



GUAR GUM IN THERAPEUTICS: A SUCCINCT EXPLORATION

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Abstract Guar gum, extracted from the seeds of *Cyamopsis tetragonolobus*, has gained prominence for its unique properties, forming a thick gel in water and releasing fatty acids through fermentation. Originating in Pakistan and India, it found industrial significance in the US during the 1940s. The galactomannan in guar's endosperm, a polysaccharide of d-mannose and d-galactose, imparts rapid solubility, pH stability, and biodegradability. Beyond its industrial applications, guar gum exhibits a myriad of health benefits. Delving into the botanical symphony of guar seeds reveals a poetic composition, and enzymatic exploration unravels the whimsical ballet of galactose side groups. Guar gum transcends its botanical origins to become a dietary sage, influencing serum cholesterol levels and aiding in weight management. Its journey through the digestive system orchestrates nuanced reductions in blood glucose and insulin, showcasing its potential for diabetes assistance. The manufacturing process involves splitting, hydration, and various treatments, resulting in guar gum's characteristics as a thickening agent with tasteless and odorless properties. Stability studies affirm its consistent performance over time, and its safety for target species, consumers, and the environment is established. Exploring guar gum's therapeutic applications reveals its potential in wound healing, inflammatory bowel disease treatment, and as a preventive measure against ulcers. Its role as a dietary fiber extends to managing irritable bowel syndrome symptoms, reducing blood sugar and cholesterol levels, promoting weight loss, and aiding in regular bowel movements. The article recommends a daily intake of 28g for adult women and 36g for men, achievable through the consumption of guar gum. Clinical studies demonstrate its positive impact on duodenal ulcers, providing relief, increasing satiety, and preventing symptoms. With its multifaceted applications, guar gum emerges as a fascinating substance intertwining chemistry, medicine, and industry.

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Introduction

Guar gum, derived from the seeds of the Indian bean *Cyamopsis tetragonolobus*, is an edible fiber known for its unique properties. It forms a thick gel when dissolved in water and undergoes fermentation, releasing fatty acids with shorter chains (Todd et al., 1990). The ground endosperm of the leguminous plant *Cyamopsis tetragonolobus* is the source of guar gum (Nandkishore et al., 2016). Originally cultivated in Pakistan and India for centuries as a food source for animals and humans, the guar gum industry emerged in the United States during the 1940s and 50s. Initially introduced into the US as a natural fertilizer before World War I, guar gum gained industrial significance in 1943 when efforts to find a local alternative to the widely used locust bean gum became essential. Guar proved to be the optimal solution, especially with

developing cationic and anionic derivatives for gas and oil stimulation (Mudgil et al., 2014). The endosperm of guar plants contains galactomannan, a complex polysaccharide of d-mannose and d-galactose. When introduced to water, galactomannan forms H-bonding, resulting in substantial thickening and viscosity. Guar gum's rapid solubility in cold water, pH stability, and biodegradability make it versatile across various industries. Over the past decades, extensive research has explored natural and modified guar gum forms for specific applications (Nandkishore et al., 2016). Guar gum finds utility in numerous sectors, serving as a food additive and pharmaceutical ingredient and in textile, paper, explosive, oil well drilling, and cosmetic industries. Additionally, it has demonstrated potential in managing health issues such as bowel movements,

heart disease, diabetes, obesity, and intestinal cancer ([Mudgil et al., 2014](#)).

Unveiling the Mystique of Guar Gum: A Symphony of Chemistry and Medicine

In the enchanting realm of the Leguminosae family, where resilience thrives, emerges *Cyamopsis tetragonoloba*, an arid-loving artisan of the plant kingdom. From the seeds of this botanical virtuoso springs forth guar gum, a substance bestowed with myriad aliases – the Indian cluster bean, guar, and guaran, each a lyrical note in its botanical symphony. Delving into the anatomy of guar seeds reveals a poetic trifecta: the outer husk, a protective cloak comprising 16-18% of the seed; the life-infused germ at the heart, pulsating with 43-46% vitality; and the ethereal endosperm, a mystical realm constituting 34-40% of the seed's essence. Within the sacred endosperm, galactomannan reigns supreme, a regal compound of mannose and galactose groups, crafting a ballet of polysaccharides with a majestic molecular weight. A linear cascade of (1-4)-linked α -D-mannopyranosyl units, intertwined with side chains of (1-6)-linked β -D-galactopyranosyl residues, dances through the fabric of guar gum's being. Yet, upon closer inspection, the tale of galactose side groups, once thought choreographed in regimented elegance, unfolds in a whimsical ballet. Enzymatic alchemy, the wizardry of spectroscopic revelation, and the artistry of computer simulation reveal a dance of randomness, a spirited deviation from the anticipated order ([Mudgil et al., 2014](#)). Behold, guar gum is not merely a botanical virtuoso; it metamorphoses into a dietary sage, a serums healer and a metabolism maestro. Its role as a dietary fiber transcends the ordinary, offering solace to those with hypercholesterolaemia, and orchestrating a harmonious reduction in serum total cholesterol levels. A kin to bile-sequestering resins, its modus operandi intertwines with the very nature of one's diet.

