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Gum Arabic Effects on Irritable Bowel Syndrome and other Gastrointestinal Disorders

Isra M. Daffaalla[1]*, Reem A. Elhibir[1,2], Abdelgadir A. Abdelgadir[1,3]*, Elhadi M. Ahmed[1,3]

[1]*Department of Pharmacognosy, Faculty of Pharmacy, University of Gezira,* Al-Razi Campus, P.O. Box 20 *Wad Medani, Sudan*

[2]*Wad Medani College of medical sciences and technology, Pharmacy Program, Wad Medani, Sudan;*

[3]*Medicinal and Aromatic Plants Research Centre, Faculty of Pharmacy, University of Gezira,* Al-Razi Campus, P.O. Box 20 *Wad Medani, Sudan;*

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Abstract

Gum Arabic (GA) has been given the approval to be used in food, pharmaceutical applications, cosmetics, paints and textile industry due to its emulsifying, stabilizing, thickening and binding properties. GA, as dietary fiber was found to provide therapeutic effects in patients with gastrointestinal disorders. Irritable6 bowel syndrome (IBS) is one of the most common functional gastrointestinal disorders, affecting around 10-20% of the adult population worldwide which is characterized by chronic, recurrent abdominal pain and altered bowel habit. Wide varieties of herbal medications have historically been used by various races all over the world and are still used today by some physicians or as home remedies. Patients with IBS can use them as complementary and alternative medicine (CAM), among these herbal products GA is most commonly used. The PubMed, Google scholar databases were searched in English for studies about Gum Arabic and IBS published between 2010 and 2021 by using the terms: irritable bowel syndrome, IBS, gum arabic, Acacia gum, microbiota, prebiotic, probiotic, synbiotic, bifidobacteria, lactobacillus, dietary fiber, diarrhea, constipation, gastrointestinal disorders, anti-ulcer, anti-fibrotic, gastroprotective, anti-inflammatory, toxicity. Results of this study indicated that GA is a safe natural product that is found to reduce symptoms of irritable bowel syndrome mainly due to its prebiotic and synbiotic effects, also by acting as dietary fibers. GA also possesses other effects on gastrointestinal tract such as gastroprotective, anti-fibrotic, anti-inflammatory and anti-ulcerogenic effect.

Keywords: Gastrointestinal disorders, Gum Arabic, Dietary fibers Irritable bowel syndrome, Prebiotics, Probiotics.

*Corresponding author E-mail address: gadora-313@hotmail.com, gadora313@uofg.edu.sd

1. Introduction

The irritable bowel syndrome (IBS) is a functional gastrointestinal disorder affects anywhere from 10-20% of the adult population worldwide. It is characterized by abdominal pain or discomfort that changes the bowel habits of the sufferers [1] over a period of at least 3 months [2]. The clinical appearances of bloating and psychological stress are also regularly used by clinicians to diagnose IBS [3]. IBS has an incomplete pathophysiology, but it is well established that there is dysregulated communication between the gut and the brain, resulting in motility disturbances, visceral hypersensitivity, and altered central nervous system functions in addition to alterations in gastrointestinal microbiota [4]. Traditionally, the diagnosis of IBS depends on the positive identification of symptoms that correlate with several different syndromes [5]. Patients with IBS are categorized into four subtypes, depending on how they behave in terms of their stools: diarrhea-predominant IBS (IBS-D), constipation-predominant IBS (IBS-C), mixed diarrhea and constipation IBS (IBS-M) and unclassified IBS-U [6].

A wide variety of herbal medications have historically been used by various races all over the world and are still used today by some physicians or as home remedies. Patients with IBS can use them as complementary and alternative medicine, when primary medications and treatment approaches fail or as adjuvant therapy. Gum Arabic is one of the herbal medicines that could be used for IBS.

Gum Arabic is a glutinous or gummy exudate derived from the branches and trunks of *Acacia senegal* trees (Hashab), that has been an air-dried [7] or *Acacia seyal* (Talha), of the family Fabaceae [8], a tree that could be found in a variety of tropical and subtropical climates across the world, particularly in Africa [9].

A. senegal is common throughout the dry tropical regions of Africa, from Senegal, Morocco, Mauritana and Mali in the west, up to Eritrea and Ethiopia in the northeast, and down to South Africa. Outside of Africa, it is also present in Oman, Pakistan, and India, and it has also been introduced to Egypt, Australia, Puerto Rico, and the Virgin Islands. However, the *A. seyal* variant is the one that is most common in the Sahel region, from Senegal to Sudan, Egypt, Ethiopia, and down through East Africa up to Tanzania from which more than 80% of GA are grown in Sudan [10-12].

