Medicinal Uses of *Acacia seyal*

Subjects: Others

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Acacia seyal is an important source of gum Arabic. The availability, traditional, medicinal, pharmaceutical, nutritional, and cosmetic applications of gum acacia have pronounced its high economic value and attracted global attention.

Keywords: gum Arabic ; Acacia seyal ; Arabic gum

1. Introduction

The genus *Acacia* (also known as wattles) is a large genus formed mainly of shrubs and trees that belong to the subfamily Mimosoideae and the pea family (Fabaceae). Plant species of this genus grow natively in the tropical and subtropical regions of the world, including Africa, Australia, middle America, the Middle East, and south Asia. The genus name "*Acacia*" was introduced by Philip Miller in 1754 [1] and is derived from the Greek name (ἀκακία) "akakia", a term used by Dioscorides (40–90 AC) for a prepared extract from leaves and pods of *Acacia nilotica* "*Vachellia nilotica*". The genus *Acacia* formerly contained 1540 species as recognized in 2011. However, these plant species were later divided into five clades (genera) after a long controversial debate [2][3][4][5]. The clades are varied in species count and habitat: Acaciella Britton & Rose (15 species) and Mariosousa Seigler & Ebinger (13 species) are confined to the Americas. Vachellia Wight & Arn. (163) and Senegalia Raf. (194 species) are pantropical (mainly in Africa and India). The largest clade, corresponding to *Acacia* following the Vienna Congress, comprises 1021 species, almost all of which are Australian [6]. However, there are a great number of botanists who conserve the old nomenclature and disagree with this recent classification [7].

Acacia seyal Del. (homotypic synonym: *Vachellia seyal* Del.; another synonym: *Acacia stenocarpa* Hochst.; English name: Whistling thorn; Arabic Name: Taleh or Talha) [8] well-known species belongs to the genus *Acacia* (or *Vachellia*), Family *Fabaceae*. Besides the ecological, social, and economic importance of *Acacia* species. *A. seyal* is a well-known traditional medicinal plant that has a wide range of medicinal applications related to its different phytoconstituents from organized parts, e.g., fruits, barks, stem, and roots, and unorganized parts, e.g., gum acacia, which is called "taleh or talha gum" [6].

The bark of *A. seyal* can be easily recognized where *A. seyal* var. *seyal* has thin red-brown bark, while the bark of *A. seyal* var. *fistula* is smooth and whitish. Both varieties have long, slender, and white thorns that occur in pairs; the thorns of *A. seyal* var. *fistula* are sometimes swollen at the base by ant galls. The inflorescence of *A. seyal* is almost yellow, pedunculate with a globose head. Pods are 7–20 cm long, thin, and slightly curved [9].

2. Main Phytoconstituents

The chemical composition, including the main phytoconstituents of *A. seyal* (**Figure 1**), has been established and previously reported, and it can change with its geographical source, age of the trees, weather, and soil conditions [10][11]. Leaves, flowers, and pods of *A. seyal* contain reasonable amounts of phytochemicals, including proteins, saponins, phenolics, flavonoids, anthocyanins, and carbohydrates [12]. Although alkaloids and anthraquinones were not detected in the bark extract of the plant according to Suleiman & Brima 2021 [13]. In other studies, the stem bark has been reported to contain flavonoids, saponins, terpenoids, steroids, alkaloids, phenols, coumarin, and tannins [14][15]. The phenolic acids "gallic acid, salicylic acid, p-coumaric acid, caffeic acid, 3,4 dihydroxy benzoic acid, and ferulic acid" were detected in *A. seyal* leaves [16][17][18]. The stem bark of *A. seyal* (Djibouti type) was reported to contain catechin, epicatechin, lupeol, campesterol, stigmasterol, clionasterol, and oleamide [19], whereas the complex of polysaccharides and calcium, magnesium, potassium salts, protein, gallic, ellagic, and chlorogenic acids were reported as phytoconstituents of *A. seyal* gum [20].

