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Gum Arabic (Acacia Gum): A Review

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Abstract: Gum Arabic (GA)(E414) is an important natural product, used in many life fields such as nutrition, food industries, pharmaceutical industries, and others. GA exudates have a hydrocolloid and emulsification physical properties, and a polysaccharide chemical nature. GA exudates derive from Acacia trees (mainly A.Senegal and A.Seyal), which are cultivated and naturally exist in semi-desert areas, mainly in Sudan. There are many gum types distributed throughout the world, but the Arabic gum (Gum Arabic) is considered the best type of these gums, noting that the term "Gum Arabic (GA)" is not restricted to the exudates from the Acacias species. As a natural food additive and "multi-functional" material, with good emulsification, stabilizing and colloidal properties, GA is expected to be a promising factor in future industries, in addition to its non-toxic properties, harmlessness and safety, which have been approved by many global organizations. This review will try to shed light on GA also known as Acacia Senegal gum, mentioning some comparisons between this gum type and others. The overview aims to collect and summarize a considerable number of studies done on GA, its definitions, types, medicinal properties, and the physiochemical differentiation between gum types.

Keywords: Gum Arabic, Acacia trees, Sudan, polysaccharide, properties.

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الصمغ العربي (أشجار الاكاشيا): دراسة مرجعية

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1. **قسم الأحياء - كلية العلوم والاداب - جامعة الحدود الشمالية- المملكة العربية السعودية- مدينة رفحاء.**
2. **عمادة البحث العلمي - جامعة الحدود الشمالية - المملكة العربية السعودية - مدينة عرعر.**
3. **باحث متعاون معهد علوم الأدلة الجنائية جامعة الرباط الوطني السودان مدينة الخرطوم.**

(قدم للنشر في 1440/07/07هـ؛ وقبل للنشر في 1441/04/14هـ)

ملخص: الصمغ العربي (E414) (GA) هو منتج طبيعي مهم، يستخدم في العديد من مجالات الحياة مثل التغذية والصناعات الغذائية والصناعات الدوائية وغيرها. تحوي إفرازات GA خواص غروانية مائية وخواص فيزيائية للاستحلاب وطبيعة كيميائية متعددة السكريات. فإفرازات GA مكتسبة من أشجار الأكاشيا (بشكل رئيسي أكاشيا سينغال وأكاشيا سيال)، والتي تزرع وتتواجد بشكل طبيعي في المناطق شبه الصحراوية، وخاصة في السودان. هناك العديد من أنواع الصمغ الموزعة في جميع أنحاء العالم، ولكن (الصمغ العربي GA) يعتبر من أفضل أنواعها، مع ملاحظة أن مصطلح (GA) لا يقتصر على الإفرازات من أنواع الأكاشيا. باعتبارها مادة مضافة طبيعية للغذاء، وهي مادة (متعددة الوظائف) ذات مستحلبات جيدة وثبات وخواص غروانية، ومن المتوقع أن يكون الصمغ العربي عاملاً واعداً في الصناعات المستقبلية، بالإضافة إلى الخواص غير السامة أو الضارة بالسلامة، والتي تمت الموافقة عليها من قبل العديد من المنظمات العالمية. ستحاول هذه الدراسة إلقاء الضوء على الصمغ العربي الذي يعرف باسم صمغ الأكاشيا، وذكر بعض المقارنات بين هذا النوع وبعض الأصماغ الأخرى، كما تهدف هذه الدراسة إلى جمع وتلخيص عدد من الدراسات التي أجريت على الصمغ العربي وتعاريفاته وأنواعه وخصائصه الطبية والتمايز الفيزيائي- الكيميائي بين أنواع الأصماغ.

كلمات مفتاحية: الصمغ العربي، أشجار الأكاشيا، السودان، سكريات عديدة، خواص.

