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Review Article

Antimicrobial Activity of Natural Edible Gums

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ABSTRACT

Edible gums are tears or flakes of dried sap (exudates) of many (mostly thorny) trees and shrubs either after natural or manmade injuries to wooden stem and branches. They are ionic, natural, complex polymers of glycopeptides containing several other compounds and mineral salts. Many of the gums are edible specifically those obtained from trees/ shrubs of Fabaceae family including *Acacia, Sterculia, Astragalus, Balanites, Buchnania* and *Anogeissus* species. Gums have been used since centuries for their nutritional, culinary and therapeutic properties in food, pharmacy and refining industries. In recent past gums have became very important starting material for green synthesis of nanomaterials including metallic (silver, copper, palladium etc.) nanoparticles and nanotubes due to their reductant and stabilizer activity. Their biogenic synthesis utility is mainly interesting due to their biodegradability, nontoxic, non-mutagenic nature, natural availability, higher resistance to microbial attacks and long shelf-life. Many of the gums are known to alleviate infections like diarrhoea, dysentery, sore-throat, kidney, wound and gum infections. However, only scattered reports are in literature evaluating their antimicrobial potential leading to underestimation and sometime over expectations from gums and gum-products in therapeutics. This short review is for understanding the available information on edible gums as herbal antimicrobial agents.

Key words: Gondh, Gond, Antibacterial, Anti-diarrhoeal, Green synthesis, Nanoparticles, Gum Arabic, Gum Ghatti, Gum Tragacanth, Gum Karaya.

INTRODUCTION

Most of the edibles gum from trees are actually exudates gums and made of sugar polymers. Natural gums often known as Gond, Goond, Dinka, Gaund or Gondh are polysaccharides of plant origin recommended for benefits in pregnancy and after delivery to strengthens back bone. They are water soluble and produce gel like viscous solutions and for this quality have utility in food industry as thickening, gelling, emulsifying and stabilizing agents [1]. For their utility as adhesives, binding agents, crystan inhibitors, clarifying agents, encapsulating agents, flocculating agents, swelling agents and foam stabilizers etc. natural gums have applications in many industries including vineyards as refining agents [2]. Chemical composition of gum varies greatly depending on plant species, agro climatic conditions and time of harvest [3]. Gums are complex mixture of glycoproteins and polysacchari des and natural source of arabinose and ribose. Arabinogalactan, major constituent of gum arabic and other edible gums is a polymer of arabinose and galactose linked to protein moiety forming gycopeptides. Gums are slightly acidic in nature due to 8-5' non cyclic diferulic acid covalently linked to carbohydrate arm of arabinogalactan-protein [4] and are referred as polyelectrolytes (ionic polymers).

The most widely used edible gum is gum arabic, dried sap (exudates) of *Acacia* spp. trees and is also known as acacia gum, chaar gund, char goond, or meska [5, 6]. It is mostly obtained from trees of two *Acacia* species viz., *A. senegal* and *A. seyal*. Besides, gum ghatti (from *Anogeissus* trees), gum tragacanth (from *Astragalus* shrubs, gond katira), karaya gum (from *Sterculia* trees), gum babul (from *Acacia nilotica*), gum chironji (from *Buchnania lanzan* trees), and gums from *Balanites aegyptica* and *Prosopis julifora* are also edible gums and available in market [7].

Gums are used since ages for their nutritional, culinary and therapeutic values throughout the

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world. Among the common edible gums in India, gums obtained from *Acacia nilotica* (Babul), *Buchnania lanzan* (Chironji), *Sterculia* (Karaya), *Anogeissus latifolia*, *Balanites aegyptica* and *Prosopis julifora* [5] are in commonplace [7] and have different utilities in food, pharma and other industries.

