Arabic Gum

Commercial Arabic gum is collected from a number of Acacia species, of which Acacia Senegal, Acacia seyal, and Acacia polyacantha are the most widespread in the gum belt **(Islam et al.,1997).**

Food and nutration organization (FAO) (1999) stated that Acacia trees can be found in semi-arid areas in Australia, India, and America . Sudan is the world`s largest producer of Arabic gum

Joseleau and Ullmann (1999) demonstrated that Acacia Senegal as a thorny tree that reaches a height of4.5–6.0 m. It is very drought-resistant and grows on sites with dry periods of 5–11 months. It also tolerates high daily temperatures of up to 45 C or more, dry winds, and sandstorms. After 5 years, trees reach maturity and are tapped. Table 1 shows Commercial grades of Acacia senegal gum from Sudan .

Table 1: Commercial grades of Acacia senegal gum from Sudan **(Islam et al., 1997)**

Grade	Description
Hand-picked selected	The cleanest and largest pieces with the lightest color .
Cleaned and sifted	The material which remains after hand-picked selected and siftings are removed. This grade comprises whole and broken lumps with a pale to dark amber color
Cleaned	The standard grade with a light to dark amber color. It contains siftings but the dust is removed
Siftings	The residue formed by sorting the above, more choice grades. This grade contains a proportion of sand, dirt, and bark
Dust	This grade is collected after the cleaning process and comprises very fine particles of gum, sand, and dirt
Red	Dark red gum particles removed from other lumps

Chemical structure:

Arabic gum is a branched, neutral or slightly acidic, complex polysaccharide obtained as a mixed calcium, magnesium, and potassium salt. The backbone consists of 1,3-linked B-d-galactopyranosyl units. The side chains are composed of two to five 1,3-linked B-d-galactopyranosyl units, joined to the main chain by 1,6-linkages. Both the main and the side chains contain units of a-l-arabinofuranosyl, a-l-rhamnopyranosyl, B-d-glucuronopyranosyl, and 4-O-methyl-b-d-glucuronopyranosyl, the latter two mostly as end-units**. (Verbeken et al.,2003)**.

Karamalla et al. (1998) stated that The characteristics may vary significantly, depending on the geographical origin and age of the trees, climatic conditions, soil environment, and even on the place of exudation on the tree. Table 2 gives an overview of some chemical characteristics of the gum from Acacia senegal

Table 2: Analytical data for the gum obtained from Acacia Senegal **(Idris et al., 1998**)

Parameter	Range
Moisture content (%)	12.5–16.0
Specific rotation	32.7 _ 27.0
Nitrogen (%)	0.22–0.39
Protein (%)	1.5–2.6
Galactose (%)	39–42
Arabinose (%)	24–27
Rhamnose (%)	12–16
Glucuronic acid (%)	15–16
Equivalent mass (Da)	1,118_1,238

The heterogeneous nature of the gum has been studied extensively using different techniques : hydrophobic affinity chromatography ,anion-exchange chromatography , gel permeation chromatography , high-performance size-exclusion chromatography, flow-field flow fractionation, enzymatic degradation, and sequential Smith degradation **(Picton et al., 2000)**

Using hydrophobic affinity chromatography, gum arabic was separated into three fractions Most of the gum was referred to as an arabinogalactan . It represented protein content 88.4% of the total gum . The second fraction represented 10.4% of the total gum and was referred to as an AG–protein complex (AGP). the protein content of the AGP was 11.8%. The smallest fraction (1.2% of total gum) was referred to as a low molecular weight glycoprotein (GP) with a protein content of 47.3%. **(Verbeken et al., 2003**)

Siddig et al. (2005) reported that the arabinogalactan fraction , has a disk-like morphology with a diameter of 20 nm and a thickness below 2nm. More over **Mahendran et al. (2008)** stated that the arabinogalactan-protein fraction (AGP), was found to decrease on treatment with proteolytic enzyme although The third component, which we will refer to as glycoprotein (GP), is not degraded by proteolytic enzyme.