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1. INTRODUCTION

Gum Arabic (GA)(E414) (Codex Committee on Nutrition and Foods for Special Dietary Uses) is a natural product of a great nutritional, industrial, and economic value. It is one of the most important commercial poly- saccharine and probably the oldest food hydro-colloid in current use (BallalEl-Siddig, Elfadl, & Luukkanen, 2005; Glu, 2002).
About 500 *Acacia* species distributed mainly in the sub-tropical and sub-Saharan areas, found in northern Africa, India, Australia, and in some regions of America (Tahir-Elkheir, Yagoub, 2007; Christian, Michael, Véronica, Thierry & Williams, 2018; Verbeken, Dirk, DIERCKX & Dewettinck, 2003). In Africa, the *Acacia* gum is found in Sudan, Senegal, Cameroon, Mauritania, Mali, Niger, Uganda, and other neighboring countries (COMMODITIES AT A GLANCE, http://unctad.org.).
Although numerous studies have been done on its physiochemical properties, GA is still loosely defined (Hassan, 2000). The difficulty of defining GA may be due to many factors such as the fact that gum exudates from non-*Acacia* species are also used commercially as Gum Arabic (Biswas, Biswas & Phillips,1992), i.e. the term GA is not restricted to the exudates from the *Acacias* species.
The colloidal and emulsification properties of GA made it a favorable factor in the manufacturing of medicines, food, and many other products. GA is used as a local medicine in many countries, such as Sudan, and used for the treatment of kidney diseases in some Middle East countries (Nasir, 2013). Other medicinal uses of GA have been cited in the literature, such as decreasing the blood pressure (Al Mosawi, 2002), and its antimicrobial activity (Ali, Ziada & Blunden, 2009).
Sudanese natural gums include, but are not restricted to *A.seyal* (two-verities), *A.polyacantha, A.mellifera, A.nilotica, A.laeta, A.nubica, A.toritils* (two-varieties) and others (Balla, 2006).The most commercially important species are the *A.Senegal* and *A.seyal* named after the trees *Acacia Senegal* and *Acacia Seyal*, which produce GA (Abubakar, 2004; Chandraju, Mythily & Chidan, 2012).

This overview aims to collect and summarize a considerable number of studies done on GA, including its definitions, types of *Acacia Senegal* and other gum types. The overview discusses the *Acacia* trees types and the gum formation and yield, and highlights the physiochemical differentiation between gum types, in addition to the medicinal properties.

2. GUM TYPES

There are many types of gums produced from different sources as listed in **Table 1**.

Table 1: Some different types of gums according to their source, *(Hassan, 2000)*

Source	Gum
Tree exudates	- Gum Arabic - Gum ragacanth - Gum Karaya - Gum Ghatti
Seaweeds extracts	- Agar - Carragreenan - Aginate
Plant extracts	- Pectins
Seed roots and gums	- Guar Gum - Locust bean gum - Teraa gum - Konjacmannan
Microbial gums	- Xanthan gum - Gellan gum

Vegetable gums are a group of plant products characterized by the ability to dissolve in water forming a viscous solution or by absorbing water to form gelatinous pastes (Whistler, 1973). Some of these are not "true gums" as they are soft and melt when subjected to heat, while the other natural gums burn without melting (Hassan, 2000).

3. GUM ARABIC IS NOT PRECISELY DEFINED

GA is defined as the gummy exudation obtained from *Acacia* trees of the *Leguminosae* family (Tahir

et al., 2018; Elkheir & Yagoub ,2007; Sanchez, Nigen, Mejia Tamayo, Doco & Williams, 2018; Verbeken, *et al*., 2003). Some researchers have written that GA is a difficult product to be defined (Hassan, 2000; Morak, Jursek, Phillips, Asadei & Chikemai, 1998). Many factors account for this difficulty, such as the fact that gum exudates from *Acacias* and non-acacia species are used commercially as GA (Biswas *et al*.,1992). Even within these species, different variants yield gum with a quite distinct chemical composition. The Sudanese official organizations define GA as gum produced from *Acacias Senegal* tree only, and that other *Acacia* gums should have their characteristic specifications with separate monograph and separate numbers (Balla, 2006). Some studies have claimed that gum from *Acacias Seyal* with the gum of *Acacias Senegal* and closely related species as sources of GA (Dondian and Phillps, 1999). The FAO/ WHO define GA as the dry exudates obtained from the stem and branches of *Acacias Senegal* and *Acacia Seyal* (FAO, 1996), for that, some authors have reported that the GA is loosely defined although numerous studies have been done on its physiochemical properties (Hassan, 2000).

