

# Gum Arabic as a natural product with antimicrobial and anticancer activities

Akram Ahmed Aloqbi

Biology Department, Faculty of Sciences and Arts-Alkamel, University of Jeddah, Jeddah, Saudi Arabia.

## Abstract

Infectious pathogens appear as significant health troubles and the major causes of diseases and death worldwide, maybe a reason for the indiscriminate utilization of drugs and multiple drug resistance in human diseases. Due to the increasing drug resistance in human diseases, it is required to search for factors leading to treat diseases especially in developing countries and without side effects. Therefore, this article presents the utilization of natural products from gum Arabic as a source of antimicrobial and anticancer compounds. Gum Arabic probiotics catalyze the growth of beneficial bacteria that live in the large intestine of the human being since birth and are useful to the digestive system, immunity system and also, protect the body against pathogens, cancer, diabetes, and overweight. Due to its rich fiber content, increasing probiotic bacteria in the gut, promoting satiety following meals, slowing down gastric emptying, and regulating hormone secretion, it protects the human health. Cancer is one of the most important reasons for death worldwide and it is of vital importance to promoting new approaches against the pathogens. Basic cancer therapy is traditional chemotherapy but it is associated with normal cell toxicities. Thus, traditional cancer therapy usually gives rise to acute side effects and toxicities. Commonly, natural factors are significantly safe. Meanwhile, some plants such as gum Arabic are anticancers.

**Keywords:** *Acacia Senegal*, antimicrobial, anticancer, natural products, gum Arabic

## INTRODUCTION

Gum Arabic (GA) is an acceptable biopolymer acquired as in particular of developing trees of *Acacia*. The exudates are non-thick fluid and rich in fiber [1]. The unmistakable gums Arabic exhibit some valuable properties, for instance, emulsification, adjustment, and microencapsulation. Gum Arabic is comprehensively used as a thickener, emulsifier, and food preparation but also in other industries like cosmetics and pharmaceuticals [2].

Gum Arabic is generally used in drugs as a carrier of the. Additionally, GA is a good source of natural antioxidants. It helps the digestion of lipids. It is used against a few sicknesses, like renal failure, cardiovascular, and gastrointestinal diseases [3]. GA has cancer prevention properties, for instance, a successful utmost with respect to coordinated radical scavenging capacity. There is growing confirmation that the antioxidant capacity is due to its protein fraction, in a general sense by amino acids, which are generally considered as cancer prevention agents [4].

## Natural products

To date, some bioactive compounds have been identified with potential of treating different diseases [5-7]. Natural products from plants, animals, marine life, microscopic organisms, and different living beings are a significant asset for current medication revelation. Their biological importance and

auxiliary decent variety make natural items great beginning stages of medication design. Specifically, compelling for medication discovery is that at any rate 10% of realized natural products are promptly purchasable and a lot increasingly natural products and subsidiaries are accessible during requests obtain from a particular source, and synthesis administrations. A significant number of the promptly bought natural products are important to medication discovery [8].

Late sequencing information recommends that microbial occupants are basic for keeping up generally speaking wellbeing. Moves in microbial networks have been connected to various sicknesses including contamination, inflammation,

**Address for correspondence:** Akram Ahmed Aloqbi, Biology Department, Faculty of Sciences and Arts-Alkamel, University of Jeddah, Jeddah, Saudi Arabia.  
Email: [aaaloqbi@uj.edu.sa](mailto:aaaloqbi@uj.edu.sa)

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cancer, and neurological disorders. A portion of these clinically and analytically important phenotypes are a result of the presence of small molecules, yet we know strikingly minimal about their commitments to the health of people [9].

In the pharmaceutical industry, the expected surge in the production of new therapeutic entities promised by technological advances, such as high-throughput screening, synthetic libraries, and advances in molecular biology and genomics, has not materialized. The unique structural diversity of natural products continues to provide opportunities to discover novel compounds. Secondary metabolites, active components of natural products such as marine organisms, microbial organisms, and terrestrial plants, are particularly exciting untapped resources for exploration as medicines [10].

