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Gum Arabic: Applications in Industries and Benefits for Human Health

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Abstract:

Gum Arabic, a naturally occurring polysaccharide obtained from the exudates of *Acacia senegal* and *Acacia seyal* trees, serves as a widely utilized food hydrocolloid. This comprehensive article focuses on the diverse applications of gum Arabic in various industries and its potential benefits for human health. With its exceptional emulsifying characteristics and minimal solution viscosity, gum Arabic finds significant utility across multiple sectors. Notably, its efficacy in the food industry is highlighted, particularly as a stabilizer and flavour enhancer in citrus oil emulsion concentrates for soft drinks.

Introduction:

Gum Arabic (GA), sourced from *Acacia senegal* and *Acacia seyal*, is a dry, gummy exudate found in the stems and branches of these trees. It is renowned for its high content of non-viscous soluble fiber, making it a valuable asset in various industries, including pharmaceuticals and food. With its emulsifying and stabilizing properties, Gum Arabic is often used as a suspending agent for insoluble drugs, further solidifying its significance in these sectors. The process of collecting Gum Arabic from the lower branches of the acacia tree is presented in Figure 1. Gum Arabic is recognized as a complex polysaccharide, characterized by a branched chain structure that is typically neutral or slightly acidic. It is commonly found in the form of a mixed salt, composed of calcium, magnesium, and potassium, forming a polysaccharidic acid known as Arabic acid. Notably, its protein content, namely in the Arabinogalactan (AG) and Arabinogalactan-Protein Complex (AGP), primarily consists of hydroxyproline, serine, and proline, while GlycoProtein (GP) is rich in aspartic acid. While it is considered indigestible in both humans and animals, its composition comprises high molecular weight, lipoprotein-rich heterogeneous gum polysaccharides it undergoes fermentation by microorganisms in the large intestine, ultimately producing short-chain fatty

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acids, predominantly propionic acid. Although often viewed as an inert substance and frequently used as a drug vehicle in experimental physiological and pharmacological experiments, recent research has suggested that Gum Arabic may possess antioxidant and nephron-protective properties, among other effects.

Fig.1. Collecting of Gum Arabic from low branches of acacia tree

Characteristics of Gum Arabic

Gum Arabic is recognized as a solid substance, displaying hues ranging from pale to orange-brown, with a vitreous texture upon rupture. High-quality Gum Arabic is typically tear-shaped and round, exhibiting an orange-brown shade. When fragmented, the pieces take on a paler appearance. Unlike other vegetable gums, Gum Arabic readily dissolves in water (up to 50%), resulting in a colourless and tasteless solution that exhibits minimal reactivity with other chemical compounds. *Acacia senegal* is a deciduous shrub or tree, typically ranging in height from small to medium, with a maximum height of 15 meters. Its bark exhibits variations in colour, ranging from yellowish-brown to crimson black, and textures that can be either rough or smooth, with a fibrous consistency. In some cases, the bark can be peeled off in strips, while in older trees, it may appear heavily cracked and black. The treetop can present a slightly rounded, flat, and widely spread-out appearance or a more slender and frayed structure with branches of irregular sizes. The branches themselves can be either smooth or textured with small goads in sets of three, positioned just below the knots. These goads often undergo a colour transformation from reddish to black as depicted in Fig.2. *Acacia seyal* is characterized as a moderate-sized tree, with heights reaching up to 17 meters and diameters of around 60 cm. In mature trees, the treetop exhibits a distinctive umbrella shape. The bark appears pale green-gray, while the *seyal* variety often presents a rusty red hue, owing to the presence of a vibrant green powder beneath the surface. Older trees tend to have a bark that is gray-black and

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composed of corrugated layers. In contrast, the bark of the fistula variety is either white or greenish-yellow.

Fig.2. Gum Arabic from *Acacia senegal* tree

Fig.3. Gum Arabic from *Acacia seyal* tree

The branches of *Acacia seyal* are vividly red and produce a yellowish gum, with cracks and crevices forming in the bark due to dryness. Small branches are adorned with numerous reddish glands and auxiliary thorns, typically arranged in pairs. These thorns are slender, straight, pointed, and approximately 7 cm long, with a light gray colour as shown in Fig.3.

Nutritional Composition of Gum Arabic

Property	Range
Moisture content (%)	13-15
Ash content (%)	2-4
Internal Energy (%)	30-39
Volatile matter (%)	51-65
Nitrogen content (%)	0.26-0.39
Fe(ppm)	730-2490
Manganese(ppm)	69-117
Zinc (ppm)	45-11

Applications of Gum Arabic

Exudate gums find extensive applications, predominantly in the food industry, although their utilization extends to various non-food sectors. Gum Arabic, in particular, serves as a stabilizer, thickener, emulsifier, and encapsulating agent in food manufacturing, and to a lesser extent, in domains such as textiles, ceramics, lithography, cosmetics, and pharmaceuticals. Within the food sector, it is particularly employed in confectionery, bakery, dairy, and beverage production, also serving as a microencapsulating agent. Gum Arabic exhibits rapid solubility in both cold and hot water, capable of forming solutions of up to 50% concentration. Its

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compact, branched structure results in a small hydrodynamic volume, leading to solutions characterized by low viscosity. While solutions display Newtonian behaviour at concentrations of up to 40%, they transition to pseudo-plastic at higher concentrations.