4. ACACIASENEGAL AND OTHER GUM TYPES

Some studies have stated that the gum exudates from the *A.Senegal* tree are completely different from the gums exuded from other *Acacia* trees (Anderson, 1986; Gum Arabic Company research, 2009; Vassal, 1972; Siddig, 2003).

Some researchers have studied the possibility of substituting GA by other gum types *Acacia Senegal* var. Senegal gum has better emulsifying and stabilizing properties than *Acacia seyal* var. seyal gum (Elmanan, Al-Assaf, Phillips, & Williams, 2008), and it is colorless, that is why *A.Senegal* has higher prices in the international markets (Vanloot, Dupuy, Guiliano & Artaud, 2012).

Some of these studies have indicated the possibility of using Anogeissus *leiocarpus* gum as a substitute for GA, i.e. because of its good viscosity and adhesive properties, and its usage in beating cloth, and making ink (Burkill, 1985). The similarities in some properties of *Anogeissus leiocarpus* and *Acacia Senegal* gums may be due to the presence of the same six different kinds of sugars in both gum types.

The study of Taha, Elmahi, Hassan, Ahmed & Shyoub, (2012) investigated the physicochemical properties of three types of gums grown in Sudan, i.e. *Gumminesinaolibanum*, *Guar Cyamopsisteyragonlobus* and *Combretum Combertaceae*, wherein they confirmed the existence of sugar moiety in the composition of the gum, and their results indicated that *Combertum* has good gum properties close to those of *Acacia Senegal* GA, and similar functionality in the industrial use, but still they mentioned that further research needs to be conducted to check its toxicity before being used in the food industry.

The study of Rabeea, Daoub, Aarif, Elmubarak, Misni Misran, Elfatih., Hassan Mohammed & Osman (2016) evaluated the functional properties of four *Acacia* Gum types, *Acacia Senegal* var. Senegal (ASG), *Acacia mellifera* (AMF), *Acacia Seyal* var. Seyal (ASY), and *Acacia tortilis* var. raddiana (ATR). The study indicated that ATR Gum bears the best emulsification characteristics. Karaya Gum (E416 in the EFSA - European Food Safety Authority) is a natural additive used in the pharmaceutical and food industries and traditionally used in African and Indian cooking. It is collected on Sterculia trees in Africa and India, so named "*Sterculia*", it is a non-starch polysaccharide (Anderson, 1986).

5. ACACIA TREES

The natural *Acacia* Gum does not contain any pesticide; the exudates are extracted after an incision (cut or wound) is made in an *Acacia* tree stem or branch. The tree grows both in the wild and is cultivated in Sudan (Hassan, Wail, Abdelgadir, Till & Thomas, 2012).

The *Acacia* trees play an environment and socio-ecological vital role in their area, they impact the desertification in the poor savanna and enrich and

restore the soil fertility (Nitrogen fixation) (Mukhtar, 2001; Karamalla, Siddig, & Osman, 1998). In the absence of agricultural insurance, Gum production is the only activity to reduce the lost income from other crops (Karamalla *et al.,*1998). Additionally, *Acacia* trees shade the crops and provide fodder for livestock, besides helping feed local communities. **(Figure 1)**

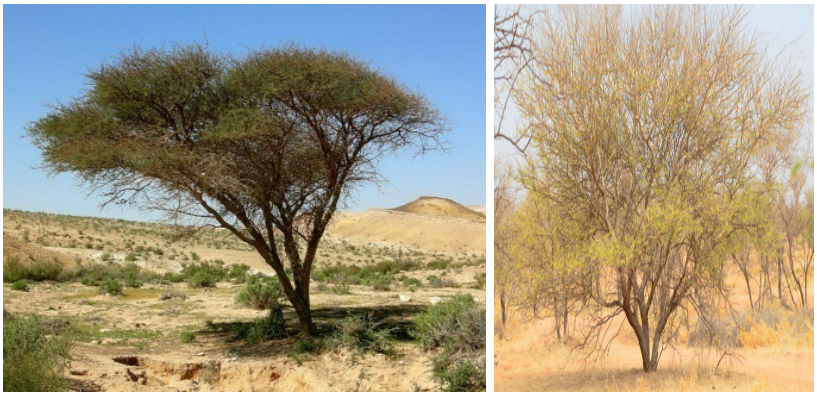

Figure 1: *Acacia* trees (https://commons.wikimedia.org]