A. Seyal gum has a molecular weight that is at least twice as great as *A. senegal* gum. When compared to *A. Senegal*, *A. Seyal* has a similar structure and consists of three main components: low protein and low molecular weight arabinogalactan, high protein and high molecular weight arabinogalactan protein complex, and glycoprotein, which has higher protein content and a higher overall molecular weight. Gummosis is a process of gum formation due to natural tree response when bark exposed to injury [13].

GA is a high-molecular weight non-starch polysaccharide [14] which contains three different fractions

of highly-branched carbohydrate structures that vary in molecular mass and protein content [15]. The main fraction is composed of polysaccharide of 1, 3-linked β-D-galactose units, L-arabinose, L-rhamnose, and D-glucuronic acid (Arabinogalactan AG), the second is arabinogalactan with protein [16]. Some sources report the third smaller fraction of gum is a mixture of polysaccharides and glyco-proteins GP [17]. Serine, hydroxyproline, proline, and aspartic acid are the major amino acids present in GA which are commonly considered as antioxidants biomolecules [18]. Minerals generally found in GA are Ca, K, Mg [19], Na, P, and traces of Pb, Co, Cu, Zn, Ni, Cd, Cr, Mn [9] and sodium salts of a polysaccharic acid or Arabic acid [8]. Based on the Food and Agriculture Organization of the United Nations and World Health Organization FAO/WHO Joint Expert Committee Food Additives (JECFA) which defined the use of gum arabic as a food additive [19] The US Food and Drug Administration (1973) had confirmed the safety use of gum Arabic as a food supplement and generally regarded as safe (GRAS). Moreover, the European Union (E414) (Directive 99/77/EC) and Codex Alimen¬tarius Committee (INS414) have endorsed the addition of gum Arabic to food [20]. GA is now also officially recognised as a dietary fiber in the EU directive 2008/100/EC [13].

GA has s solid reputation as an antiplasmodium, antitumor, antioxidant and immune-modulation agent with promising outcomes [19]. Arabic gum has a long history as a preventive supplement in Arabic traditional medicine, and it has recently gotten a lot of attention because of its ability to protect against the effects of chemical and environmental risks [20].

Native Africans have traditionally used gum Arabic in food preparation as well as human and animal health. For centuries, various portions of acacia trees have been utilized to treat numerous health conditions involving the alimentary canal, such as diarrhea, typhoid, and intestinal inflammation. Gum arabic is used as a stomach tonic in Iranian traditional medicine to cure peptic ulcers [21], having beneficial effect in preventing and healing of gastric ulcers due to both gastric antisecretory and cytoprotective effects [22].

In Middle Eastern countries, GA has also been proposed as a treatment option for chronic kidney disease [9,23]. GA appears to have a hypocholesterolemic effect, decreasing low-density lipoproteins (LDL) and very low-density lipoproteins (VLDL) without affecting high-density lipoproteins (HDL) and triglycerides in animal models [15] also antischistosomal properties of AG in mice infected with the immature stage of Schistosoma mansoni in mice has been reported [24].

Industrially GA has found broad utility in the food industry for its emulsifying [25], stabilizing, thickening and binding attributes. It is also used in soft drinks, food flavorings and food sweeteners [26-27]. It is also incorporated in food formulations ranging from ice creams, jellies, candies, beverages, syrups, and chewing gums. It is perfect for confectionery coatings and glazes because of its film-forming

capabilities [18]. Its ability to extend the shelf life of flavors makes it a desirable food addition. The European Union has given its approval to GA for food applications. In pharmaceuticals and herbal medicines, it coats pills and lozenges. Also, it is used in cosmeceuticals for formulation of creams and lotions [9]. It is widely used in pharmaceutical applications which mostly have been used as capping agent for nanoparticles and considered as physiologically harmless substance [16, 27] and corrosion inhibitors for the biotechnology and food industry [28]. GA has found use in the textile industry as for its ability to enhance tensile strength of the yarns, due to its excellent binding property [15] and efficient in removal of toxic heavy metals [29]. It is a key ingredient in traditional lithography, printing, and water color paints [30] as shown in Table1. One of the most promising applications linked with gum arabic, concerns its use as prebiotic due to its relative inaccessibility to the various enzymes within the small intestine. This review aimed to display the outcomes of the earlier and recent studies conducted on gum arabic, evaluating its effectiveness in irritable bowel syndrome and other gastrointestinal disorders together with the proposed mechanisms of action.