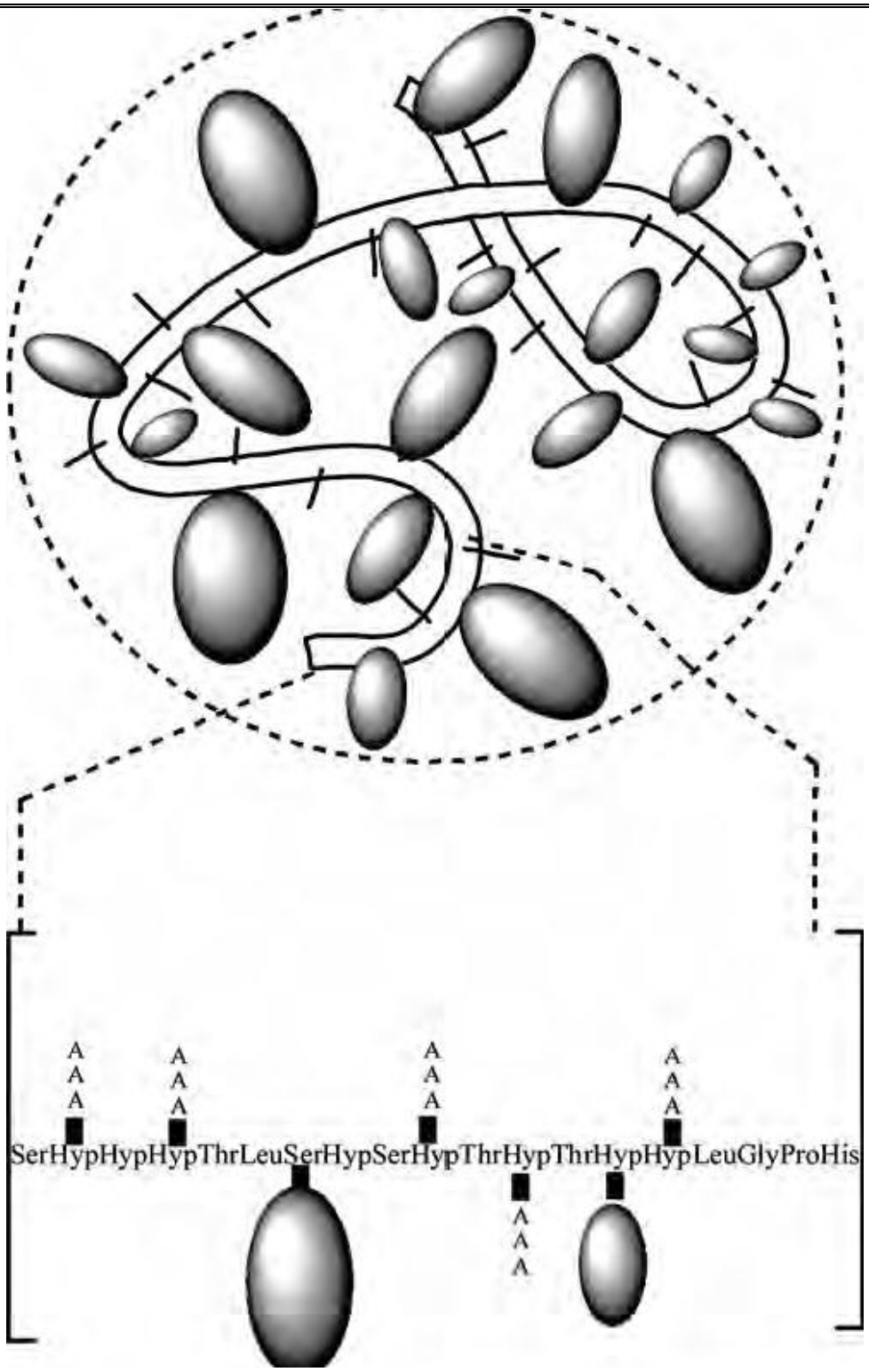

Figure (3) Schematic illustration of the structure of the gum arabic arabinogalactan protein complex**(Goodrum et al., 2000)**

Properties

Arabic gum readily dissolves in cold and hot water in concentrations up to 50%. Because of the compact, branched structure and therefore small hydrodynamic volume, Arabic gum solutions are characterized by a low viscosity, allowing the use of high gum concentrations in various applications **(Dziezak, 1999)**.