In Sudan, GA trees "*Acacia*" are called "*Hashab*", "*Sunot*" and "*Talha*"; the *Hashab* trees produce the best Gum (Balla, 2006). Hundreds of thousands of Sudanese people use Gum Arabic for their livelihood, and Sudan is still the world's largest producer of Gum Arabic. The "*Hashab*" trees - which produce the world's highest quality. Gum Arabic- is a thorny tree that grows in the wild and cultivated in Sudan. It is common in the sand plains of *Kordofan* and *Darfur*. The Gum Arabic Company (GAC), Sudan, reported that the two main types of Gum Arabic in Sudan are Gum *Hashab* and Gum *Talha,* within the ratio 95:5 (5- year annual averages: 1960–94) (AbdelNour, 2007).

6. GUM FORMATION AND YIELD

The natural raw Gum Arabic occurs as solid masses or nodules exudates of the *Acacia* trees when they are cut or wounded intentionally by farmers but somewhat soft when they are new. These exudates are like "tears" of these trees, they secreted out by osmosis in a liquefied form then solidify when exposed to the air on the cut area on the tree stems and branches as a protecting mechanism (Sanchez *et al.*, 2018; Verbeken, *et al.,* 2003; Hassan, 2000) as shown in **Figure 2.**

Figure 2: Picking Gum Arabic from the tree(Alland& Robert]

This action is called "Gummosis phenomenon" defined as the formation of gum to prevent the microorganisms' attacks by sealing off the affected section of the tree (Smith and Montogemry, 1959). Other authors have suggest that the gummosis phenomenon is an effort to cover wounds on the bark of the tree (Karamalla *et al.,*1998), or the gum may act as anti-desiccant to prevent loss of water from the tree (Anderson and Dea, 1971). Whether gum exudates are formed at the site of the wound or generated elsewhere in the tree and then transported to the site of exudation is still a matter of debate (AwadElkarim, 1994; Hassan, 2000) and further investigation is needed.

Acacia Senegal produces nearly 90% of the commercial Gum Arabic, and its quality is superior over other natural gums (Awouda, 1988). No or little reliable data are available about yields of Gum Arabic from a single tree, so it is not easy to base sound estimates of average yields. A maximum average yield of several kgs of gum per season from individual trees had been reported. (Dione and Vassal, 1993).Yields from cultivated *Acacia Senegal* trees may increase up to the age of 15 years, then it begin to decline after 20 years. In Mali, the best yields from *Acacia Senegal* trees are between age 7 and 15 years (Dione and Vassal, 1993).

7. CHEMICAL AND STRUCTURAL PROPERTIES OF GUM ARABIC

Many studies have been conducted to reveal the molecular structure of Gum Arabic (Yael Dror, Yachin Cohen, Rachel Yerushalmi & Rozen, 2006; Chikamai, Banks, Anderson & Weiping, 1996). The average molecular weights (Mw) of *Acacia Senegal* and *Acacia seyal* gums were about 380,000 Da and 850,000 Da, respectively (Mahendran, Williams, Phillips, Al-Assaf & Baldwin, 2008).

The "wattleblossom" model describing the Gum Arabic structure as several arabinogalactan units have a molecular weight of ~2X105 g/mol each unit attached to a common protein chain forming a compact spherical structure (Goodrum, Patel, Leykam, & Kieliszewski, 2000; Connolly, Fenyo & vandervelde, 1988). Many authors have classified these units into three main groups (i) Arabinogalactan (AG, Mw ≈ 280kDa), (ii) Arabinogalactan protein complex (AGP, Mw ≈ 1450kDa), and (iii) Glycoprotein (GP, Mw ≈ 250kDa) (Elmanan *et al*., 2008, Idris, Williams, & Phillips, 1998; Akiyama, Eda, & Kota, 2014).

Some studies on the chemical structure of *A. Senegal* gum have suggested that it is a protein structure "backbone" of repeated amino acid sequences [ser-hyp-hyp-hyp-thr-leu-ser-hyp-ser-hyp-thr-hyp-thr-hyp-hyp-hyp-gly-pro-his]. Some short protein side chains are attached to this protein backbone beside an arabinogalactan (α-1-3) moiety (Mahendran *et al*., 2008).