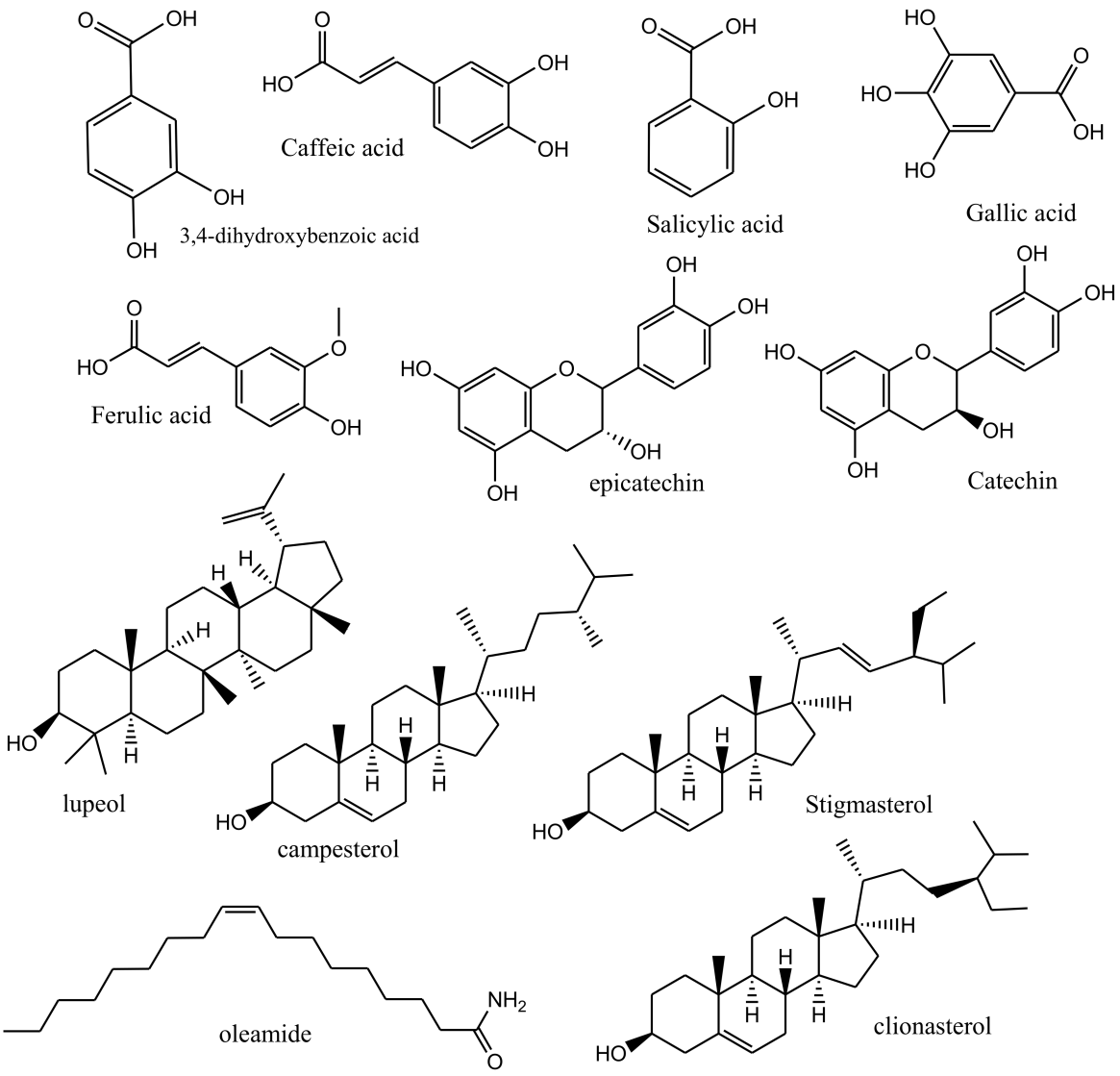

Figure 1. The main phytoconstituents of *A. seyal*.

According to Eltayeb et al. 2017 [21], the Sudanese *A. seyal* stem and stem wood contain tannins, terpenoids, cardiac glycosides, reducing sugars, flavonoids, alkaloids, steroids. The stem barks extract shows only positive results for tannins, terpenoids, cardiac glycosides, and reducing sugars, while all test materials are free from saponins. The dry distillates of the stem materials of *A. seyal* (known in Sudan as Dokhan) are used as fumigants for their cosmetic, aromatic, and medicinal values. The GC-MS analysis of this dry distillate revealed the presence of more than 130 volatile constituents, while the major vol. constituents were solerone, furfural, catechol, syringol, allo-inositol, mequinol, furfuralcohol, 3-methyl-1,2-cyclopentanedione, phenol, homovanillyl alcohol, 1,3-dimethyl-5-methoxypyrazol, and 1,2-anhydro-3,4,5,6-alloinositol. [21].