Arabic gum has excellent emulsifying properties, particularly thanks to its AGP fraction. The hydrophobic polypeptide backbone strongly adsorbs at the oil–water interface, while the attached carbohydrate units stabilize the emulsion by steric and electrostatic repulsion **(Ray et al.,1999)**. **Buffo et al. (2001)** found that stability of beverage emulsions is influenced by a number of processing factors, such as pasteurization and demineralization, and by the pH of the emulsion.

Arabic gum enhances water, electrolyte, and glucose absorption in animal models of diarrhea. The mechanisms implicated in this effect have not been fully elucidated **(Rehman et al.,2003)**. **Ibrahim et al. (2004)** found that Arabic gum appears to be an effective enhancer of zinc absorption when orally administered in isotonic solutions to laboratory animals. This proabsorptive capacity could be attributed to some of the physicochemical and biochemical properties of Arabic gum and suggest possible applications of Arabic gum in liquid formulas and solid food preparations.

In experimental models of gastroenterological disease, the soluble fiber Arabic gum acts as a proabsorptive adjuvant by stimulating transcellular and/or transjunctional transport pathways; therefore Arabic gum may be useful to increase absorption of solutes transported by diffusion **(Wingertzahn et al.,2001)**. **Codipilly and Wapnir, (2004)** stated that oral administration of Arabic gum can accelerate absorption of some solutes, including pharmacologic agents as acetaminophen. Acetaminophen blood concentrations peaked about 30 min after administration, and the AUC in rats that received Arabic gum was higher than in those that got the solution without Arabic gum .

Teichberg et al. (2000) demonstrated that positive effects of arabic gum-supplemented rehydration solution on fluid and electrolyte absorption seen during jejunal perfusion also occurred during recovery from chronic osmotic secretory diarrhea, when free-living animals drank the solution ad libitum

Arabic gum promotes lumen to blood intestinal transport of water and sodium despite cholera toxin activation. These observations support a potential role for Arabic gum in enhancing the efficacy of oral rehydration solution (ORS) **(Turvill et al., 2000)**

Supplementation with dietary fiber from gum arabic was associated with a decrease in the percentage of incontinent stools and an improvemen of stool consistency **(Bliss et al., 2002)**

Atsushi et al.(2007) stated that the intestinal Ca absorption was significantly improved by pretreatment of rats with Arabic gum in drinking water for 10 days. So that Arabic gum could be used to produce more efficient Ca supplements.

In addition to Arabic gum ability to remove nitric oxide (NO) diffused into the intestinal lumen, it may also partially inhibit intestinal nitric oxide synthase (NOS) and thus modulate intestinal absorption through these mechanisms. Use of Arabic gum as a food additive may help in restoring or improving small intestinal function in conditions where functional damage has occurred (**Khalil et al. ,2004)**

Mochida et al. (1996) studied the effect of Arabic gum on macrophage activation (which play an important role in the regulation of immunological process in rats) by their ability to produce superoxide anions in vitro, and found that Arabic gum suppresses macrophage activation in vitro. Such effects of Arabic gum would merit consideration in the therapy for chronic liver disease, as deranged function of Kupffer cells and hepatic macrophages occurs in this disease and is involved in its complications, such as endotoxemia

Wadood et al. (1999) found that The powdered seeds of Arabic gum were administered in doses of 2, 3 and 4 gm/kg body-weight to normal and alloxan-diabetic rabbits. The blood glucose levels were

estimated before and 2, 4, 6 and 8 hours after the administration of plant suspension. The powdered seeds of Arabic gum exerted a significant hypoglycemic effect in normal but not in alloxan diabetic rabbits. So that Arabic gum may be act as hypoglycemic agent by initiating the release of insulin from pancreatic beta cells of normal rabbits.

