Dedication

I dedicate this work to…

My parents…

My husband…

My children…

My brothers and sisters …

Acknowledgement

Praise is to Allah, Almighty, who blessed me with this opportunity to learn and work.

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Abstract

Four Authentic representative gum exudate samples from *Acacia* species namely *Acacia senegal* var. *senegal* (ASG), *Acacia mellifera* (AMF), *Acacia seyal* var. *seyal* (ASY), and *Acacia tortilis* var. *raddiana* (ATR), were characterized. The moisture, ash, nitrogen, protein content, pH, specific optical rotation, and number average molecular weight were found to be 9.76, 3.40, 0.327, 2.158, 4.94, -31.75, and 0.24×10^6 for ASG, 9.56, 2.5, 0.630, 4.158, 4.53, -48.25, and 2.10×10^6 for AMF, 8.35%, 3.13, 0.243%, 1.610%, 4.84, +56.00, and 2.95×10^6 for ASY and 8.49%, 2.05, 1.549%, 10.378%, 4.45, +86.75, and 2.06×10^6 for ATR respectively. The ^{13}C and ^{1}H NMR spectra of gum samples showed similarity in individual sugars components, but characteristic patterns of each gum, were observed. The same functional groups were observed from the FTIR spectra of the gums. DSC and TGA thermograms were characteristic for each gum. ASG, AMF, ASY, and ATR gum emulsions were prepared, without the addition of weighting agents, using different concentrations of Isopropyl Myristate (IPM). ASG and AMF gums from the *Vulgares* series and ASY and ATR gums from the *Gummiferae* series were blended in different proportions. Blends emulsions were prepared with 20% IPM oil concentration. The morphology of gums and blends emulsions; over seven days of incubation at 45**C,** exhibited spherical and dense droplets. Particles size measurements, over a period of four weeks of incubation at 45**C,** showed that ATR gum formed smaller and more stable droplets compared to the other gums. Phase separation was observed at low oil concentration for all gum emulsions. Emulsions of blends showed remarkable stability. The dye test confirmed that all gums and blends emulsions are oil in water (O/W) system. The rheological flow profiles of gums solutions at varying concentrations reflect a Newtonian flow for 50% and 40% concentrations and shear-thinning flow behavior for 30% and 20% concentrations. All gums and blends, O/W, emulsions showed oil's concentration dependence; their profiles exhibited a shear-thinning flow behavior and a Newtonian flow beyond 100 s^{-1} shear rate suggesting the alignment, of gums molecules, with shear direction. The dynamic rheological study showed moduli frequency dependence pattern for gum dispersions, gum emulsions, and blend emulsions suggesting network formation of the gum molecules around the oil droplets of the emulsions.

Abstract (Arabic)

المستخلص

تم توصيف أربعة عينات موثوقة المصدر من افرازات صمغ الأكاشيا وهي أكاشيا السنغال. السنغال (ASG)، أكاشيا المليفرا (AMF)، أكاشيا سيال . سيال (ASY)، وأكاشيا السمر . raddiana(ATR)، وتمايزت في محتوى الرطوبة والرماد والنتروجين والبروتين، ودرجة الحموضة، والدوران الضوئي المحدد، وعدد متوسط الوزن الجزيئي لتكون 9.76%، 3.40%، 0.327%، 2.158%، 4.94، -31.75، و $0.24x10^6$ لASG، 9.56%، 2.5%، 0.630%، 4.158%، 4.53، -48.25، و $2.10x10^6$ لAMF، 8.35 %، 3.13%، 0.243%، 1.610 % ، 4.84، +56.00، و $2.95\ x10^6$ لASY و 8.49 %، 2.05 %، 1.549%، 10.378%، 4.45، +86.75، و $2.06\ x10^6$ لATR على التوالي.

أظهرت أطياف ^{13}C NMR و ^{1}H لعينات الصمغ التشابه في مكونات السكريات الفردية ولقد لوحظت أنماط مميزة. وكذلك لوحظت المجموعات الوظيفية نفسها من أنماط FTIR . كانت الأطياف الحرارية DSC وTGA مميزة لكل . أعدت المستحلبات ASG،AMF، ASY، وATR بدون إضافة عوامل الترجيح باستخدام تركيزات مختلفة من الآيزوبروبيل ميريستيت (IPM). وخليط ASG وAMF من سلسلة *Vulgares* وASY و ATR من سلسلة *Gummiferae* بنسب مختلفة. تم إعداد مستحلبات الخليط بتركيز 20٪ IPM. مورفولوجية المستحلبات على مدى سبعة أيام من الحضانة عند **45C** ، عرضت قطرات كروية وكثيفة.أما قياسات حجم الجسيمات، وعلى مدى أربعة أسابيع من الحضانة في **54C**، أظهرت أن ATR شكلت قطرات أصغر حجما وأكثر استقرارا مقارنة بالأخرى. وقد لوحظ حالة فصل المستحلبات في تراكيز الزيت المنخفضة لجميع المستحلبات وأظهرت مستحلبات المزيج استقرارا ملحوظا ومقاومة لحالة الانفصال. أكد اختبار الصبغة ان مستحلبات الأصماغ ومستحلبات مزيج الأصماغ انها كونت مستحلب زيت في ماء (O / W) . لمحات تدفق الريولوجية لمحاليل الأصماغ بتركيزات متفاوتة تعكس تدفق نيوتن لتركيزات50٪

و 40٪ وسلوك تدفق القص الرقيق لتركيزات 30٪ و 20٪. وأظهرت جميع مستحلبات الأصماغ والمزيج أن اللزوجةتتناسب طرديا مع زيادة تركيز الزيت؛ و وأظهرت البيانات تدفق القص الرقيق بشكل عام وتدفق النيوتونية لمعدلات تدفق قص تتجاوز $100s^{-1}$ مما يشير إلى المواءمة بين جزيئات الأصماغ مع اتجاه القص. وأظهرت الدراسة الريولوجية الديناميكية تناسبا طرديا للتردد مع أنماط الرجوعية لمحاليل الأصماغ و مستحلباتها، ومستحلبات المزيج مما يشير إلى تشكيل شبكة من جزيئات الأصماغ حول قطرات الزيت في المستحلبات.