### Natural products as an anticancer

Chemotherapy is the standard of inward medical therapy for cancer. Nonetheless, obstruction of cancer cells to almost a wide range of chemotherapeutic medications have turned out to be predominant, and around 80-90% of deaths in cancer patients are legitimately or in a roundabout way ascribed to medication resistance. The advancement of new medication innovative work has likewise been blocked by the event of medication resistance, which has developed as an extensive challenge in cancer treatment [11].

Breast cancer is the most well-known cancer among females around the world. A few epidemiological investigations recommended the backward connection among the eating of vegetables and fruits and the occurrence of breast cancer. More researches showed that numerous dietary natural products influence the advancement and development of breast cancer, such as fruits like pomegranate, mangosteen, orange, apple, grape, mango, and cruciferous vegetables, some herbs, and grains like soybean. Their anti-breast cancer impacts include different components of activity, for example, down-regulating ER- $\alpha$  articulation and action, restraining expansion, movement, and sensitizing breast tumor cells to radiotherapy and chemotherapy [12].

Liver cancer is the greatest widely recognized threat of the stomach with a great death average. Gathering confirmations propose that numerous dietary natural products are sources for the aversion and therapy of liver cancer, like, grapes, fruits, cruciferous vegetables, herbs, and grain-like soybean and rice and some consumable full-scale organism. These natural products and their dynamic parts influence the improvement and movement of liver cancer in different methods, for example, restraining tumor cell development and metastasis, ensuring against liver cancer-causing agents, and increasing impacts of chemotherapeutic medications [13].

### Natural products as an antimicrobial

Natural products had been a source of antibacterial and anticancer medications for quite a long time. Some significant difficulties in natural product revelation are that so far

characteristic item's biosynthetic gene clusters (BGCs) have not been described because they are silent or express at extremely low levels in laboratory conditions. Techniques created as of late for actuating silent BGCs were described. These techniques can be classified into two groups. Also, we examined ongoing improvements in new computational ways for distinguishing properties of BGCs, and high-throughput techniques for the identification of natural products [14].

The procedure of angiogenesis is very outstanding these days. A few medications and concentrates influencing this procedure are now utilized routinely in supporting the traditional treatment of numerous diseases that are considered angiogenic, for example, cancer. In any case, we should know that the region of as of now utilized medications of this sort is much smaller than the hypothetical potential outcomes existing in therapeutic angiogenesis. Plant substances are an enormous and differing group of compounds that are found normally in fruits, vegetables, flavors, and medicinal plants [15]. They likewise have diverse anticancer properties. Khalid *et al.* [15] displayed the present condition of learning concerning the sub-atomic focuses on tumor angiogenesis and the dynamic substances (polyphenols, alkaloids, phytohormones, starches, and terpenes) got from natural sources, whose action against cancer angiogenesis has been affirmed.

Synthetic preservatives are broadly utilized by the sustenance business to control the development of decay and pathogenic microorganisms and to restrain the procedure of lipid oxidation broadening the time span of usability, quality, and security of food items. Nonetheless, consumer's preference for natural substances incited the food industry to search for natural alternatives. A few spices and some herb concentrates were cancer prevention agents. The antimicrobial/cancer prevention agents of some plant extracts, as well as their essential oils, are some of the major bioactive compounds including natural antioxidants. Many investigations were done on the utilization of common additives in meat and poultry items just as products of the soil to broaden their shelf-life of realistic usability. The advancement of Nutrition substances containing common additives is developing and they're additionally introduced in food [16].

Natural products have been a rich source of medication. Their utilization has been decreased in the previous two decades, to a limited extent on account of specialized obstructions to the examination of nutrition material in high-throughput studies versus molecular targets. Moreover, their utilization has been decreased in the past two decades, in part may be due to technical barriers to the examination of nutrition material in high-throughput screening against molecular targets. The same authors evaluated the utilization of genomic and metabolomic ways to deal with enlarged conventional strategies for researching nutrition substances, and feature ongoing instances of natural products in antimicrobial

medication disclosure and as inhibitors of protein-protein interactions. The developing energy about practical measures and phenotypic screens may further add to a recovery of enthusiasm for natural products for medication discovery<sup>[17]</sup>.