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Nasir et al. (2008) found that the Arabic gum solutions contained particularly high concentrations of Ca2+, Mg2+, and K+. Because of enhanced uptake, treatment with Arabic gum significantly increased both the intestinal and renal excretion of Mg2+ and Ca(2+). Arabic gum significantly increased fecal weight and Na+ excretion. Arabic gum increased 24-h creatinine clearance and urinary antidiuretic hormone excretion, and decreased daily urine output as well as the urinary excretion of sodium**.**

Ali et al. (2008) reported that Arabic gum was given to patients With chronic renal failure (CRF) on a low-protein diet at an oral dose of 50 g/day for 3 months, with or without supplementing the diet with ferrous sulfate (200mg/day) and folic acid (5 mg/day).Serum creatinine, urea, phosphate and uric acid concentrations were reported to be significantly reduced by Arabic gum.

Adel et al. (2002) reported that administration of Arabic gum produced a significant protection against cardiotoxicity induced by doxorubicin in mice. This was evidented by significant reduction in serum creatine phosphokinase (CPK) and cardiac lipid peroxides.

Gamal el-din et al. (2003) stated that Arabic gum protects mice from acetaminophen-induced liver injury as evident from significant decrease in serum alanine transaminase (ALT) , aspartate transaminase (AST) and hepatic lipid peroxides . The protection afforded by Arabic gum dose not appear to be caused by a decrease in the formation of toxic acetaminophen metabolites which consumes glutathione, because Arabic gum did not alter acetaminophen-induced hepatic glutathione depletion. So that the protective effect of Arabic gum is due to reduction of oxidative stress.

Arabic gum has anti-oxidant action. By testing whether treatment with gum Arabic has any effect on the concentrations of some free radical scavengers [reduced glutathione (GSH), ascorbic acid (AA), lipid peroxidation (LP), and superoxide dismutase (SOD)] in the kidneys and liver of healthy rats given Arabic gum in the drinking water at a concentration of 2.5, 5.0 or 10.0% for eight consecutive days. . The results indicated that the Arabic gum, at the three doses used, did not significantly affect any of the variables measured. It seems highly unlikely that Arabic gum has a palliative effect on renal failure through an antioxidant mechanism **(Ali, 2004)**

Trommer and Neubert (2005) studied eight different polysaccharidic compounds (including Arabic gum) for their antioxidant and lipid peroxidation lowering effects in vitro. It was found that Arabic gum protected against lipid peroxidation in a dose-dependent manner.

Uses

Arabic gum was once extensively used in the pharmaceutical industry, but is now replaced by celluloses and modified starches in many applications. It is still used as a suspending agent, emulsifier, adhesive, and binder in tabletting and in demulcent syrups **(Verbeken et al.,2003)**

Arabic gum functions as a stabilizer in lotions and protective creams, where it increases viscosity, imparts spreading properties, provides a protective coating and a smooth feel **(Phillips and Williams,2001)**

Amphotericin B-gum arabic conjugates were stable, non-hemolytic and non-toxic to the internal organs of the animal and showed good anti-fungal and anti-leishmanial activity in vitro. The highest concentration of Amphotericin B was found in the spleen after a single injection, these conjugates may have potential in anti-leishmanial therapy **(Nishi et al., 2007)**

Nishi et al.(2007) stated that ampicillin conjugated with oxidized Arabic gum and fabricated into microspheres possesses sustained-release characteristics for prolonged periods. These microspheres did not undergo dissolution in water on prolonged incubation. In-vitro release of ampicillin into gastric fluid was faster due to faster hydrolysis of the drug-arabic gum

bond in the acid medium, but when the medium was changed to intestinal fluid, the release was slowed down. Ampicillin released was functionally active and inhibited the growth of S. aureus and E. coli in cultures.

