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Review Article

Medical Implications of Gum Arabic

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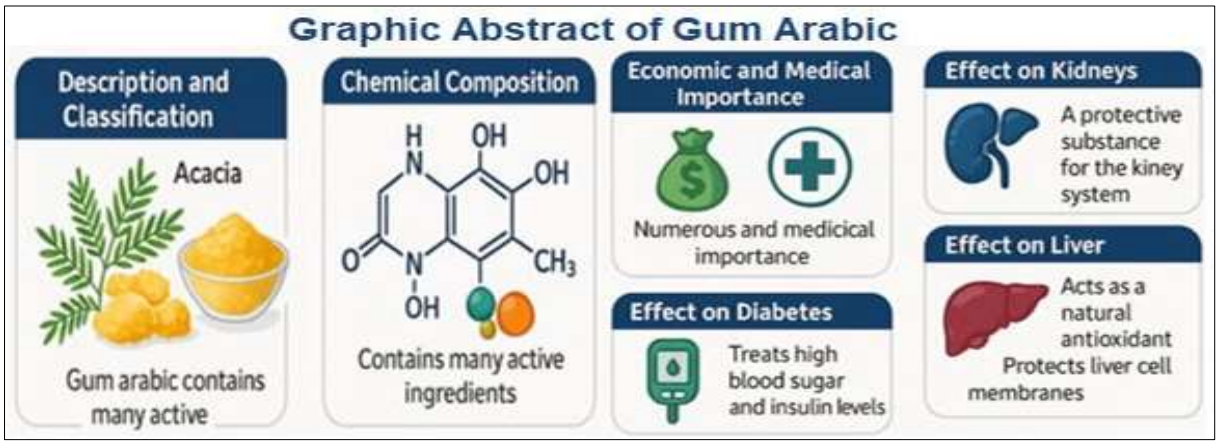
Abstract: When conventional medical interventions fail to adequately address chronic illnesses, numerous individuals resort to alternative remedies. Included among these treatments are herbal medications, which may have a role in the prevalent and popular use of nutritional supplement-based therapies. This review sought to examine the description and classification of the gum arabic plant, its chemical makeup, its economic and medicinal significance, and its impact on the kidneys, liver, and diabetes. Gum arabic comprises several active constituents and offers multiple economic and medicinal advantages, serving as a protective agent for the renal system. Gum arabic functions as a natural antioxidant, crucially suppressing free radicals and mitigating the impact of reactive oxygen species, so safeguarding liver cell membranes from oxidative damage. Gum arabic also addresses elevated blood sugar and insulin levels, rendering it a possible therapeutic agent for diabetes. We ascertain that gum arabic has numerous active constituents and offers economic and medicinal advantages, playing a significant role in the management of renal and liver dysfunctions as well as diabetes.



Keywords: Gum Arabic, Medical and Economic Importance, Kidneys, Liver, Diabetes.

INTRODUCTION

Pharmaceuticals are insufficient in addressing various conditions, leading individuals to pursue alternative therapies, including complementary and alternative medicine, to restore health (Ahmed *et al*., 2020; Ahmed *et al*., 2023; Hasan *et al*., 2025). Vascular plants possess a remarkable capacity to eliminate dangerous levels of diverse contaminants due to their effective physiological mechanisms that mitigate the harmful effects of accumulated toxins in their tissues (Hanus-Fajerska *et al*., 2021). Consequently, gum arabic is a natural exudate derived from the stems and branches of plants. This significant commercial compound consists of polysaccharides and has been utilized for a minimum of 4,000 years. It comprises phenols, flavonoids, carotenoids, and salts of calcium, magnesium, and potassium. Gum arabic is utilized in