Gum Arabic (GA) or acacia gum is dried gummy exudate (mainly shaped in tears, spherical, or subspherical forms) obtained pathologically, mainly by incision, from the stems and stem branches of acacia trees, especially *A. senegal* and *A. seyal*, family Fabaceae. *A. senegal* gum is called “hashab gum” and has a milky white appearance and is hard; while *A. seyal* gum is known as “Talha gum”, which has mainly amber yellow color and is friable [22]. GA is an arabinogalactan-protein complex (known as arabin) which is composed mainly of calcium, magnesium, and potassium salts of Arabic acid. Arabic acid is composed mainly of 1-3-linked β-D-galactopyranosyl units with branches that consist of two to five β-D-galactopyranosyl residues linked together through 1,3-ether linkages and attached to the fundamental β-D-galactopyranosyl chain (**Figure 2**) through 1,6-linkages. Both fundamental and branches contain additional α- l -arabinofuranosyl and α-l-rhamnopyranosyl units and terminated with β-D-glucopyranosyl and 4-O-methyl-β-D-glucopyranosyl residues (**Figure 3**).

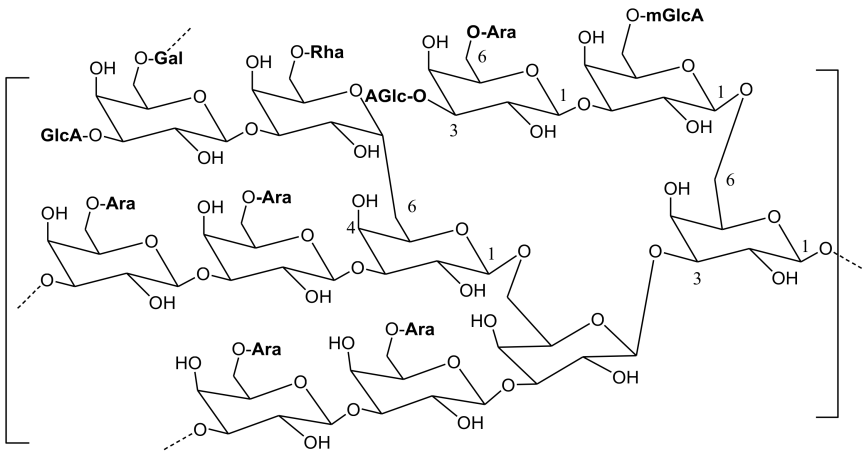

Figure 2. Part of the fundamental chain of gum Arabic shows 1-3-linked β-D-galactopyranosyl residues and its main branches. (Gal) β-D-galactopyranose, (Ara) α-l-arabinofuranose, (Rha) α-l-rhamnopyranose, (GlcA) β-D-glucuronic acid, and (mGlcA) 4-O-methyl-β-D-glucuronic acid.

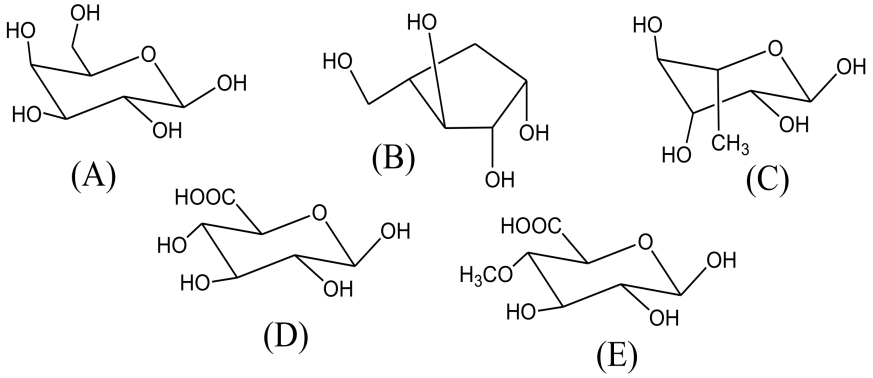

Figure 3. The main monosaccharide residues in gum Arabic: (A) β-D-galactopyranose, (B) α-l-arabinofuranose, (C) α-l-rhamnopyranose, (D) β-D-glucuronic acid, and (E) 4-O-methyl-β-D-glucuronic acid.