Utilization of Gum Arabic in Food Industry

Gum Arabic is widely utilized in the confectionery industry, playing a critical role in various product formulations. It has a long-standing presence in the production of wine gums, contributing to superior transparency compared to other hydrocolloids. It functions as an anti-crystallization agent, regulates flavour release, and prolongs the dissolving process, thereby extending the longevity of wine gums. Moreover, it confers the desired texture, allowing easy malleability without sticking to the teeth. In the context of low-calorie confectionery, Gum Arabic compensates for texture loss resulting from sugar replacement with artificial sweeteners. It serves as a coating agent and stabilizer in chewing gum and acts as a stabilizing agent in aerated confectionery such as marshmallows and nougats. Additionally, it plays an emulsifying role in toffees and caramels, ensuring uniform fat distribution. In jelly products, it enhances the overall texture, creating a fruit-like consistency for superior product quality (Fig.4).

Fig.4. Applications of Gum Arabic in food industry

Gum Arabic finds extensive application as an emulsifier in the production of soft drinks. Its acid-resistance and high solubility make it particularly well-suited for use in the emulsification of citrus and cola flavour oils. Its effective use involves employing high levels of gum to ensure comprehensive coverage of the interface, preventing the aggregation and merging of oil droplets. Typically, the addition of a weighting agent is necessary to increase the density of the oil phase, thereby impeding destabilization caused by creaming. In the context of low-calorie and dietetic beverages, Gum Arabic is increasingly used as a source of soluble fiber. Additionally, it is incorporated into powdered beverage mixes to replicate the opacity, appearance, mouth-feel, and palatability of natural fruit juices.

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Utilization of Gum Arabic in Non-Food Industry

Gum Arabic, formerly a staple in the pharmaceutical industry, has experienced substitution by celluloses and modified starches in various applications. Despite this, it remains in use as a suspending agent, emulsifier, adhesive, and binder in tabletting, as well as in the production of demulcent syrups. Within the cosmetics sector, Gum Arabic serves as a stabilizer in lotions and protective creams, enhancing viscosity, facilitating spreading, and delivering a protective coating and a smooth texture. It finds application as an adhesive agent in blusher and as a foam stabilizer in liquid soaps. Moreover, it plays a significant role in the preparation of etching and plating solutions in the lithography industry. In the field of paints and insecticidal/acaricidal emulsions, it functions as a dispersant, ensuring the uniform distribution of pigments and active components throughout the

Fig.5. Applications of Gum Arabic in non-food industry

product. In the textile industry, Gum Arabic operates as a thickening agent in printing pastes for the colouring of knitted cellulose fabrics. It also finds utilization in ink and pigment manufacture, ceramics, and polishes (Fig.5).

Uses of Gum Arabic

Gum Arabic finds utility in various domestic applications, including ink production, adhesive making, crafts, cosmetics, confectionery, and food production. Locally, it is incorporated in special meals and is utilized as a chewing gum substitute. In terms of human consumption, Gum Arabic is recognized for its dietary benefits, with less than 1 calorie per gram. It has been noted that the Hottentots in southern Africa can subsist for several days solely on gum, while Moorish populations in northern Africa consume a daily portion of 170 grams of gum. Its historical usage in traditional medicine dates back to the pharaonic era, where it was employed as a calming and softening agent. In traditional medicine, it is incorporated into medicinal preparations to alleviate internal ailments such as cough, diarrhoea, dysentery, and

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haemorrhage. Additionally, it is utilized in veterinary medicine to treat skin diseases, diabetes, weight loss and inflammations.

Conclusion:

Gum Arabic, recognized for its non-digestible nature, finds extensive use within the food industry, serving diverse purposes in various food and pharmaceutical applications. It is often employed as an additive or ingredient due to its unique properties and functional characteristics. Its multifaceted role includes applications such as stabilizing, emulsifying, and thickening in a range of food products. Moreover, its ability to enhance texture, viscosity, and mouth-feel makes it an invaluable component in the formulation of numerous food items. In the pharmaceutical sector, it is utilized for its binding and coating properties, contributing to the development of various medicinal formulations. Its versatility and wide-ranging applications make it an indispensable ingredient in both the food and pharmaceutical industries, playing a crucial role in enhancing product quality and stability.

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