Natural products and their subsidiaries are backbones of our anti-microbial medications; however, they are progressively at risk. The mix of boundless multi-drug resistance in bacterial pathogens, disillusionment with nutrition substances as wellsprings of new medicines, absence of progress utilizing artificial compounds, and objective-based revelation strategies, alongside moving financial and administrative issues, plot to move interest in innovative work away from the anti-infection agents' field. The outcome is a developing emergency in anti-infection tranquilize revelation that compromises present-day drug. 21st-century characteristic item research is consummately situated to fill the anti-microbial disclosure gap and bring new medication possibility to the clinic. Advancements in genomics and strategies to investigate new wellsprings of antimicrobial chemical matter are uncovering new compounds. Evaluation of narrow-spectrum medications combined with engineering science techniques to create new mixes and improve yields offer new procedures to rejuvenate once hopeless normal item programs. In each of these territories, characteristic items offer compound issue, molded by a normal determination that is special in this remedial territory. Normal item research is ready to recapture unmistakable quality in conveying new medications to eliminate the antimicrobial emergency<sup>[18]</sup>.

Microbial natural products have been the greatest effective sources of drugs to treat infectious pathogens, but today, the move out of unmet clinical necessity poses completely novel challenges to the discovery of new candidates with the desired characteristics to be advanced as antibiotics. Meanwhile, smaller biotechnology companies and research organizations are taking over the lead in the discovery of novel antibacterials. New strategies to isolate new uncultivable species, and artificial biology is developed from genome mining of microbial strains for cryptic biosynthetic pathways in association with high-throughput sequencing platforms, integrated bioinformatic analysis, and on-site analytical detection and dereplication tools for new compounds. These various innovative approaches are setting the bases for the future discovery of new chemical scaffolds that should encourage a renovated interest in the consistency of new classes of natural antibiotics from the microbial world<sup>[19]</sup>.

### Gum Arabic

Gum Arabic is widely utilized as a food additive; however, there is no administrative or logical agreement about its calorific worth. It is an intricate polysaccharide, basically toxic to both humans and animals, not degraded in the digestive system, yet fermented in the colon affected by microorganisms. Notwithstanding, in the scope of animal studies, there is no usable information for humans, which can

measure the utilizable energy of Gum Arabic. After specific remittances are made for the vitality misfortunes from gaseous fermentation products, an upper degree of 2 kcal/g for rodents has been set. The circumstance in man is obviously extraordinary, with enormously diminished measures of such products, and the need to adjust for differing periods before Gum Arabic is assaulted by colonic microbes. Without a concurred logical task, the FDA in the USA demands 4 kcal/g in the nutritional labeling, while in Europe, no value has been appointed to soluble dietary fiber, like Gum Arabic<sup>[20]</sup>.

Gum Arabic is one of the treatments against the development of tumors following cancerogenesis. The impacts of GA therapy on plasma phosphate concentration, circulatory strain, and proteinuria may demonstrate gainful in interminable kidney disappointment and diabetic kidney failure. The impact of GA on intestinal glucose transport might be valuable in the prophylaxis and therapy of corpulence and diabetes; the impact of GA on angiogenin and  $\beta$ -catenin articulation may be abused for the prophylaxis versus colon carcinoma; the impacts of GA on angiogenin expression and dendritic cells might help in the therapy of inflammatory pathogenesis and malaria<sup>[21]</sup>.

### Gum Arabic as a nanomaterial

Gamal-Eldeen *et al.*<sup>[22]</sup> have widely assessed the physicochemical properties of gum Arabic-encapsulated gold nanoparticles and detailed their viability in ceasing the tumor initiation by means of repressing the pre-neoplastic injuries in the liver. They researched the cytotoxicity of GA-AuNPs on A549 cells and afterward analyzed their apoptotic, lipid peroxidation, and ant-neovascular impact in vivo model utilizing a chemically-prompted lung cancer in mice.