Compared with *A. senegal* gum, *A. seyal* gum is more compact and friable, less charged, less hydrolyzable by enzymes, less surface-active, more unstable in solution, richer in minerals and polyphenols, and less rich in proteins [23]. In a study reported by Karamalla 1999 [24], GA contains about 10.75% as an average moisture content, which determines the hardness of the gum and average ash content as 3.27% for *A. senegal* var. *senegal* samples, while the average moisture and ash content of *A. seyal* gum was reported to be 14.41% and 3.5%, respectively [25]. The protein content is responsible for the emulsification properties of GA. For good-quality GA, the European specifications and the United States pharmacopeia define that at least 3% of GA should be protein content [11]. However, the percentage of GA proteins is varied according to the geographical source, the constitution of soil, time of collection, and the plant species; for example, the protein contents in GA from Nigerian *A. senegal* contain approximately double the content found in Nigerian *A. seyal* gum, which could explain the instability of the oil in water emulsification properties of *A. seyal* gum [11][26]. *A. senegal* gum contains high amounts of hydroxyproline, serine, leucine, threonine, histidine, and aspartic amino acids compared with lower amino acid contents present in *A. seyal* gum [27]. GA is acidic; its pH is 4.66, as described by Karamalla 1999. [24] The average optical rotation of hashab gum (*A. senegal* gum) is −30°, while the [α]D values of talha gum (*A. seyal* gum) are ranged between +45° to +54° [28].

Although polysaccharides macromolecules are mainly sparingly soluble in water, GA is soluble easily in hot and cold water, forming aqueous concentrated solutions of up to 50% concentration. Like most polysaccharides, GA is insoluble in non-polar organic solvent and oils, but it can be soluble in aqueous ethanol solutions up to 60% ethanol concentration [29]. The mineral types and concentrations in gum Arabic attract important attention as they are responsible for the polarity of the arabinogalactan protein complex and, in turn, have an impact on the solubility, hydration compactness, and stability of the colloidal solution of the gum [11].

Gum talha (Sudanese type) is mainly formed of rhamnose (3–4%) and arabinose (41–45%) in addition to nitrogen contents (0.147–0.175%) and protein (0.97–1.15%). Gum talha has [α]D values ranging between +45° and +54° [28]. However, *A. seyal* gum could be fractionated into three fractions using size exclusion chromatography (SEC) and hydrophobic interaction chromatography (HIC), which were designated as arabinogalactan (AG), arabinogalactan-protein (AGP), and glycoprotein (GP) [30][31]. Li et al. (2020) [25] provided another method for commercial fractionation of *A. seyal*

gum using subsequent concentrations of ethanol in distilled water (60% and 80%) to obtain a gum precipitate AY60 and AY80, respectively. In addition to the dried supernatant (AYS), Li et al. (2020) [25] provided analytical data regarding *A. seyal* gum and its these fractions (**Table 1**).

Table 1. Analytical data (percentage values) of precepitated fractionsn of *Acacia seyal* gum Arabic compared with its entire substance according to Li et al. 2020 [25].

Fraction	AY60 (Fraction)	AY 80 (Fraction)	AYS (Fraction)	AY (Entire Substance)
Weight percentage (%)	44	39	2.4	100
Average molecular weight	924,900 Da	ND	ND	ND
% moisture content	12.67 ± 0.04	13.59 ± 0.21	ND	14.41 ± 0.11
% Ash content	4.44 ± 0.01	4.51 ± 0.02	ND	3.50 ± 0.02
% total protein content	0.14 ± 0.01	0.13 ± 0.06	0.45 ± 0.02	0.32 ± 0.02
% neutral sugar content	61.24 ± 3.44	63.82 ± 2.76	67.82± 1.62	60.90 ±2.13
% uronic acid content	15.26 ± 0.25	16.17 ± 0.19	1.83 ± 0.07	17.43 ± 0.62
the total molar percentage (mol%) of rhamnose	2.13	2.24	2.28	3.09
mol% of arabinose	43.54	44.80	40.13	47.29
mol% of galactose	39.38	37.22	49.61	33.00
mol% of galacturonic acid	14.95	15.74	1.54	16.62

ND: not determined.