This mystical substance, in its alchemical journey through the digestive realms, extends its influence over gastric time, navigating the intricate pathways of the gastrointestinal tract, and casting a spell to diminish absorption in the small intestine. A ballet of biochemistry ensues, orchestrating a diminuendo in blood glucose and insulin levels, a nuanced dance that whispers tales of non-insulin-dependent diabetes assistance. Yet, the saga of guar gum transcends the confines of medical approval. In its enigmatic presence, serum total cholesterol bows by 10 to 15%, LDL-cholesterol gracefully dips by 15 to 25% in hypercholesterolaemic entities, all without unsettling the equilibrium of serum HDL-cholesterol or triglyceride levels. A paradoxical waltz ensues, where some find themselves shedding weight, a quirk that touches a select few's appetite and dietary intake, adding another layer to guar gum's mystique ([Todd et al., 1990](#)) (Figure 1).

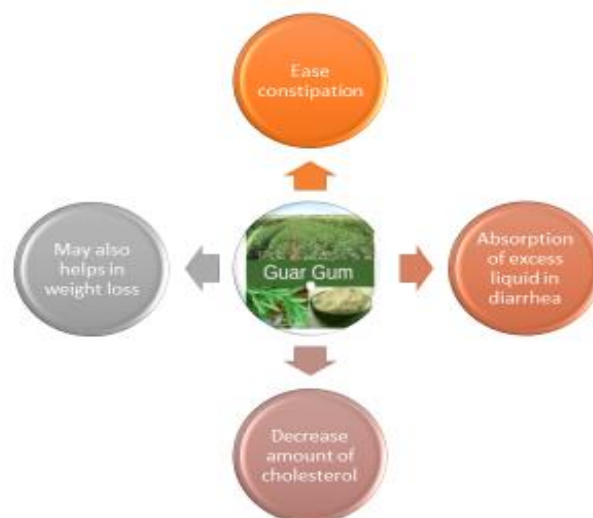


Figure 1. Medicinal Properties of Guar Gum

Manufacturing of Guar Gum
The germ and endosperm undergo division into halves, termed "guar splits." These splits undergo additional processes, including hydration, whitening, pH adjustment, thin slicing, crushing, desiccation, filtration, and eventual storage (Figure 2).



Figure 2: Guar Gum Manufacturing

Guar Gum Characteristics

- Recognized as a proficient thickening agent, contributing significantly to water retention.
- Exhibits rapid hydration when combined with cold water.
- Plays a crucial role in food formulations.
- Possesses versatility due to the presence of free hydroxyl groups.
- Features a tasteless profile and lacks any discernible odor.
- Soluble in hot and cold water but insoluble in organic solvents.
- Demonstrates film-forming capabilities.

Stability and Homogeneity

Guar gum showcased consistent stability, along with the presence of microorganisms. This experimental duration was extended to 24 months, with no significant differences observed at any stage during sampling.

Conditions of Use

Guar gum can be effectively utilized alongside emulsifiers, gelling, and balancing agents. This flexibility allows its incorporation into animal feed without necessitating precise measurements.

Safety for the Target Species

Following extensive research and publication-focused investigations, guar gum has been deemed safe for application in cats and dogs, ensuring the protection of the target species.

Safety for all animal species

No review literature supporting the protection of target species could be found because study design failed to meet certain standards with no endpoint. In a toxicological study, a safe quantity of additives was measured (Table 1)

Table 1. Maximum protective amount provided by guar gum for different target species

<u>Types of animals</u>	<u>Body mass index (kg)</u>	<u>Feed consumption (g of dry matter per day)</u>	<u>Maximum concentration in feed (mg/kg feed)</u>
<i>Laying Hen</i>	~2	106	415
<i>Calf (milk replacer)</i>	100	1890	1164
<i>Cattle for fattening</i>	400	8000	1100
<i>Goat/Sheep</i>	60	1200	1100
<i>Dairy Cow</i>	650	20000	715
<i>Horse</i>	400	8000	1100

DM stands for dry matter.