Dietary supplementation with acacia gum may be an alternative to renal replacement therapy to improve the quality of life and reduce or eliminate the need for dialysis in children with end-stage renal disease (ESRD) in some developing countries **(Al-Mosawi, 2004)**

Arabic gum can be used as a nontoxic phytochemical construct in the production of readily administrable Gold nanoparticles for diagnostic and therapeutic applications in nanomedicine **(Kattumuri et al.,2007)**

Onishi et al.(2008) demonstrated that Arabic gum is considered to have an ability to enhance remineralization, because of its high concentration of Ca(2+).So when human third molars were exposed to 10 mg/ml of gum arabic, sodium fluoride (NaF), or double distilled water (DW, negative control), then subjected to demineralization-remineralization cycles. Before and after demineralization-remineralization cycles, contact microradiographs of each sample were taken and mineral distribution quantities were calculated. The remineralization ratio of the molars exposed to gum arabic was similar to that of those exposed to sodium fluoride , while the ratios of both were significantly greater than that of those exposed to distilled water.

Arabic gum used in toffees and caramels as an emulsifier, to maintain a uniform distribution of the fat across the product. In jelly products, it is used to provide a fibrous, fruit-like texture. It is used increasingly as a source of soluble fiber in low-calorie and dietetic beverages**(Phillips and Williams, 2001)**

Arabic gum is widely used as an emulsifier in the manufacture of soft drinks. Due to its stability in acid conditions and its high solubility, Arabic gum is well suited for use in citrus and cola flavor oil emulsions **(Verbeken et al.,2003)**

Arabic gum is an effective encapsulation agent because of its high water solubility, low viscosity, and emulsification properties and is used in soups and dessert mixes. It is also used in the preparation of etching and plating solutions in the lithography industry **(Williams and Phillips, 2000)**

Side effects

Arabic gum when administered to both sexes of rats in the drinking water at a concentration of 0 (control), 1.25%, 2.5% and 5.0% the treatment had no effects on clinical signs, survival, body weights, food and water consumption, or on findings of urine analysis, ophthalmology, hematology, or blood biochemistry. Gross pathology and histopathology exhibited no differences of toxicological significance between control and treated rats. Increased relative cecum (filled) weights, evident in both sexes of 5.0% group and females of 1.25% and 2.5% groups, were considered to be a physiological adaptation. Thus, the results indicated the toxic level of arabic gum to be more than 5.0% **(Doi et al.,2006)**

A pharmaceutical industry worker was exposed to dust of arabic gum in the tablet coating plant and complained of work-related shortness of breath, chest tightness, runny nose, itching and redness of the eyes. This case was investigated for allergy to arabic gum and compared with a control group. Sensitization to arabic gum carbohydrate structures occurs casually in atopic patients with pollen sensitization without obvious exposure to arabic gum. So that allergy to arabic gum is mediated preferentially by IgE antibodies directed to polypeptide chains of arabic gum **(Sander et al.,2006)**

Arabic Gum in the drinking water at a concentration of 0, 1, 2, 4, 7.5 or 15% was available to male and female Osborne-Mendel rats during premating and mating and throughout gestation. During gestation, the treated females consumed from 683 mg gum/kg body weight/day in the 1% group to 10,647 mg gum/kg/day in the 15% group. The animals were killed on gestation day 20. There were no dose-related changes in maternal findings, number of foetuses, foetal viability or external, visceral or skeletal variations. No teratogenicity was seen **(Collins et al.,1999)**

Melnick et al. (1993) demonstrated that diets containing (2.5%) or (5.0%) agar, guar gum, Arabic gum, locust-bean gum or tara gum were fed to groups of 50 male and 50 female rats and mice for 103 weeks. None of the five polysaccharides was carcinogenic for rats or mice of either sex.