Table 1: Industrial applications of Gum Arabic:

Food industry	• confectioneries,functional food, beverages and juices as diatery fibres.
pharmaceutical industry	• as demulcent, suspending agent, and emulsifying agent in syrups, tablet binders, drug encapsulation and others
Cosmetic industry	• gum arabic is used in creams,lotions, mascaras and cake cosmetics as protective colloid.
Other Industerial applications	• detergents,shoe polish, ceramics, porcelan, paints and textile.

2. Materials and methods

Searching of the medical literature in the English language was undertaken using PubMed and Google Scholar to find research assessing the impact of GA on IBS and other gastrointestinal problems from 2010 to 2021. For the explained topic, a literature search was conducted in each section of the article. Information was gathered by searching for the terms irritable bowel syndrome, IBS, gum Arabic (Photo 1), Acacia gum, microbiota, prebiotic, probiotic, synbiotic, bifidobacteria, lactobacillus, dietary fiber,

diarrhea, constipation, gastrointestinal disorders, anti-ulcer, anti-fibrotic gastroprotective, anti-inflammatory, toxicity, and focusing on the literature that describes therapeutics. The search was limited to English-language articles. This review is based on existing research and does not include any experiments involving human subjects or animals.

Photo 1 : Gum Arabic

3. Results and discussion

Managing irritable bowel syndrome has attracted international attention because single-agent therapy rarely relieves bothersome symptoms for all patients, since the cornerstone of its therapy is a solid patient physician relationship [31, 32]. The first-line approach in the dietary management of IBS is general advice on healthy eating and lifestyle. Standard recommendations include adhering to a regular meal pattern, reducing intake of insoluble fibers, alcohol, caffeine, spicy foods, and fat, as well as performing regular physical activity and ensuring a good hydration. Second-line dietary approach should be considered where IBS symptoms persist and recommendations include following a low FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols) diet, to be delivered only by a healthcare professional with expertise in dietary management [33].

Antispasmodics for stomach discomfort, antidiarrheals for IBS-D, and laxatives for IBS-C should all be used as part of the first therapy regimen [34]. Patient education regarding the illness, dietary adjustments, and soluble fiber are the cornerstones of treatment. Other treatments, such as central neuromodulators, intestinal secretagogues, drugs acting on opioid or 5-HT receptors, or minimally absorbed antibiotics (all of which are chosen based on the predominant bowel habit), as well as psychological therapies, are usually reserved for people with severe symptoms [4]. IBS has a significant financial impact on the healthcare system, as well as a negative impact on patient quality of life. Natural alternatives for management of IBS such as GA are really important to reduce symptoms and improve patient's quality of life rather than conventional drugs with undesirable side effects [35]. However, GA is commonly used traditionally to treat gastrointestinal disorders including IBS by different mechanisms as shown in (Fig. 1).

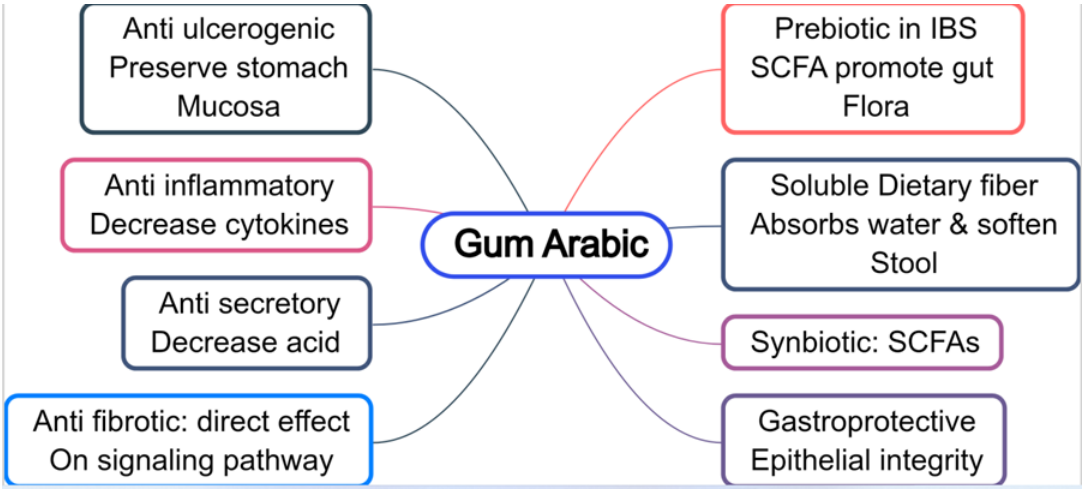

Figure 1. Illustrate the possible mechanism of action of gum arabic in gastrointestinal disorders.