Complete feed DM = 88%, milk replacer DM = 94.5%.

The caloric amount of guar gum for chicken feed is 278 mg/kg, and for ornamental fish, the amount was calculated to be 4889 mg/kg. The FEEDAP panel could not measure the safe value of guar gum for reproduction and long-lasting life. The FEEDAP panel gives a rough amount of guar gum, which is safe for consuming chickens, pigeons, cattle, and calves. The amount of guar gum declared by the study of accumulated variation is 280 mg/kg for chicken fattening, 375 mg/kg for turkey fattening, 500 mg/kg for piglets, 600 mg/kg for pigs, 1150 mg/kg for veal

calves, 1100 mg/kg for cattle, and 3000 mg/kg for salmonoids.

Consumer Safety

In animal species, guar gum exhibits non-absorption within the gastrointestinal tract, with no evidence of additive deposition in tissues and organs. As no consumers have experienced adverse effects from additive consumption, and including guar gum in animal nutrition demonstrates no negative impacts, it is deemed safe for buyers.

User Safety

Limited data suggests a notable potential for elevated dusting (2.2-2.6 g/m³) with the additive. Inhalation is a plausible route of exposure, yet no toxicity has been observed for inhaled spores. Irritation is noted for the skin and eyes. However, insufficient data hampers the measurement of additive protection across all animal species.

Environmental Safety

Given the ubiquitous presence of its components in nature, incorporating guar gum into any animal's diet is deemed environmentally safe, ensuring harmony with our surroundings (Ghosh et al., 2013).

Therapeutics of Guar Gum

Wound Healing by Guar Gum

The process of wound healing, a natural phenomenon wherein new ones replace damaged tissues, has garnered attention in recent studies, highlighting the advantageous role of guar gum (Ghosh et al., 2013). Crafting wound dressing materials that possess both antibacterial properties through the utilization of arabinoxylan (ARX) and natural polymers such as guar gum (GG) presented a challenging endeavor (Khan et al., 2020). Incorporating cross-linked carboxymethyl guar gum (CMGG) has been instrumental in expediting tissue healing (Orsu and Matta 2020). Noteworthy for its exceptional antibacterial properties, guar gum demonstrates the capacity to impede bacterial growth. Furthermore, it can be introduced into the body to facilitate the accelerated development of regenerative tissues (Bhubhanil et al., 2021). Additional research underscores its efficacy in healing mucosal epithelium wounds in the intestine and its potential benefits in addressing bowel diseases (Hori et al., 2016) (Figure 3). In wound care, hydrogel composite applications extend beyond antibacterial attributes. They foster the creation of new blood vessels and stimulate fibroblast production, transforming the inflammatory stage into a proliferative healing phase. Moreover, these composites target gene expression, motivating tissue remodeling and ensuring robust wound recovery (Palem et al., 2019).