traditional medicine to address renal issues in individuals with chronic renal insufficiency (Khalid *et al*., 2021; Malabadi *et al*., 2021). Moreover, gum arabic has demonstrated the ability to diminish nitrogen excretion in urine by enhancing urea excretion and lowering its concentration in the blood serum of both mice and humans. It is also utilized in the treatment of intestinal mucosal inflammation and serves as an external application for inflamed regions. Furthermore, it is utilized throughout several industrial sectors, including food, pharmaceuticals, and textiles (Ali *et al*., 2021). There exists a significant discrepancy in research concerning the preventive and antioxidant properties of gum arabic. Various components of edible plants, alongside naturally occurring plant antioxidants, have been utilized to inhibit oxidation and mitigate the proliferation of numerous diseases arising from an imbalance in the oxidative-antioxidative equilibrium inside the body, culminating in oxidative damage. Plant extracts are distinguished by their safer and more moderate impact on bodily health in comparison to chemically manufactured pharmaceuticals (Sief *et al*., 2020).

Gum arabic serves as an antioxidant and a crucial cellular protective agent, demonstrating efficacy against experimental nephrotoxicity in murine models (Al-Jubori *et al*., 2023). The amino acids tyrosine, histidine, and methionine enhance the antioxidant capacity of gum arabic against reactive oxygen species (ROS), while gum arabic also contains vitamin E (α-tocopherol), an effective antioxidant that inhibits lipid peroxidation (Ahmed *et al*., 2022; Aljaff *et al*., 2023). Besides its antioxidant properties, gum arabic exhibits protective effects in various clinical conditions associated with heightened lipid peroxidation and tissue damage. It plays a crucial role in safeguarding the liver, kidneys, heart, and blood vessels. Furthermore, gum arabic comprises zinc and manganese, both of which are essential for the synthesis of GSH and SOD, particularly zinc, which safeguards the sulfur sulfhydryl group of glutathione (Prasad *et al*., 2022). Glucuronic acid, present in gum arabic and regarded as a highly efficient compound (Chai *et al*., 2021), regulates cytokines such as tumor necrosis factor alpha (TNF-α), restoring them to their normal levels (Hussein, 2023). This review sought to investigate the protective function of gum arabic (Gum acacia) in safeguarding the body's organs and to identify alternatives to chemical medications that adversely affect essential organs and bodily functions, utilizing natural components devoid of side effects.

Description and Classification of the Arabic Gum Plant

The gum arabic tree displays variety in size, shape, and the types of active chemicals extracted, due to varying climatic and environmental conditions. It necessitates specific climatic and environmental conditions characterized by high relative humidity, increased temperatures, and areas with rocky, calcareous soil. Its development is more pronounced in gravelly soil than in clay soil, especially on mountain slopes and in valley bottoms. The tree requires eight to ten years from germination to yield fruit and grows rapidly when situated away from areas with seasonal precipitation. It measures between three and five meters in height, featuring numerous branches and dark green leaves. It possesses a singular trunk or basal branches, including gum glands that develop in tiny clusters and exude gum resin. Paper scales originate from the process of bark separation from trees. It possesses short, slender, and robust branches. The tree's leaves are gathered at the branch tips. The blooms are clustered at the branch terminals, and the leaves are compound (Ilu *et al*., 2020).

The common name is: Arabic Gum and the scientific name is: Acacia Senegal, and it is scientifically classified under the following ranks:
Kingdom: Plantae
Subkingdom: Tracheobionta (Vascular plants)
Division: Magnoliophyta (Flowering plants)
Class: Magnoliopyta (Dicotyledons)
Subclass: Rosidae
Order: Fabales
Family: Fabaceae
Genus: Acacia
Species: *Senegal (L.) Willd* (Satti *et al*., 2020)

The Chemical Composition of Arabic Gum

The chemical makeup of gum arabic is intricate, characterized by a branching chain structure comprising several sugar compounds that are either neutral or somewhat acidic. The principal chain column comprises 1-3 units linked to B-D galactopyranosyl, while the side links consist of two to five 3-1 units linked to B-D galactopyranosyl, connecting to the major chain via (1,6 linkages). The core chain and the side chains are composed of α-L-rhamnopyranosyl units. a-L-arabinofuranosyl and 4-O-methyl-β-D-glucuronopyranosyl, as well as β-D-glucuronopyranosyl, the latter two mostly serving as terminal units. Moreover, gum arabic comprises calcium, magnesium, and potassium salts (Koyada and Orsu, 2021).