Horst *et al.*<sup>[23]</sup> utilized two blend strategies; first utilizing the strong biopolymer in the co-precipitation media, and second, utilizing a fluid arrangement of the polysaccharide. The deliberate estimations of hydrodynamic diameters by the unique light scattering, in aqueous dispersions, were around 70-80nm, while sizes lower than 20nm were enrolled by TEM microscopy. A surface charge of gum Arabic covered attractive nanoparticles was essentially not the same as the crude materials (magnetite and GA). Magnetocalorimetric estimations were performed in a wide scope of field adequacy and recurrence. These outcomes exhibit their practicality to be connected to tumor removal medications<sup>[23]</sup>.

Kong *et al.*<sup>[24]</sup> announced that selenium nanocomposites (SeNPs) can be settled in gum Arabic aqueous solutions for roughly 30 days. FTIR results demonstrated that SeNPs were joined to the hydroxyl groups of GA. In their examination, these authors arranged soluble base hydrolyzed GA (AHGA) and its effectiveness in balancing out SeNPs and contrasted them and GA. They presumed that the stretched structure of GA was a critical factor for its usefulness. The hydroxyl radical rummaging capacity and DPPH scavenging capacity of GA-SeNPs were higher than those of AHGA-SeNPs.

Gum Arabic was exposed to periodate oxidation to acquire Gum Arabic Aldehyde (GAA). Cross-connecting happens because of Schiff's base response among aldehyde gatherings and amino groups of gelatine for oxidized gum Arabic. The platform arranged from the hydrogel was portrayed by swelling characteristics, level of cross-connecting, in vitro degradation, and scanning electron microscopy (SEM). Cytocompatibility assessment utilizing L-929 and HepG2 cells affirmed the non-cytotoxic and non-follower nature of the platform. These characteristics are basic for creating multicellular spheroids and thus the platform is proposed to be a reasonable possibility for spheroid cell culture [25].

Gum Arabic (GA) is a biomaterial utilized for adjustment of medication delivery. GA microspheres were made by coprecipitation technique and described by XRD, FESEM, <sup>1</sup>H NMR, FTIR, UV spectra, and DLS. In spite of its potential against cancer growth, the solvency of curcumin is low rendering its point of confinement in the application. Gum Arabic microspheres were utilized where curcumin can be stacked so easily and in this way expand its bioavailability. The cytotoxicity of GA microspheres was assessed on triple-negative breast cancer cell lines. The results showed it incite apoptosis by irritating the mitochondrial film possibility. The in-vivo study in BALB/C mice model showed more tumor relapse if there was an occurrence of folic acid focused on curcumin embodied GA microsphere. These microspheres can be a compelling helpful operator to folate receptors overcommunicating cancer cells [26].

Notwithstanding the broad uses of tree gums in nourishment, there are significant non-sustenance uses of these industrial gums, which have increased boundless consideration because of their accessibility, auxiliary decent variety, and noteworthy characteristics as 'green' bio-based inexhaustible materials. Tree gums are reachable as normal polysaccharides from different tree genera having uncommon characteristics, with renewable, biocompatible, biodegradable, and non-harmful nature and their capacity to experience simple synthetic alterations. Tree gums were utilized for the greener blend and adjustment of metal/metal oxide NPs, creation of electrospun filaments, natural bioremediation, biocatalysis, biosensors, coordination edifices of metal-hydrogels, and for antimicrobial and biomedical applications [27].

Gum Arabic (GA) contained a complex polysaccharide, either neutral or somewhat acidic, found as blended calcium, magnesium, and potassium salt of a polysaccharide acid. Moreover, the core consisted of 1,3-connected beta-D-galactopyranosyl units. The side chains are made of two to five 1,3-connected beta-D-galactopyranosyl units, joined to the fundamental chain by 1,6-linkages. Pharmacologically, GA has been known as an antioxidant, protects against trial hepatic, renal and heart toxicities in rats. GA ingestion can lessen plasma cholesterol fixations in rats. GA has genius absorptive characteristics and it could be utilized in diarrhea. It upgrades dental re-mineralization, and has some antimicrobial effects, recommending a conceivable use in

dentistry. GA can affect electrolyte equalization and vitamin D in mice, and to cause excessive sensitivity in humans [28].