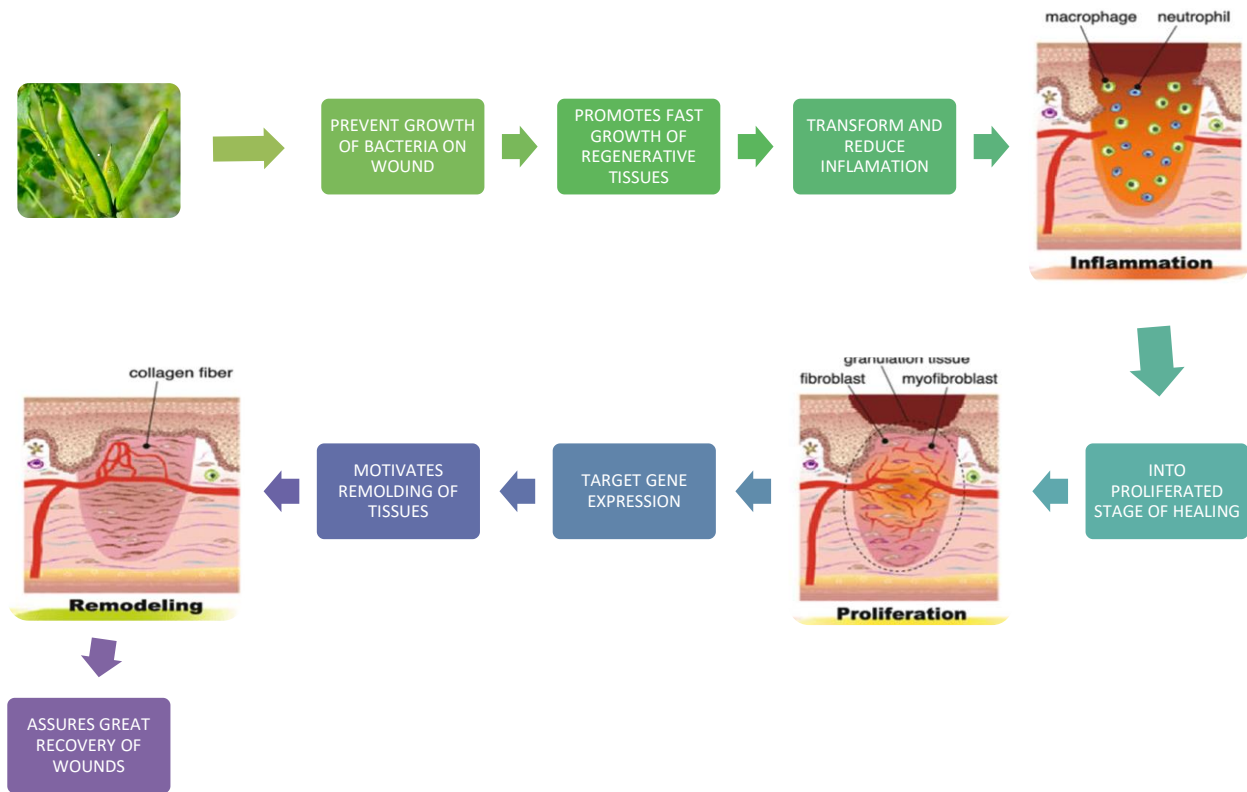


Figure 3: Wound Healing Process

Laxative effects of guar gum on the large intestine

Numerous studies involving animals have been conducted to scrutinize the potential positive and negative consequences of guar gum. Moreover, the presence of *Clostridium butyricum* is found to completely break down guar in the large intestine (Hartemink et al., 1999). Adverse effects are observed only when animals are subjected to high concentrations of guar gum, typically around 10-15 percent based on weight. This elevated concentration hinders animal growth due to reduced feed intake and impaired digestion. The primary factor believed to induce these negative effects is the heightened viscosity of the intestinal tract contents resulting from the ingestion of guar gum at higher concentrations. Therefore, the efficacy of guar gum is optimal within lower concentrations, typically ranging from 0.5 to 1.0 percent. Beyond this range, detrimental effects emerge, including heightened consistency, diminished protein efficacy, and compromised fat assimilation. Employing guar gum at concentrations surpassing 1.0 percent not only disrupts the nutritional attributes of the food but also interferes with its physicochemical and sensory qualities, a consequence that consumers find intolerable.

Guar Gum as a Dietary Fiber

A novel emulsified fiber, possessing a chemical composition akin to the original guar gum, is crafted through fractional hydrolysis. This process reduces the polymer's chain length and lowers its molecular weight. The resulting fiber finds diverse clinical nutrition applications, particularly dietary fiber consumption. It effectively addresses issues

stemming from the excessive viscosity associated with guar gum. Notably, the essential nutritional and sensory qualities of various food products, such as hydrolyzed guar gum-infused beverages, can be maintained while elevating the dietary fiber content. Adding this fiber to the diet, known as partially hydrolyzed guar gum (PHGG), also diminishes the reliance on laxatives, alleviates the frequency of diarrhea, and mitigates symptoms associated with irritable bowel syndrome (Slavin and Greenberg, 2003; Greenberg and Sellman, 1998).