Gum Arabic: The most commonly available and most used edible gum all over the globe has multiple uses. *Acacia* gum (gum Arabic) contains chiefly arabin, mixture of calcium, magnesium and potassium salts of arabic acid and also contains enzymes like oxidases, peroxidases and pectinases [8]. Gum arabic is water soluble and can be used as decoctum and syrup in therapeutic uses. In therapeutics gum arabic is known to be beneficial in kidney diseases [5] and is known for its analgesic, astringent, emollient, liver tonic, antipyretic and anti-asthmatic properties [6, 9]. It has been claimed to act as an anti-oxidant, and protects in experimental hepatic, renal and cardiac toxicities in rats [6, 10]. Gum acacia has been used for cure of diarrhoea, dysentery and diabetes [6, 10]. It is used in diarrhoea, dysentery and diabetes, dry cough in amoebic dysentery, as a tonic, anti-asthmatic, analgesic and in oral cavity lesions.

Antimicrobial activity of *Acacia* is reported to be concentrated either in leaves or bark and their extracts have been reported inhibitory against *Streptococcus viridans*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* Typhi, *Bacillus subtilis, B. creus, Shigella sonnei* and even against *Candida albicans, C. glabrata* and *Aspergillus niger* and *Rhizoctonia solani* [9, 11-15]. The antimicrobial activity has been chiefly detected in methanolic extracts rather than in aqueous extract [14]. Even the leaf extract was found active against strains of *Serratia marcescens*, *Erwinia herbicola*, *Xanthomonas* sp. *Arthrobactor chlorophenolicus* and fungal strains of *Botrytis cineria*, *Fusarium oxysporum*, *A. flavus* [14]. Antimicrobial activity was detected in ethanolic extract but not in chloroform, benzene, ether or aqueous extracts [15]. Flavonoids and alkaloids from leaves of *Acacia nilotica* inhibited *S. aureus, B. subtilis, E. coli* and *S.* Typhi, but not inhibited *P. aeruginosa* and *K. pneumoniae*. For sensitive strains, it had minimum inhibitory concentration (MIC) of 0.125 to 1mg/ ml [16]. Besides, saponins of *Acacia* spp. inhibit *P. aeruginosa* and polysaccharides inhibit *S. aureus* and *B. subtilis* [16].

Though antimicrobial activity of gum acacia (gum arabic) is rarely reported [17, 18] it has been successfully used as carrier of other antimicrobial herbal preparations (garlic extract or cinnamon) to form an antimicrobial coating on foods [19]. Besides, metal arabates (mercury, silver and copper) prepared using arabic acid of gum acacia have potent antimicrobial activity against *E. coli, B. subtilis, B. anthracis, B. pumilus, S.* Typhi, *S. aureus, Streptococcus pyogenes, Proteus vulgaris* and A. *niger*, *A. flavus, Trichophyton equingia, Fusarium oxysporum* and *Cryptococcus neoformans* [20]. Alcoholic extract of gum Arabic from *A. nilotica* has rare report for antimicrobial potential but from *Acacia senegal*, *Acacia seyal* aqueous extracts is active against S. *aureus, S. epidermidis*, *St. pneumoniae*, *P. aeroginosa*, *Proteus merabilis*, *Acinetobacter*, *Enterobacter*, *Klebsiella pneumoniae*, *Serratia* spp., *E. coli*, *Salmonella* Typhi and *C. albicans* in agar well diffusion method [17, 21]. Alcoholic extract of gum *Acacia nilotica* has been shown to inhibit *E. coli, B. cereus* and *Cerospora pongamae* but not inhibited *A. niger* which could be inhibited by its hot water extract [18].

Gum Chironji: Chironji (*Buchnania lanzan*) gum is light brown or golden coloured amorphous solid. It is known for its several therapeutic uses in Unani and Ayurvedic medicine as analgesic (nerve soothing), anti-rheumatic and antidiarrhoeic agent [7].

Similar to *Acacia*, chironji leaves are known to contain antimicrobial activity [22]. Chironji leaves contain saponins, flavanoids, steroids, cardiac glycosides, carbohydrate, tannins and phenolics. Its alcoholic extract has the maximum activity and minimum activity is detected in aqueous extract. Its extract can inhibit *E. coli, P. aeruginosa* and *S. aureus*, *A. niger* and *Penicillium* sp. [22]. Among ethanol and methanol, latter has been found to extract better antimicrobial activity of chironji leaves and extract could inhibit *E. coli*, *S.* Typhi, *S. aureus* and *B. subtilis* [23]. Only little antimicrobial activity is reported in petroleum ether, chloroform and water extracts of *B. lanzan* leaves [22, 23]. There is hardly any reference to antimicrobial activity in gum chironji [7]. Gum chironji is reported beneficial in intercostals' pain and diarrhoea. But more commonly used for adulteration of guggul (oleoresin from *Commiphora wightii*) by adding some perfume/ scent [7].