Active Ingredients of Arabic Gum

Gum arabic comprises numerous active constituents, primarily Phenols, Flavonoids, and Carotenoids (Tkacz *et al*., 2020). Gum arabic consists of 39-42% galactose, 24-27% arabinose, 12-16% rhamnose, and 15-16% glucuronic acid.

Gum arabic comprises 2.6-1.5% protein, 0.39-0.2% nitrogen, and 16.6-12.5% moisture, along with amino acids like hydroxyproline, serine, proline, and aspartic acid (Aloqbi, 2020).

The Economic and Medical Importance of Arabic Gum

Gum arabic, abundant in non-viscous soluble fibers, is a dry, edible emulsion derived from the stems and branches of the Acacia senegal tree (Acacia seyal) (Song *et al*., 2021). Gum arabic serves as a thickening and emulsifying agent with widespread industrial applications in the food sector (for refreshing beverages and confections), as well as in the textile, ceramic, lithographic, cosmetic, and pharmaceutical industries (Barak *et al*., 2020).

Arabic gum is frequently employed as a drug carrier in biochemical and pharmacological studies, however it is presumed to be an inert substance. Recent results indicate that gum arabic functions as an antioxidant and a nephroprotective agent, diminishing both the necessity and frequency of dialysis treatments in patients with chronic kidney failure, along with its further effects (Shakir *et al*., 2022). Arabic gum comprises natural antioxidants, including phenolic chemicals, flavonoids, and carotenoids, which function to suppress free radicals and limit the oxidation of proteins and amino acids, hence diminishing the synthesis of urea and creatinine in the body (Ahmed *et al*., 2021).

A notable correlation exists between gum arabic and blood pressure, as gum arabic can normalize sodium levels in the blood and elevate potassium levels. These two aspects seem to be highly significant in regulating blood pressure, alongside the pronounced influence of arabic gum on minerals, which enhances dietary potassium absorption (Khalid *et al*., 2021). Gum arabic may retard tissue damage progression by mitigating inflammation and oxidative stress (Melo *et al*., 2024). Gum Arabic exhibits reparative properties in certain tissue regions, attributed to its antioxidant constituents, including polyphenols, tannins, and essential minerals such as phosphorus, zinc, manganese, calcium, sodium, and potassium, alongside its significant capacity to modulate cytokines and restore their normal function (Raj *et al*., 2021).

The Impact of Arabic Gum on the Kidneys

Arabic gum serves as a protective agent for the renal system by enhancing the excretion of nitrogen through urine. Research has demonstrated the efficacy of gum arabic in elevating sodium concentrations excreted in urine by regulating the opening and closing of sodium channels, thereby acting as a hypotensive agent and concurrently diminishing inorganic phosphate levels in urine. It also functions to diminish the concentration of 1,25-dihydroxy vitamin D in plasma, so sustaining vitamin D levels in the body and mitigating ailments associated with vitamin D shortage. Gum arabic possesses anti-inflammatory properties in oxidatively stressed kidneys, as evidenced by studies demonstrating its capacity to diminish C-Reactive protein levels and elevate the enzyme Superoxide dismutase (SOD) levels, indicating its efficacy in mitigating inflammation induced by agents such as gentamicin and hydrogen peroxide (Amang *et al*., 2020). Research has demonstrated that gum arabic enhances the production of the pro-fibrotic cytokine transforming growth factor beta-1 (TGF-B1), which facilitates cellular regeneration that mitigates kidney damage. Gum arabic enhances the immune system in oxidatively exposed organs by activating immune cells (Al-Baadani *et al*., 2022).