Water-soluble fibers not forming gels are preferred to treat irritable bowel syndrome. Partially hydrolyzed guar gum stands out due to its ability to dissolve in water and its non-reactivity with other substances. It effectively addresses symptoms in both constipation- and diarrhea-predominant irritable bowel syndrome (Giannini et al., 2006). In vitro studies reveal that guar gum significantly retards starch digestion by acting as a barrier between starch and the enzymes responsible for its breakdown (Dartois et al., 2010). The gel-forming property of guar gum yields benefits that extend to reducing blood sugar and cholesterol levels. Moreover, it contributes to weight loss and obesity prevention. The soluble fiber in guar gum, forming a gel, induces a heightened sense of satiety through delayed stomach emptying. Incorporating guar gum into the diet curtails hunger, suppresses appetite, and mitigates intense cravings (Butt et al., 2007). Guar gum's influence extends to increasing bile acid excretion in feces while concurrently reducing liver and intestinal metabolism. This dual action may lead to elevated bile acid production from lower hepatic

free cholesterol concentrations (Rideout et al., 2008). Toxicology research indicates that partially hydrolyzed guar gum, consumed at levels up to 2500 mg daily, does not exhibit carcinogenic properties. Adequate intake of guar gum as dietary fiber promotes regular bowel movements, substantial reductions in total and low-density lipoprotein cholesterol, management of metabolic diseases like diabetes, enhanced mineral absorption, and prevention of digestive issues such as constipation (Yoon et al., 2008).

Anti-inflammatory Properties of Guar Gum

Recent research indicates that oligosaccharides play a role in the therapeutic anti-inflammatory effects observed in treating inflammatory bowel disease (Figure 4). However, other polysaccharides are being explored for their diverse applications. When guar gum undergoes hydrolysis, it yields simple sugars. While guar gum finds use in various medicinal applications, its potential anti-inflammatory effects in treating inflammatory bowel disease remain undiscovered. The oral administration of guar gum is a binder, aids in disintegration, and reduces mucosal inflammation. This makes it a promising treatment for inflammatory bowel disease (Jhundo et al., 2021). Furthermore, guar gum can bind to toxic substances, facilitating their removal from the body and thereby reducing blood sugar and cholesterol levels. Additionally, it plays a role in promoting healthy bowel activity and facilitating weight loss (Gamal-Eldeen et al., 2006).

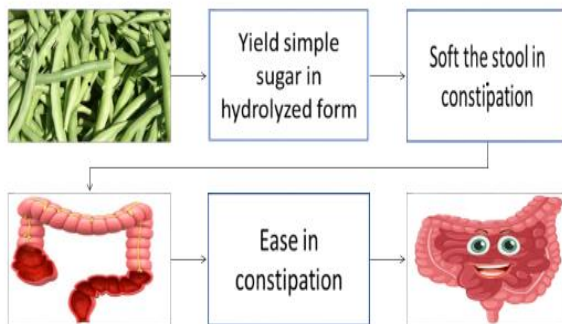


Figure 4: Guar gum is very useful for the treatment of constipation

Guar gum in the treatment of ulcers
 Due to its acid-neutralizing effects, hydrolyzed guar may offer benefits to patients with duodenal ulcers (Anderson et al., 2009). This form of guar, rich in soluble fibers, prevents ulcer. The recommended daily fiber intake is 38g for males and 25g for females [23]. Guar gum is prominently produced in the Indian subcontinent, particularly in various commendable regions across the continent. "Ultrafine Gums" processes guar to create certified food-grade guar gum powder directly suitable for consumption. This high-quality guar gum powder is meticulously packaged in well-insulated bags using premium materials,

ensuring its availability to customers (Anderson et al., 2009; Ghosh et al., 2013).

Dietary fiber plays a crucial role in the gastrointestinal tract. Recent studies suggest that soluble fiber decelerates food transit through the digestive system, while insoluble fiber expedites food digestion. With its gelling properties, guar gum forms a protective layer between the stomach wall and stomach acid, preventing acid corrosion. Dietary fibers trigger the release of various hormones, contributing to increased appetite (Harju and Makela, 1987). The growing popularity of guar gum among nutritionists is attributed to its high dietary fiber content. It commonly applies to treating stomach ulcers, where the stomach mucus and duodenum are compromised, leading to severe pain and a burning sensation. Excessive stomach acid overwhelms the mucus, resulting in crater-like sensations and pain in the duodenum. Helicobacter pylori is another common cause of ulcers, disrupting the normal acid balance and contributing to ulcer formation (Harju and Lami, 1985) (Figure 5).