Gum Tragacanth: Obtained from *Astragalus* shrubs and is commonly known as gond katira. The *Astragalus* shrubs, known as locoweeds are native to arid regions of the eastern Mediterranean and South Western Asia [24]. The common gum producing species are *A. gummifer, A. adscendens* and *A. microcephalus*. The name "tragacanth" has origin from ribbon shape of exuded gum, similar to goat horn ("tragos"

meaning goat and "akantha" meaning horn) in morphology. Tragacanth gum has been used as laxative, antitussive, anti-diarrhoeic, and as an aphrodisiac. It is used as an adhesive agent in making pills and tablets, as an emulsifying agent in lotions, creams and pastes and as a thickener in cosmetics, toothpastes, jellies, salad dressings, syrups, mayonnaise, sauces, liqueurs, candy, ice cream and popsicles [24].

Antimicrobial activity of ethanolic extract of gum acacia, gum tragacanth and guar gum has been detected against *St. pneumoniae, S. aureus, E. coli, K. pneumoniae* and *P. aeruginosa*, and *C. albicans* [25]. Tragacanth gum extract had significantly higher antimicrobial activity than other gum extracts [25]. Gum tragacanth, similar to Karaya and Ghatti gums, is not generally considered to have any significant antimicrobial activity but has been used as an ideal material for green synthesis of nanoparticles and nano-fiber scaffolds having application in infection control due to their broad spectrum antimicrobial activity [26]. Due to biodegradability, nontoxic, non-mutagenic nature, natural availability, higher resistance to microbial attacks and long shelf-life natural gums are ideal materials for nanosynthesis of microcapsules loaded with herbal extracts [27]. Besides, tragacanth gum fed at a level of 3% along with 3% cholesterol in the diet of cockerels inhibited the development of hypercholesterolemia [28]. Instead of getting inhibited some of the potential pathogens including species of *Klebsiella, Serratia,* and *Yersinia* ferment tragacanth gum indicating its rapid biodegradability in intestine [29].

***Gum Balanites aegyptiaca* (Hingot Gum)**: *Balanites aegyptiaca* (L), soapberry tree or thorn tree or desert date occurs throughout dry and hot regions of Africa and parts of Middle East including India and is known as Hingot tree [30]. The different parts of the plant have utility in therapy of bacterial infections, viral fever and parasitic infestations. It has been used as an antidote for arrow poison and snake venom [30]. Antibacterial and antimycotic activity has been reported in *B. aegyptiaca* leaves, bark and fruit mesocarps [31-34]. Antimicrobial ingredients could be extracted in more concentrated form in aqueous extract than in alcoholic extracts [31]. However, in some studies [35] growth inhibition of metallo-B-lactmase producing *E. coli, Klebsiella* spp. and *Citrobacter* spp. was observed both in alcoholic and aqueous extracts of fruit mesocarp of *B. aegyptiaca.* However, very little is understood about edible gum of *B. aegyptiaca* or its antimicrobial activity. Gum mixed with maize meal porridge has been reported useful in treatment of chest complaints [36].

Kikar Gum: It is dried wooden sap of *Prosopis julifera* (Vilayati kikar) plant. The exudates gum of *P. juliflora* is odourless with little taste. It is a non-crystalline water soluble substance but insoluble in alcohol or ether [37]. It has been used to treat eye infections [37]. Though gum has rarely been studied for its antimicrobial activity, the bark of the tree (source of gum) has been shown to possess antimicrobial activity against *E. coli, Proteus mirabilis, P. aeruginosa, K. pneumoniae, S.* Paratyphi B, *Shigella flexneri, St. pyogenes* and *S. aureus* in its methonolic extract due to alkaloids in it, the MIC of bark extract was determined in range of 4.6 to 7.5 mg/ ml [38]. Hot and cold aqueous extracts of *P. juliflora* leaves is reported as a potent antibacterial at 100 mg/ml concentration against *B. subtilis, E. coli, E. faecalis, K. pneumoniae, P. aeruginosa, S. aureus, S. epidermidis, St. pyogenes, S.* Typhi and *S.* Typhimurium [39].