Many authors (Hassan, 2000; Siddig, 2003; Nie, Wang, Cui, Wang, Xie, & Phillips, 2013) have suggested that the sugar structures and amino acid composition are the same in *A.Senegal* and *A.Seyal*. Other authors have stated that *A.Seyal* has more "branched" polysaccharides (Nie *et al.*, 2013). The composition of GA is dependent to some extent on the age of the tree, location, and other ecological factors (Tahir, 2007). In addition to its fibrous nature (Tiss, Carriere, & Verger, 2001), GA is a polysaccharide with branched chains of linked β-D-galactopyranosyl units containing α-L-arabinofuranosyl, α-Lrhamnopyranosyl,β-D-glucuronopyranosyl and 4-O-methyl-β-D-glucuronopyranosyl units (Tiss *et al.,* 2001; Younes, Garleb, Behr , Remesy & Demigne, 1995).

The dried gum Arabic is rich in magnesium, calcium and potassium salts of Arabic acid (a glycosidal acid), and contains the enzyme oxidase, but has very few starch granules (Nasir, 2013).

8. PHYSIOCHEMICAL DIFFERENTIATION BETWEEN GUM TYPES

Some parameters that can be used to identify raw gums include the specific optical rotation, the nitrogen content, the ash content, and the moisture content (Karamalla *et al.,* 1998).

Gum Arabic readily dissolves in water (cold and hot) in concentrations up to 50% (Hassan, 2000; Karamalla *et al.,*1998). Generally, Gum Arabic is odorless and tasteless. *A.Senegal* gums are

nodules of globular shape or tears, the surface of nodules are rough with small cracks, hard, their color varies from colorless through shades of yellow to light brown. *A.Seyal* var.Seyal is exuded in the form of fragile nodules that may be crushed, its color varies from colorless to dark brown, sometimes with a sweet or bitter taste and odorless as shown in **figure 3,** (Satti, Mohammed, Abdallah,, Bawadekji & Eltahir, 2019).

Figure 3: Two Gum Arabic varieties of *Acacia* types, A. *Senegal*: almost colorless (to your left hand); A. *Seyal*: brown to reddish color (to your right hand), (Satti *et al*., 2019).

Besides the general appearance of gum types, the chemical taxonomic keys or fingerprints can be determined by analyzing the gum. Although this research could not find a simple fingerprint of the gum in the literature, except that reported by Chandraju, Mythily & Chidan (2012), who used the optical rotation as a fingerprint of *A.Senegal* (laevorotatory of about -30°) and *A.Seyal* (dextrorotatory of about +50°). The work which was done by Samia, Babiker & Karamalla (2009) proposed a straightforward analytical strategy for gum identification using their mass fingerprints. The results of the screening approximate investigation confirmed the classification of the samples as *Acacia Senegal* gum (from *Hashab* trees), *Acacia. seyal* var.Seyal and *Acacia.Seyal* var.fistula gum (*Talha*).

Anderson and Dea (1971) & Samia *et al.* (2009), used some analytical parameters and essential chemical components of the *Acacia* gum as a fingerprint to distinguish it from other gum types, these parameters included ash, nitrogen, molecular weight, equivalent weight, (Uronic acid) and ratios of sugars present (Galactose, Arabinose, Rhamnose) after hydrolysis. Some findings showed an approximately equal ash content of *A. Senegal* ; *A.Seyal* var.Seyal and *A.Seyal*var.fistula, (**Table 2)** (Satti *et al*., 2019; Balla, 2006; & Karamalla,1998).

Table 2: Results of some physicochemical parameters of three GA varieties samples

	Acacia Senegal	***Acacia.seyal* var. seyal**	***Acacia.seyal* var. fistula**
Moisture%	9 - 13	7.2 - 98	11.3
Ash%	4.5 (Satti, 2019) 3.3 (Balla, 2006) 3.9 (Karamalla, 1998)	4.0 (Satti, 2019) 3.5 3 (Balla, 2006) 1.6 (Karamalla, 1998)	3.8 (Satti, 2019) 2.9 3 (Balla,2006)
pH	4	4.2	3.8