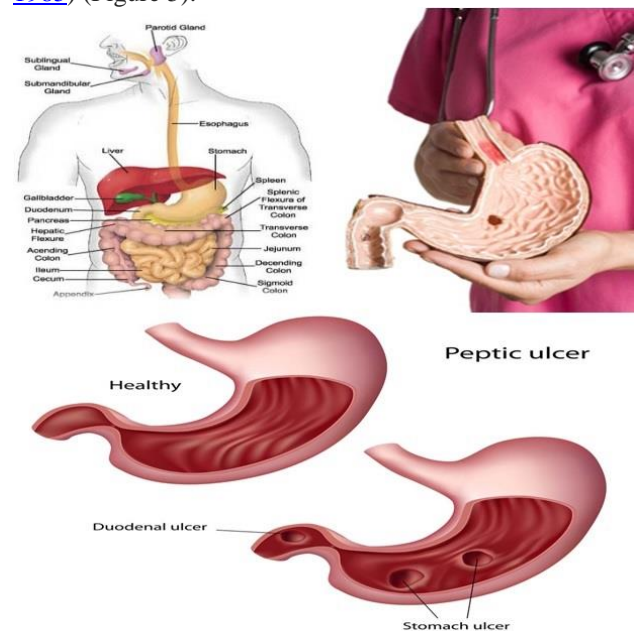


Figure 5: Peptic and duodenal ulcers affect a healthy stomach and other stomachs

The presence of dietary fiber influences the occurrence of stomach ulcers. Recent studies revealed that individuals with non-fiber diets had a significant ulcer incidence, accounting for 81 percent. In contrast, those with a high dietary fibre intake exhibited a considerably lower ulcer rate at 14 percent. Guar gum, rich in natural gel-forming fibers, boasts high fiber content. Studies indicate that elevated gel polysaccharides such as guar contribute to the delayed gastric emptying of liquids into the initial segment of the small intestine, thereby playing a preventive role against ulcers (Harju and Lami, 1985) (Figure 6).



Figure 6: Role of dietary fibres in prevention of stomach ulcers

The recommended fiber intake advised by the doctor is 14g per 1000 kcal. For women consuming 2000 kcal daily, and men consuming 2600 kcal daily, this translates to a daily requirement of 28g for adult women and 36g for adult men. This demand can be effectively met by consuming 225-4 gms of guar gum. Examining the impact of 5g of guar gum, a dietary blend of galactose and mannose comprising dietary fibers, these fibers were introduced to 20 patients with duodenal ulcers over one week. The patients were under clinical supervision. Upon comparing symptoms during guar gum administration with those experienced before, ten patients experienced benefits, five patients reported prevention by guar gum, while four patients showed no improvement. The positive effect included increased post-meal satiety feelings, particularly benefiting patients with minimal symptoms. Guar gum alleviated pain, relieving the patients ([Harju and Lami, 1985](#)).

Conclusion

In conclusion, guar gum, derived from the seeds of *Cyamopsis tetragonolobus*, emerges as a versatile and intriguing substance with a rich history and diverse applications. Its unique properties, such as forming a thick gel in water and fermentation yielding fatty acids, underscore its significance in various industries. Exploring its botanical origins reveals a poetic interplay of components, particularly the galactomannan within the endosperm, lending guar gum its distinctive qualities. The symphony of chemistry and medicine unfolds as guar gum transcends its botanical identity, becoming a healer and metabolic maestro. Its role as a dietary fiber extends beyond conventional expectations, offering benefits in managing health issues like hypercholesterolemia and diabetes. The mystique of guar gum is further heightened by its role in wound healing, where it demonstrates antibacterial properties and aids in tissue regeneration.

The manufacturing process of guar gum, from splits to characteristics like thickening agent capabilities and solubility, is intricately detailed. Stability studies affirm its resilience over time, and its safety for target species, consumers, users, and the environment is established through meticulous research. Exploring guar gum's therapeutic applications reveals its potential in inflammatory bowel disease treatment

and its ability to bind to toxic substances. Additionally, it shows promise in ulcer prevention and treatment due to its acid-neutralizing effects. The dietary fiber content of guar gum contributes to its popularity among nutritionists, particularly in addressing stomach ulcers.

Finally, the recommended daily intake of guar gum for its therapeutic effects is highlighted, emphasizing its potential benefits in aiding patients with duodenal ulcers. The detailed examination of its impact on symptoms, including enhanced satiety and pain relief, further emphasizes the multifaceted nature of guar gum's therapeutic potential. Guar gum emerges as a fascinating and multifunctional substance with a rich tapestry of applications in industry and health.

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SJA wrote the initial draft of manuscript. ZF, SK, ASK, TF, SI, MS, and SIN edit the manuscript for final submission. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable

Consent for Publication

Not applicable

Competing interests

The authors declare that they have no competing interests.



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