Gum Arabic enhances nitrogen excretion via feces, which is a beneficial attribute, as it facilitates the elimination of urea and surplus nitrogen through the intestines, thereby alleviating the kidneys' workload in processing these substances. Furthermore, Gum Arabic comprises resinous compounds that aid in the cleansing or removal of nitrogenous toxins from the kidneys (Rojas-Sandoval, 2023). The antioxidant capability of gum arabic can inhibit the generation of superoxide and free radicals that induce oxidative stress to DNA, hence averting cellular instability and atypical mutations, and promoting death (Altawari, 2024). Free radicals are entities comprising unpaired electrons that require additional electrons in their outer shell for stability. Gum Arabic safeguards cellular organelles, including membranes, lipids, proteins, and DNA, from free radicals, reactive oxygen species, and antioxidants like Superoxide (Barbi *et al*., 2024).

The Impact of Arabic Gum on the Liver

Gum arabic functions as an antioxidant and is beneficial in the treatment of various diseases due to its composition of active compounds, including flavonoids, phenols, and carotenoids. These natural antioxidants possess diverse properties, effectively mitigating harmful free radicals and decreasing the proliferation of free radicals that induce oxidative stress. Phenols function as anticoagulants (Abdel-Aty *et al*., 2023).

This elevates the function of gum arabic as an antioxidant both internally and externally, due to its quantities of physiologically active compounds. A study was performed to illustrate its hepatoprotective efficacy in mice subjected to carbon tetrachloride as an oxidative stressor. The study demonstrated a reduction in liver enzyme efficacy, suggesting the preventive capacity of the extract in supplying the body with natural antioxidants derived from the potent phytochemical constituents of phenols, flavonoids, and carotenoids present in gum arabic. These compounds, as natural antioxidants, are essential in suppressing free radical scavengers and mitigating the impact of reactive oxygen species, thereby safeguarding liver cell membranes from oxidative damage (Fareed *et al*., 2022; Melo *et al*., 2024).

The Impact of Arabic Gum on Diabetes

Arabic gum possesses antioxidant properties due to its constituents, including copper, iron, manganese, and zinc, which function as non-enzymatic antioxidants (Rady *et al*., 2023). Alongside components such as a-L-arabinofuranosyl, a-L-rhamnopyranosyl, B-D-glucuronopyranosyl, and O-methyl-B-D-glucuronopyranosyl, these substances address elevated calcium excretion in urine, reduced phosphate and urea concentrations in blood plasma, the regulation of nutrient, sugar, and protein flow in urine, and hypertension (Chen *et al*., 2024).It also addresses the small intestine's capacity to express sodium, regulates the sodium-glucose linked transporter protein SGLT1, and manages elevated blood glucose and insulin levels. All chemicals present in gum arabic were adequate for the treatment of diabetes (Afoakwah *et al*., 2023). It positively influences cell membranes comprised of lipid molecules subjected to oxidative stress by inhibiting lipid peroxidation (Shahin and Aburay, 2023). It also mitigates the risks of hypercholesterolemia and obesity, while diminishing inflammatory cytokines, oxidative stress, reactive oxygen species (ROS), and reactive nitrogen species. It effectively addresses insulin resistance, hence regulating blood glucose levels. Gum Arabic is a compound composed of soluble fibers that can reduce blood sugar levels and modulate fat metabolism in the body (Ahmed *et al*., 2024). Previous research indicate that gum arabic diminishes both the Body Adiposity Index and the Visceral Adiposity Index, hence mitigating the heightened risk of cardiovascular disease (Alshelleh *et al*., 2023).

CONCLUSION

Our review indicates that gum arabic comprises active compounds such as flavonoids, phenols, and carotenoids, and offers economic advantages through its applications in the production of beverages, confections, textiles, ceramics, stone printing, and cosmetics. Furthermore, gum arabic plays a significant role in the pharmaceutical sector as a protective agent for the renal system, aids in maintaining vitamin D levels in the body, and inhibits the formation of free radicals. It safeguards the kidneys by modulating the urine filtration process and preserving nephron composition from oxidative stress, and it protects the liver by diminishing the efficacy of liver enzymes and mitigating the impact of reactive oxygen species. Additionally, it shields the body from diabetes by inhibiting elevations in blood glucose levels and excessive insulin hormone concentrations.

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