Nasir *et al.* [29] studied the impacts of Gum Arabic (GA), on intestinal glucose transport and body weight in wild-type C57Bl/6 mice. Oral treatment with GA (100 g/l) in drinking water for about a month did not influence intestinal SGLT1 transcript levels, yet diminished SGLT1 protein levels in jejunal brush outskirt layer vesicles. It was revealed that GA therapy diminished electrogenic glucose transport. Taken orally for about a month, a 20% glucose solution developed obesity and fasting plasma glucose issues, which was fundamentally decreased by synchronous therapy with GA. GA decreased obesity, fasting plasma glucose, and fasting insulin concentrations during a high-fat routine. These remarks showed a totally novel impact of gum Arabic, for example, its capacity to diminish intestinal SGLT1 expression and activity and glucose-actuated overweight.

### Antimicrobial activity of gum Arabic

Daffalla [30] studied the phytochemical properties of gum Arabic of *Acacia Senegal* (GA). The phytochemical examination revealed that the GA consists of a great number of saponins and alkaloids, some cardiac glycosides, and a few quantities of tannins. The author investigated the bioactive compound from GA aqueous extract as antimicrobial and mosquito larvicides. This result showed that GA extracts prevented antimicrobial activity versus the experiment organisms with various zones of inhibition between from 0 to 18 mm. The results showed that the crude extract of GA contained essential biomolecules which had an antimicrobial activity.

The antimicrobial activity of extracts of *Acacia Senegal* and *Acacia Seyal* as prebiotics (Al Manna and Tayebat) were assayed against twelve gram-positive and gram-negative bacteria namely *S. aureus*, *S. epidermidis*, *St. pneumoniae*, *Ps. aeruginosa*, *Proteus merabilis*, *Acinetobacter*, *Enterobacter*, *Klebsiella pneumoniae*, *Serratia* spp., *E. coli*, *Salmonella typhi*, and *C. albicans* using agar well diffusion method. The aqueous extract was able to offer antimicrobial activity. The greatest antimicrobial activity of Tayebat was reported with a zone of inhibition of 20 mm and Al Manna with a zone of inhibition of 10 and 20 for different microorganisms. Prebiotic (Al Manna and Tayebat) could be utilized as a source of antimicrobial factors to treat different medical cases [31].

Shehu *et al.* [32] studied the antibacterial action of Kaolin, Gum Arabic and combined nanocomposite on *E. coli* and *Pseudomonas aeruginosa* by agar well diffusion strategy. The antibacterial activity of Gum Arabic concentrate on *E. coli* was observed to be 29mm, 18m, and 12 mm at 100, 50 and 25µg/L concentrations, respectively. Additionally, the antibacterial activity of the Kaolin/Gum Arabic nanocomposite at the same concentrations was observed to be 27mm, 15mm, and 9mm respectively.

The antimicrobial activity results demonstrated considerable growth inhibition by in vitro shoot concentrate of *A. Senegal* followed by in vivo leaf concentrate and callus extract. The altogether most extreme restraint zone (23 mm) was accomplished by in vitro shoot extract at 50 mg mL<sup>-1</sup> against *Escherichia coli*. The fundamental antimicrobial screening of *A. Senegal* concentrates indicated variable effects relying upon the concentrate source [33].

Al Alawi [34] studied the antimicrobial and cytotoxic activities of various extremity natural concentrates of Omani and Sudanese Gum acacia latex utilizing a maceration technique. The two Omani and Sudanese Gum acacia latex tests were utilized to obtain various portions utilizing different natural solvents. They studied the antimicrobial effect of various natural concentrates through plate dispersion technique against clinically disengaged bacterial strains. Both latex tests of extracts with different concentrations demonstrated antimicrobial activity against the pathogenic human bacterial strains with a restraint scope of 0–15 mm. The organic concentrates from the two sorts of Gum acacia represent a decent source of common anti-microbia for the treatment of different infectious diseases.