9. POLYSACCHARIDES IN ACACIA AND DIFFERENT GUM TYPES

GA is a complex structure of a mixture of polysaccharides and glycoprotein. It is an important source of the sugars arabinose and ribose, both of which were first discovered and isolated from it, and are named after it as in **Tables 3 & 4.**

Table 3: Sugar levels in *Acacia* gums (general)

Ref / Sugar	Anderson (1976)	Akiyama et al. (2014)	Abbashar (1989)	Abdelkariem (1992)
Galactose %	44.0	41.0	68.0	45.2
Arabinose%	27.0	28.0	13.6	25.8
Rhamnose%	13.0	12.0	4.2	10.7
Glucoronic acid %	14.5	14.3	14.2	11.0

Table 4: Comparison of sugar levels (%) in two *Acacia* gum varieties from three studies

Gum type / Parameter	A. Senegal			A.seyal var. seyal		
	Balla (2006)	Karamalla (1998)	Satti, (2019)	Balla (2006)	Karamalla (1998)	Satti, (2019)
Uronic acid	12.8	16	10.2	11.6	6.6	5.5
Galactose	44	44	40.2	37	46	32.5
Arabinose	24	27	22.2	45	4	5.6
Rhamnose	12	13	10.4	4.0	4	2.7

The GA molecules are a highly branched natural composite, sopolysaccharides are characteristic for all gum types (Mirhosseini & Amid, 2012), they contribute largely to the physicochemical properties of gums (Ismail,2000). The analysis of sugar mixtures is of considerable importance to the food and beverage industries (Peris-Tortajada, 1996; Chandraju, Mythily, & Chidan Kumar, 2011). GA contain reducing sugars at the range 0.49-0.56%, these reducing sugars were calculated as arabinose (Samia *et al*., 2009). GA– and closely related species – composed of six carbohydrate moieties including galactose and arobinopyranose (FAO 1996; Anderson,1976). Almost similar polysaccharides mixture were found in other similar gums such as gum *tragacanth* (Astragalusgummifer, E413) which consist of arabinogalactan containing α-L-arabinofuranose and 1-4-linked β-D-galalactopyranose (Tischer, Iacomini, & Gorin, 2002), Gum *karaya* (Sterculiaurens) and Gum *ghatti* (AnogeissusLatifolia tree) (López, Franco, Córdova Moreno, Goycoolea, Valdez, Juárez, Onofre & Lizardi Mendoza, 2012) had an almost similar structure. *Acacia* Gum has been compared with *Acacia nilotica* exudates gum, and *Brea* Gum (BG) (from the Cercidium praecox tree- Argentina), which consist of approx. 84% of the polysaccharides (Bhushette & Annapure, 2017).

Gum *Karaya* Indian Gum (FAO, 1996) yields galactose, rhamnose, and arabinose with a small amount of glucuronic acid (Anderson and Dea, 1971). Almost similar sugar moieties were found in Gum *ALBIZIA* and Gum *TRAGACANTH* (FAO, 1996; Anderson and Morrison, 1990), together with *Anogeissusleiocarpus* Gum which consists of L-arabinose, D-galactose, and D-glucuronic acid in an approximate ratio 10:6:2 (Aspinall & Hirst, 1955). While Samia E. studies added L- rhamnose to those mentioned sugars and did not report the D-xylose sugar (Samia *et al*., 2009).

Many gums contain glucuronic acid, such as Gum Arabic (c. 18%). Glucuronic acid is a uronic acid (class of sugar acids, either hexuronic or pentoses) that was first isolated from urine (hence the name), it is important for the metabolism of microorganisms, plants and animals (Dictionary of Food and Nutrition).

The mean value of reducing sugar of samples from different locations in Sudan, which was analyzed by Samia *et al*. (2009) was 0.44 %, that was in agreement with that reported by Karamalla *et al.* (1998) for *Senegal* Gum (0.16 %-0.44%). Table 5 shows a comparison between the major sugar contents of GA and other gum types reported by different studies.