3.1. Prebiotic effect of Gum Arabic:

Probiotics as defined by FDA and WHO (2002) are the "live microorganisms that when administered in adequate amounts confer a health benefit to the host" as *Lactobacillus* spp. and *Bifidobacterium* spp. [36]. Prebiotics were redefined at the 6th International Scientific Association meeting of probiotics and prebiotics (ISAPP, 2008) as "selectively fermented ingredients that result in specific changes, in the composition and/or activity of the gastrointestinal microbiota, thus conferring benefit(s) upon host health" [13]. The use of prebiotics to boost particular gut flora is a hot topic in gut ecology research right now [37]. Prebiotics are non-digestible, fermentable dietary components that improve the host's health by altering the composition or activity of the gut microbiota [38]. Natural sources of prebiotics are artichokes, chicory, cereals, fruit, and green vegetables, plants including bananas, berries, tomatoes, garlic, onions, legumes, linseed, oats, barley and wheat. One of the most important natural prebiotic is Gum Arabic [39]. Gum fermentation stimulates the production of microbial metabolic end products such acetate, butyrate, and propionate, which are SCFAs binding to 'metabolite-sensing' G-protein coupled receptors like GPR43, GPR41 and GPR109A which liable for the promotion of gut homeostasis and epithelial integrity. SCFAs are an energy source for the epithelium, muscle and brain, decrease the pH and steroid solubility within the colon, increase mineral absorption, water and sodium, decrease ammonia absorption, increase colonic blood flow and oxygen uptake and regulate the host metabolism, Prebiotics such as inulin-type fructans and short chain FOS, for example, can have significant microbiota-independent benefits for the host, such as powerful immunomodulatory actions and direct barrier integrity promotion [40].

The AG has anti-dysbiosis potential because it stimulates gut-probiotics by modulating microbial population and SCFA synthesis, particularly butyrate [36]. GA It is not digested in the small intestine, but it is fermented into short-chain fatty acids in the large intestine by intestinal bacteria, primarily propionic acid and butyric acid. GA is a prebiotic fiber that promotes the growth of lactic acid bacteria and Bifidobacteria, which may be especially beneficial for persons with low Bifidobacteria populations, such as the elderly. At a dosage of 10gm/day, GA had a prebiotic effect [8]. Other GA research has found that eating 10 g of GA per day for four weeks results in greater counts of bifidobacteria and lactobacilli [15].

It is necessary to consume and maintain a minimum of 106 CFU/ml of probiotic cultures in food on a daily basis in order to achieve the necessary microbial balance that promotes health. Gums, like other polysaccharides, include the necessary food elements that may help bacteria survive in food and, as a result, in the stomach, resulting in gastrointestinal equilibrium and other health advantages [26].

3.2. Synbiotics effect of GA:

Synbiotics are dietary supplements that mix prebiotics and probiotics to boost the number and activity of beneficial bacteria in the stomach [38]. Composite yogurt enriched with acacia fiber and Bifidobacterium lactis: such combination may be able to optimise the manipulation of the gut microbiota composition towards a healthy gut, regulation of immune function, and also reduction of the levels of carcinogen-releasing enzymes Synbiotics' preservation of a healthy gut microbiota might be seen as a promising approach to maintaining human and animal health and illness prevention [13].

Min *et al.*, 2012 [41] conducted a well-designed trial with a sufficient number of patients to examine the additive effects of high-dose B. lactis and acacia dietary fiber on bowel habit satisfaction and overall IBS symptoms, primarily in IBS associated with constipation and in IBS associated with diarrhea. Finally, it was found that a new composite yogurt provided stronger therapeutic effects in patients with IBS than normal yogurt.

3.3. Gum Arabic as Dietary Fiber:

The Codex Alimentarius Commission has defined in 2010 dietary fiber as carbohydrate polymers with ten, less or more monomeric units, which are not hydrolysed by the endogenous enzymes in the small intestine of humans [38]. GA conforms to the definitions of dietary fiber, i.e., a non-starch polysaccharide, resistant to intestinal enzymes and fermentable in the colon to liberate short-chain fatty acids [9]. US FDA recognized Gum Arabic (GA) as one of the safest dietary fibers [42].

Non-digestible carbohydrates and the complex polymer lignin, which are found in plants and have low or no physiological consequences in humans, are examples of dietary fiber. Dietary fiber has long been used to treat a variety of gastrointestinal problems. Irritable bowel syndrome is thought to be caused mostly by a lack of dietary fiber. The traditional suggestion for patients with IBS has been to increase their dietary fiber intake [6]. Gum Arabic is a soluble fiber that absorbs water and forms a gel after digestion. The additional water is supposed to soften the stool and make it easier to pass [43].