Gum Ghatti (Indian Gum, Ghatti Gum): It is a water-soluble complex proteinaceous polysaccharide bark exuded of *Anogeissus latifolia* tree found in dry-deciduous forests of India and Shri Lanka. It is glossy and amorphous, found in rounded tears or in vermiform masses of off white to dark brown colour [40]. It is rich in calcium and magnesium and on hydrolysis produces arabinose, galactose, mannose, xylose and glucuronic acid. It is soluble in water; 1 g in 5 ml water forms viscous adhesive mucilage. It is an alternative hydrocolloid approved for the food industry as a thickener and emulsifying agent [40]. It is also used as an emulsifier and stabilizer in beverages, table syrups, petroleum and in non-petroleum waxes to form liquid and wax paste emulsions and flavor fixative [41]. It is mainly used as thickening agent and stabilizer and is a promising polysaccharide for pharmaceutical purposes [41]. Recently it has been used to formulate responsive hydrogels [42]. Though gum ghatti has no antimicrobial activity it has been used for green (biogenic) production of silver nanoparticles with wide spectrum antimicrobial potential [43]. Gum ghatti has been exploited for its dual functional reductant and stabilizer activity for the synthesis of nanoparticles [43]. Gum ghatti imparted better antibacterial activity to silver nanoparticles synthesized with it (Ag NP-GT) than that could be produced with gum olibanum [43]. It has also been used for biogenic synthesis (green synthesis) of palladium nanoparticles having possible application as nanocatalyst in environmental remediation [44].

Gum Karaya: It is from *Sterculia urens* tree and is traditionally tapped by scarring the bark in trunk or at the base of the trunk with an axe. Ethaphon, a plant growth hormone has been reported useful in stimulating gum production without causing any

harm to plant health [45]. It is a partially acylated polysaccharide made of galacturonic acid, beta-D-galactose, glucuronic acid, L-rhamnose [46-48]. Karaya gum is one of the least soluble gums but it rapidly absorbs water (up to 100 times of its weight) to swell and forms viscous colloidal solutions [47]. At 1% concentration in water it forms a colloidal solution while at 4% a thick gel/ paste. Unlike other gums, karaya gum is soluble in 60% alcohol, but insoluble in other organic solvents [47].

Karaya gum has many pharmaceutical uses as an adhesive for dental fixtures and ostomyo-equipment, and as a base for salicylic acid patches [49, 50], corrective for blood sugar and plasma lipid levels [51]. Its demulcent properties make it an important ingredient of lozenges used to relieve sore throat [48]. Due to its bulk forming ability it acts as laxative. It is also boasted for its aphrodisiac powers. Though antibacterial activity of Karaya gum is not reported, it has been reported to reduce bacterial adhesion by 98% when applied as protective coating to dentures [52].

Similar to gum tragacanth, and ghatti gum, karaya gum has potential for biogenic synthesis of silver [53] and copper [54] nanoparticles which possess useful antimicrobial activity against *E. coli*, *S. aureus* and *Micrococcus luteus* strains and have several potential therapeutic and pharmaceutical applications.

Conclusion: Plant gums have been consumed all over the world since centuries for their nutritional, culinary and therapeutic properties. Except a few examples, gums are usually not important as herbal antimicrobial agents, but have several therapeutic (tonic, anti-diarrhoeic, laxative, immune-stimulant, strength providers), industrial (thickeners, refining agents) and pharmaceutical (excipient, adhesives, binders) uses. Recent use of gums in green synthesis of nanomaterials from silver, copper and palladium etc., has paved the way to their utility in synthesis of antimicrobial nanomaterials and casings.

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