Table 5 Comparison of major sugars content between GA and other gum types reported by different studies

	***Durain seeds* gum (Cui & Mazza,1996)**	***Acacia mearnsii de Wild* (AlineGrein,2013)**	**Gum Arabic (AlineGrein,2013)**
Galactose%	8	46	39
Arabinose %	NA*	43	31
Rhamnose%	21	7	13
Uronic acid %	NA	4	17

* **NA: not available**

The study of Balla (2006) reported no differences between sugar content of crude and processed GA, in agreement with Ismail (2000) notification of insignificant effect in the sugar composition in the freeze-dried samples. But Ismail himself had noted total content of sugars ranged from 66.54 to 88.01% with decreasing in total sugars in freeze, drum and spray drying gums. The location of GA trees was found to insignificantly affect the reduction in sugar contents (Ismail, 2000).

10. THE APPROXIMATE RATIOS OF THE THREE ESSENTIAL SUGARS IN GUM

The approximate ratios of the three essential sugars in gum, which are galactose, arabinose, and rhamnose in *Acacia* gums have been reported by 6 previous studies as in Table **6.**

Table 6: The approximate ratio of the main sugars in AG (Galactose: Arabinose: Rhamnose) reported by 6 previous studies.

Ratios	**11:6:3**	**10:6:3**	**10:6:3**	**11:6:4**	**20:4:1**	**9:16:3**
Ref	Satti *et al.* (2019)	Anderson (1986)	Akiyama *et al.* (2014)	Abdelkariem (1992)	Abbashar (1989)	AlineGrein (2013)

The similarity of sugar ratios in most studies may be an indicator for the *Acacia* gums, though the differentiation is a hard task. Factors affecting sugar levels in gum samples include the age of the tree, location, soil type and the part of the tree produce the gum. Grein and Silva (2013) showed that (galactose: arabinose: rhamnose) approximate ration was 10:9:2 for *Acacia mearnsii de Wild*. Some variations in the results of studies may be due to the different methodologies of extraction and detection techniques.

Most studies conducted on gum types throughout the world have taken Gum Arabic as a reference for doing comparisons. For example, the studies on *Brea* Gum (BG) (exudates from the Cercidium praecox tree) that grows in Argentina, showed physicochemical characteristics and functional features similar to those of Gum Arabic (Grein *et al.,* 2013). Another example was the *Acacia mearnsii de Wild* Gum exudates, collected from trees growing in the south of Brazil, which were characterized for polysaccharides and compared with commercial Gum Arabic. *Acacia mearnsii de Wild* had a higher protein content than Gum Arabic, with small differences in the monosaccharide composition, the uronic acid content of *Acacia mearnsii de Wild* (4%), compared with Gum Arabic (17%). This study proposed *mearnsii de Wild* Gum as a substitute for *Acacia Senegal* and *Acacia Seyal* for use in some applications (Grein *et al.,* 2013). A third example was a study of Cui & Mazza (1996) on *durian* seed Gums, its sugar composition was very different compared to other commercial Gums such as *guar*, and Arabic Gum.

11. EMULSIFICATION

Gum Arabic is considered to be a "multi-functional" material with good emulsification properties and used as a stabilizer of the dispersed system (Nakayma, Funami, Noda, Ishihara, Al-Assaf, Nishinari & Phillip, 2008).

GA is a food additive used as a coating for confectionery or pharmaceuticals, it is also used as an emulsifier (oils, lotions), a stabilizing agent (drinks like wine). *Acacia* gum is widely used in the food industry in a process referred to as (encapsulation), almost a large number of everyday products contain some small doses of Gum Arabic. The gum used to stabilize concentrated oil emulsion in the beverages for long periods prior to bottling (Islam, Phillips, Sljivo, Snowden & Williams, 1997).

Investigating the methods for chemical modification of carboxylic acid groups in the protein and carbohydrate parts of the gum may help in improving emulsification properties of "poor" gums, i.e. to reduce the electrostatic repulsion between these carboxylic groups (Ma, Bell, & Davis, 2015). Some studies had related the "availability" of the protein "backbone" to the eventual emulsifying capacity of the gum (Mahendran *et al*., 2008; Goodrum *et al.,* 2000).

12. MEDICINAL PROPERTIES

The harmlessness and safety of *Acacia* gum as a food additive has been approved. The concerned organizations (such as FDA or the JECFA) do not set a maximum daily intake (ADI-acceptable daily intake) (FAO, 1996).