### Anticancer activity of gum Arabic

A few reports demonstrated that expanded colorectal cancer pervasiveness was related to low fiber diets utilization [35]. Also, Ganta *et al.* [36] reported that nanoparticles were in organic liquids for seven days.

The treatment with GA for 4 days fundamentally decreased the colonic mRNA levels of the angiogenetic factors. The Western blotting results revealed that GA therapy diminished angiogenin protein expression. Besides, using immunohistochemistry, GA diminished ss-catenin expression. The treatment of the mice with cancerogenic compounds produced numerous colonic tumors in 12 weeks. Nonetheless, the treatment with GA (10% wt/wt) with drinking water decreased the number of tumors by 70% [37].

The researches revealed an anticarcinogenic impact of GA. The mechanism of activity during which GA changes cancer growth-concerning gene expressions is yet unknown. More examinations are needed to know the method of activity [37].

Ongoing investigations demonstrated that Arabic gum can treat the poisonous appearances of some basic medications, for example, indomethacin, aspirin, acetaminophen, and gentamicin just as some chemotherapeutic medications, for example, cyclophosphamide, doxorubicin, and cisplatin other than its intense prophylactic effect in certain chemicals toxicity cases, for example, trichloroacetic acid, paraquat, and mercuric chloride [38]. Consistently and with the research advancement, the defensive impact of Arabic gum demonstrates its adequacy in averting the dangers of numerous chemical compounds lethality. Mercury and its various structures are viewed as unsafe ecological and industrial toxicants that cause serious changes in the human

body tissues wherein it aggregates predominantly in the kidneys, prompting intense renal failure, diminish glutathione levels, and increases the reactive oxygen species levels, for example, superoxide radicals and hydrogen peroxide. In this specific situation, Gado and Aldahmash [39] demonstrated a successful cytoprotective effect of Arabic gum in regulating the nephrotoxicity of mercuric chloride using its fitness to keep up the activity of antioxidant enzymes in the renal tissues related with a decrease in the oxidative stress that is delivered by the harmful impact of mercuric chloride.

### CONCLUSION

From the present review article, the following results were concluded that Gum Arabic is a powerful antimicrobial and anticancer tool. The antimicrobial activities of two products *Acacia Senegal* and *Acacia Seyal* as prebiotic extracts were found against twelve gram-positive and gram-negative bacteria namely *S. aureus*, *S. epidermidis*, *St. pneumoniae*, *Ps. aeruginosa*, *Proteus mirabilis*, *Acinetobacter*, *Enterobacter*, *Klebsiella pneumoniae*, *Serratia* spp., *E. coli*, *Salmonella typhi*, and *C. albicans*. Also, the Gum Arabic and the Kaolin/Gum Arabic nanocomposite were demonstrated to be powerful antibacterial tools for both *Escherichia coli* and *Pseudomonas aeruginosa* bacteria. The antibacterial effects of nanocomposites of the gum Arabic extract were great at different concentrations (100µL, 50µL, and 25µL) against *Pseudomonas aeruginosa* and *E. coli*. Whereas the inhibition zone of *Pseudomonas aeruginosa* and *Escherichia coli* using Kaolin/Gum Arabic nanocomposites was found to be the lowest at the same concentrations.

GA treatment adjusts in colonic tissue the transcript levels of various genes recognized to be essential for cell proliferation and/or tumor growth. Moreover, GA therapy lowers the protein abundance of β-catenin, a potent oncogene in colonic tumors. The changed expression of these and more genes could be driving to the prevention of tumor growth through GA therapy. The statement for the capacity to influence gum Arabic on tumor growth may be caused by fermenting gum Arabic under the impact of microorganisms in the colon to short-chain fatty acids, which may counteract inflammation and tumor growth. Furthermore, short-chain fatty acids have been observed to affect oncogenes' expression.

In summary, we conclude that the Gum Arabic, a natural proteoglycan with known uses in the pharmaceutical and food industry is a natural protective agent as an antimicrobial and anticancer.

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