent of this review is to systematically summarize the clinical effects of guar fiber in appetite control exhibited via delayed colonic mobility, induction of satiety hormones and increased perception of satiety.

2. What is guar fiber?

Guar gum, derived from the plants of Indian cluster bean (*Cyanopsis tetragonolopus*), is generally used as thickening agent and stabilizer in various foods and other industrial products due to its high gel-forming properties. The gum is composed of long linear chains of polysaccharides namely galactomannans with 50–8000 × 10^3 units composed of β-1.4 mannose and α-1.6-galactose in a 2:1 ratio. The molecular weight of the gum is in the range of 200–300 kDa. The viscosity of a solution containing 1% guar gum is about 2700 cps. Whereas the guar fiber (PHGG) is a near non-viscous soluble dietary fiber derived from a controlled partial enzymatic hydrolysis of guar gum. Guar fiber has the same chemical structure of guar gum with the same ratio (2:1) of mannose/galactose but with reduced chain length comprised normally between 3 and 30 units, of which the majority (>80%) are medium chain length oligomers with >9 units [13]. The average molecular weight of guar fiber is about 20 kDa, which is approximately a 10 times reduction in polymerization compared to intact guar gum. The viscosity of guar fiber is also significantly reduced to near non-viscous solution (5 cps, 5% guar fiber solution) compared to the high viscosity with intact guar gum. Guar fiber containing >85% of soluble fiber content, with clear solubility in both warm and cold water at different pH conditions is an ideal soluble dietary fiber. Ever since guar fiber was developed in early 1990s, it has been providing promising opportunities as a user friendly, taste free, invisible soluble dietary fiber for use in many foods, nutritional supplements and medical foods. Several studies confirmed its many physiological benefits, which assigned the notion "invisible fiber with visible benefits" to it. Unlike other dietary fibers, which are commonly recommended for constipation, guar fiber was confirmed to have a true regulatory effect normalizing bowel conditions such as constipation, diarrhea and irritable bowel syndrome [54,60,64,70,76]. Guar fiber, largely composed of medium chain length oligomers, are fermented over a longer period of time [10,58] and provides a better prebiotic effects [65,83] with the production of high amounts of short-chain fatty acids [10,59,83] when compared to other soluble fibers. Guar fiber also found effective in lowering hyperglycemia [19,80] and hyperlipidemia [35,37] even at small doses (<6 g/day). In addition, guar fiber showed no negative influence on the absorption and utilization of nutrients especially minerals and proteins [2,25,76,77,78,85], which are normally hindered by the intake of dietary fibers.

In the case of appetite control and energy consumption, the intake of guar gum in its original form is known to induce hunger suppression hormone GLP1 [1] and provide satiation effects [18,40,43]. Earlier, Pasman et al., [63] reported that the consumption of 40 g of guar fiber per day for one week reduced the subsequent energy intake by 19% compared to control. Recent studies suggest that guar fiber is effective in reduction of colonic mobility, induction of satiety hormones and increasing the post-meal perception of satiety with administration at small doses. Each of these effects are reviewed and discussed in the below sections.

3. Gastro-intestinal mobility

High fiber diet is associated with less hunger, this phenomenon is mainly attributed to slow gastric emptying and/or colonic mobility of digested food in the gastro-intestinal system [21,33]. Viscous soluble fibers like guar gum, pectin and psyllium, when taken in high doses delays gastric emptying due to increased viscosity, which can reduce pyloric flow [6,31,74] and increase retention [48] of gastric contents. However, the same mechanism of action may not apply to the non- or low-viscous fibers such as guar fiber. The effect of guar fiber on gastric emptying has not yet been examined, but it was found effective in flocculation of fats [52] and production of CCK [27,51], which are expected to delay gastric emptying [45,49]. The role of guar fiber alone or in combination with high fat foods may have an impact on gastric emptying and the effect shall be examined and confirmed separately.

There are, however, a few studies (Table 1) that have examined the effect of guar fiber on colonic mobility. Lampe et al. [42], was the first to indicate the slow colonic mobility related to intake of guar fiber. They examined the effects in terms of colonic transit time (CTT) using radio markers. In a double-blind, randomized block design, 11 healthy male subjects were given an enteral feeding with 3 test diets in the form of complete nutrition formulas for 18 days, as follows; 0 g (21 g of Maltodextrin) or 15 g of dietary fiber either as guar fiber (21 g of Sunfiber) or soy polysaccharides (21 g of Fibrim). A 10 day washout period was implemented in between the change of test diets. Subjects consumed their habitual standard normal diets during the washout period. CTT was measured by swallowing radiopaque pellets on 9, 11, and 14th days and stools were collected for tracing. The mean CTT with guar fiber was significantly ($p < 0.0001$) raised by +42 h (day 9), +6 h (day 11) and +24 h (day 14), when compared to the standard diets of 0 g fiber diet and soy polysaccharide diet, respectively.

Later, a similar study was conducted by Meier et al. [51] with guar fiber. In a randomized cross over study, isocaloric liquid formulas containing 0 g or 21 g of guar fiber/L were administered to 12 normal healthy subjects for 7 consecutive days with a washout period of 1 week in between tests. Subjects consumed a standard habitual normal diet at basal (pre-test period) and washout periods. CTT was assessed similar to the method applied by Lampe et al. [42]. The guar fiber diet was found to have significantly increased ($p < 0.05$) colon transit time by +25 h over the standard diet and increased +16 h over the fiber free diet, respectively.

The above results suggest that guar fiber is effective in increasing the CTT, more prominently when compared to standard normal diet than