The chemical nature of GA is described both as a polysaccharide and a dietary fiber, this description may explain the physiological and medical function of GA. The US Food and Drug Administration considers GA as one of the safest dietary fibers (Anderson, 1986). For many years, the term "dietary fiber" was used for the non-digestible constituents of plant cell walls, but the Codex Committee on Nutrition and Foods for Special Dietary Uses, (2014) adopted the definition of dietary fibers as "Carbohydrate polymers with ten or more monomeric units which are not hydrolyzed by the enzymes of the small intestine of humans" (Phillips, 2013).

GA ingestion decreases body weight in humans (Babiker, Merghani, Elmusharaf, Badi, Lang, & Saeed, 2012) and spleen weight (Abdelkareem, 2015). The reduction of body weight by GA may be due to the fibrous nature of GA, which affects fat metabolism (Ali, Ziada, & Blunden, 2009;

Slavin, 2003), or lowering caloric density of food (Schneeman, 1987). However, the effect of fiber-containing nutrients on the incidence of colon cancer has been questioned and still controversial (Fuchs, Giovannucci, Colditz, Hunter, Stampfer, Rosner , Speizer & Willett, 1999).

The use of GA in the treatment of renal diseases (Nasir, 2013) may be due to the ability of GA to reduce urinary glucose excretion, and Na+ excretion in urine (Nasir, Umbach, Rexhepaj & Ackermann 2012). In addition to GA antioxidant effects and protective effects in experimental hepatic- renal- and cardiac toxicity (Ali *et al.,*2009). GA may decrease blood pressure (AlMosawi, 2002), and decrease plasma cholesterol concentrations (Ali *et al*., 2009). They suggested this decreasing effect of GA on the plasma cholesterol concentrations in rats.

The administration of GA at concentration 15% may treat diabetes and chronic kidney disease in rats by enhancing the activities of Glutathione peroxidase (GPx) (ElTobgy, 2019).

Said, Essam, and Khalifa (2019) concluded that oral administration of GA could possibly improve the adverse effects of CKD which might be ascribed to their antioxidant properties. Ali *et al*. (2013) suggested that the treatment with GA may induce significant increases in the concentration of the measured inflammatory mediators. Some recent studies have suggested a novel effect of GA, which may be used to foster fetal hemoglobin production (Lamis, Imad, Omer, Haydar, Mustafa, Florian , & Amal, 2015).

Limited studies have reported an antimicrobial activity of GA, and its stimulation of the intestinal absorption may cause counteracting diarrhea (Ali *et al*., 2009). The *Sunt* tree (*Acacia nilotica* (L.) *Willed.ex* Del., *Fabaceae*, subfamily Mimosoideae) gum exudates are traditionally used as antidiarrhoetic in Sudan. (ElGhazali, Abdalla, Khalid, Khalafalla & Hamad, 2003). In Sudan, the wood of the *Talih* tree (*Acacia Seyal* Del., Fabaceae, subfamily Mimosoideae) is traditionally used as a fumigant for rheumatic pain. It is also used to protect women from fever after childbirth (ElGhazali *et al*., 2003).

13. CONCLUSION

While most researchers define Gum Arabic (GA) as a "polysaccharides' with branched chains, others define it as a water-soluble dietary fiber. Because of the variations in its constituent levels according to its source (s), the exact molecular structures of Gum Arabic are still rather uncertain, its structural characterization is incomplete and subject to many corrections. Therefore, the physical appearance of the natural gums and the source of gum are of great importance as a measure to determine their types, commercial value, and end-use.

According to the data cited in the literature, *A.Senegal* gum is highly distinct from other natural gums, notifying that, there are no great differences between the physical and chemical properties of *A. Senegal* gum in its natural state and processed state (Kibbled, mechanical powder, spray dried and freeze-dried).

GA (*Acacia* Gum) is considered as the most important gum, used in food and medicinal applications, as it is a natural vegetable contains a non-carcinogenic soluble fibers. GA has a prebiotic and hypoglycaemic effect. *Acacia* gum is used as a meal-substitute, and in making dairy products and confections, making cosmetics, textiles and biomedical/pharmaceutics, it is used as hydrocolloidal and emulsifier in these industries, but it is a less consistent material than other hydrocolloids.

It seems that the carbohydrate content is NOT the only factor which gives GA its unique property.

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