Dietary fibers interact with the microbiota and the immune system which appearing to work as a prebiotic, influencing the composition of the gut microbiota. Furthermore, the fermentation of dietary fiber byproducts like short-chain fatty acids (acetate, propionate, and butyrate), as well as the drop in luminal colonic pH, encourage the growth of beneficial bacteria like lactobacilli and Bifidobacteria [6]. However, this fiber (GA) may have an impact on human physiological condition via obstructing glucose absorption, stool bulk increase, bile acid trapping, and other factors [8].

Increasing dietary fiber intake has long been a popular method, especially for IBS-C sufferers. Because soluble nonviscous dietary fibers (guar gum and wheat dextrin) ferment quickly, they can cause gas, whereas soluble viscous (psyllium and polycarbophil) and insoluble fibers ferment slowly and cause less flatulence as gum arabic [44]. Hence, in mild to moderate chronic constipation (CC) and IBS-C, fiber supplementation is effective [2].

3.4. Effect of Gum Arabic on gastrointestinal tract:

GA has been found to increase the transfer of water and electrolytes from the intestinal lumen to the bloodstream, lowering diarrhea, electrolyte loss and increase intestinal absorption [18]. Gum Arabic is said to be used in traditional medicine to cure a variety of ailments, including stomach problems. Researchers discovered a link between the components of gum Arabic and its ability to keep the stomach mucosa in a healthy state. Gum arabic aqueous solution contains a high percentage of polysaccharides, which could explain its gastroprotective ability against gastritis and make it a prospective therapeutic for treating stomach cancer and ulcers. Gum arabic antioxidant ability, protection of the stomach cell from necrosis, inhibitory activity against gastric acid secretion, and augmentation of mucous secretion are all attributed to its Gastroprotection and treating inflammation of the intestinal mucosa by covering inflamed surfaces [20, 45]. Moreover, GA from *Acacia senegal* when investigated for its anti-ulcerogenic activity against gastric mucosal damage was found to preserve the stomach mucosa and maintain its integrity [46].

3.5. Anti-fibrotic effect of gum arabic in recovery from inflammatory bowel disease:

Ulcerative colitis (UC) is characterized by chronic inflammation of the colonic mucosa, which can

extend to the submucosa layers in advanced stages. Following the inflammatory phase, fibrotic damage leads to a disruption in colonic functions, which is associated with a poor quality of life. GA has a preventive and protective effect on inflammatory damage in the colon, as well as a direct influence on fibrotic signaling pathways, as seen by lower levels of alpha-smooth muscle actin, a marker of active pro-fibroblasts, and SMAD 1,2 and TGFBR1 protein production [47].

3.6. Anti-inflammatory effect of Gum Arabic:

In treatment of colitis, acacia gums had a better therapeutic impact than guar gums when paired with the anti-inflammatory medication 5- amino salicylic acid 5ASA, especially at the higher dose of acacia (300 mg/kg), which considerably decreased inflammation in vivo compared to 5ASA alone [48]. Gum Arabic possesses anti-inflammatory properties through its short chain fatty acids butyrate, which is a byproduct of colonic bacterial aerobic fermentation of acacia gum fiber and starch, by increasing anti-inflammatory cytokine IL10 and decreasing TNF, C- reactive protein (CRP) and IL 1β [14, 45]. Butyrate has a potent anti-inflammatory effect. It decreases the pro-inflammatory cytokine expression through inhibition of NFκB [42]. Also GA can reduce oxidative stress and inflammation in the gut of in chronic kidney disease (CKD) [49]. Alteration of gut microbiota by prebiotics exerts a positive impact on the link between the immune system and microbiota, to have a beneficial role in inhibiting inflammation and colorectal cancer [50].

3.7. Safety of Gum Arabic:

According to the US Food and Drug Administration (FDA), GA is one of the safest dietary fibers; it comes under the generally regarded as safe GRAS [50, 39].

Conclusion:

GA is very important trade commodity involved in health promotion, food, beverages and pharmaceutical industries. Gum Arabic is a safe natural product that found to reduce symptoms of irritable bowel syndrome mainly due to its prebiotic and synbiotic effects and by acting as dietary fibers. Gum Arabic also possesses other effects on gastrointestinal tract such as gastroprotective, anti-fibrotic, anti-inflammatory and anti-ulcerogenic effect. Further evidence from well-controlled studies is needed to evaluate the long-term use of GA in patients with IBS and other gastric disorders to clarify its effects as well as to identify optimal dose strategies and long-term efficacy.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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