Further experiments confirmed that the AY60 backbone is composed of 1,3-linked galactopyransyl residues substituted at O-4 and O-6 positions, while the substitutions were 3-1α arabinofuranosyl (~2.25%) or 4-1β glucuronopyranosyl (~14.4%) and terminated by arabinofuranosyl and occasionally by rhamnopyranosyl or glucuronopyranosyl residues [25]. GC/MS analysis of *A. seyal* gum revealed the presence of several phytoconstituents, including 4-methylcatechol; 2,5-diamino-4,6-dihydroxypyrimidine; dihydrouracil; 2-acetyl-3-hydroxy-5,6,8-trimethoxy-1,4-naphthoquinone; fisetin; ferulic acid; resveratrol; β-citronellol; dihydrocarvone; patchoulol; 5,7,3′,4′-tetrahydroxyflavone; chromone, 5-hydroxy-6,7,8-trimethoxy-2,3-dimethyl; α-bisabolol; isolongifolol; genistin; glycitein; quercetin; vanylglycol; quercetin 3-D-galactoside, among others [32].

3. Traditional Uses

Unorganized parts (e.g., acacia gum and acacia extracts) and organized parts (e.g., fruits, stem barks, and roots) of acacia trees have been used since ancient times for medical, nutrition, and economic benefits. From the first Egyptian Dynasty (3400 B.C.), gum Arabic (or gum acacia) was used in crafts for the production of ink (mixture of carbon, gum, and water) and also in human and veterinary medicine [25]. Traditionally, African herbalists also used gum acacia to bind pills and stabilize emulsions and in aromatherapy for applying essential oils. The fruits and bark of the acacia tree had also been used by the local people of Sudan to tan leather or as a dye [33]. *A. seyal* (Del.) is a multi-purpose tree that is cultivated for animal fodder, wood, and charcoal in many countries, such as Sudan, Egypt, Somalia Mozambique, and

Namibia [34][35]. Presently, gum acacia is used widely in the food and pharmaceutical industries as an important naturally occurring oil-in-water emulsifier. After many years of vacillation, in June 1999, the Codex Alimentarius and the FAO Joint Expert Committee issued the specification for gum acacia [33]. Commercially, it is also used as a film-forming agent in peel-off masks and candies and as emulsifying agents for the production of beverages and flavor concentrates [18][33][36]. Due to the low emulsification properties of *A. seyal* gum, Bi et al. (2017) [37] have incorporated *A. seyal* gum with β-lactoglobulin through Millard reaction to obtain high-quality conjugate.

4. Medicinal Uses

Several studies conducted in recent decades revealed that extracts from the bark of *A. seyal* have antibacterial action [25][38][39], antimalarial effect [40], antimycobacterial effect, cyclooxygenase inhibition effect [41], molluscicidal activity [42], and anticancer activities [43][44]. Acacia gum has been established to possess several therapeutic actions, such as hypoglycemic, antidiabetic, antioxidant, immunomodulatory, and cytoprotective antiulcer, and has prebiotic properties [18][25]. **Table 2** shows the traditional uses of the different parts of *A. seyal* in different countries for the treatment of various conditions, such as pneumonia, malaria, joint pain, bleeding, rheumatic arthritis, jaundice, chest pain, diarrhea, skin necrosis, bleeding leprosy, dysmenorrhea, eye infection, stomach ulcers, and respiratory tract infection.

Table 2. Traditional uses of *A. seyal* in some African countries.

Country	Use	Part	Ref.
Kenya	Pneumonia	Bark, stem, trunk, twig	[45]
Kenya	Malaria	Roots	[46]
Kenya	Joint pain	Bark, stems, leaves	[47]
Sudan	Bleeding, leprosy	Bark, leaves	[48]
Sudan	Arthritis, rheumatisms, rheumatoid fever	Wood	[49]
Ethiopia	Intestinal parasites	Roots, leaves	[50]
Ethiopia	Chest pain	Roots	[51]
Uganda	Diarrhea, Viral skin necrosis nodules	Roots, bark, leaves	[52]
Djibouti	Dysentery	Bark, roots	[53]
Algeria, Egypt, Morocco	Infected wounds, fever, dysmenorrhea, eye infections, stomach ulcers, rheumatisms	Seed	[54]
Algeria, Egypt, Morocco	Rheumatisms, respiratory tract infection, gastric ulcer	Gum	[55]

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