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Introduction

1.1.Definition of gums

Gums are polysaccharides either hydrophobic or hydrophilic ,high molecular weight molecules, usually with colloidal properties, which in an appropriate solvent or swelling agent produce gel, highly viscous suspension, or solutions at low dry substance content (Anderson, Dea, and Hirst, 1968; Anderson, Dea, Karamalla, and Smith, 1968), thus, the term gum is applied to a wide variety of substances of "gummy" characteristics and cannot be, precisely, defined. Hydrophobic substances, often, called gums are high molecular weight hydrocarbons and other petroleum products, rubbers, certain synthetic polymers, chicly for chewing gum, and the resinous saps which often exude from evergreens which are sometimes, commercially, tapped yielding, gum balsam and gum resin.

Most commonly, however, the term gum as technically employed in industry refers to plant polysaccharides or their derivatives which are dispersible in either cold or hot water to produce viscous mixture or solutions. Thus, modern usage includes the water – soluble or water-swellable derivatives of cellulose and the derivatives and modifications of other polysaccharides which in the natural form are insoluble. Usage would classify as gums all polysaccharides or their derivatives which when dispersed in water at low dry substance content, swell to produce gels, highly viscous dispersions, or solutions (Coppen, 1995). This definition does not require that gums have the property of tackiness, and consequently, such a definition includes as gums those polysaccharides and derivatives which are slimy or mucilaginous. Some authors have tried to classify, separately, these slimy substances from plants into a category called mucilage. Yet, it is more logical to consider tackiness and sliminess as the exhibition of two different physical properties of gums. Hence, there are tacky gums and slimy or mucilaginous gums. Tackiness and sliminess are manifestations of two, somewhat, controllable physical properties. It is possible to modify a gum so that tacky properties are withdrawn and mucilaginous properties introduced. Yet the gum remains hydrophilic and capable of giving high viscosity to its dispersions even at low concentrations consequently, the mucilaginous property is distinctive but a category of mucilage's has no chemical significance (Glicksman, 1962).

1.2. Colloidal systems

The word colloid is of Greek origin; the Greek word kola, meaning “glue”. Thomas Graham is usually regarded as the founder of colloids science (Sharma, 2009). A colloid is a solution in which a substance is dispersed evenly throughout a solvent. Because of this dispersal, some colloids have the appearance of solutions. Colloid is defined as a hydrocolloid system wherein the colloid particles are dispersed in water. Colloids are intermediate between true solutions on one hand

and suspensions on the other. It is, obviously impossible to draw a boundary between true solutions and colloidal solutions. Colloidal behavior can be connected with greatly increased area compared with the volume as the size is reduced. The essential properties of colloidal dispersions can be ascribed to the fact that the ratio of the surface area to the volume of particles is very large. In a true solution, the system consists of one phase only and there is no true surface of separation between the molecular particles of solute and solvent. The sizes of particles in colloidal state range from 1nm to 1 m (Levine, 2001). Ostwald regarded colloidal system as heterogeneous in character consisting of two phases: (1) Disperse phase and (2) Dispersion medium. Dispersed phase refers to the phase forming the particles. Dispersion medium is the medium in which dispersion of the particles takes place. Colloidal dispersions are, thermodynamically, unstable and tend to coagulate and precipitate on standing unless precautions are taken. Since both the disperse phase and dispersion medium may be solid, liquid or gaseous there can be several different types of colloidal system (Sharma, 2009). Colloidal solutions are known as sols. If the dispersion medium is water, they are called "hydrosols" or sometimes "aqua sols". And if it is liquid, the colloidal solution is known as emulsion. Table 1.1 shows the classification of colloids (Sharma, 2009; Shaw, 1992).

Table 1. 1

Table1.1Classification of colloids

Dispersed phase	**Dispersion medium**	**Name**	**Example**
liquid	Gas	Liquid aerosol	Fog, liquid spray
Solid	Gas	Solid aerosol	Smoke, dust
Gas	liquid	Foam	Foam from soap
liquid	liquid	Emulsion	Milk, crude oil
Solid	liquid	Sol	AgI sol, pastes
Gas	Solid	Solid foam	Expanded polystyrene
liquid	Solid	Gel	Opal, pearl
Solid	Solid	Solid suspension	Pigmented plastics

Dispersion of solids in liquids can be roughly divided into two categories lyophilic and lyophobic sols. Lyophobic (solvent hating) sols have little attraction between the disperse phase and dispersion medium. These are relatively less stable as compared with lyophilic sols. On heating or cooling the lyophobic systems, solids are obtained which cannot be reconverted into sols either by adding solvent or by warming. Lyophilic (solvent loving) sols on the other hand are system in which the disperse phase shows some definite affinity for the medium. Lyophilic sols are generally reversible and behave like true solutions to some extent e.g. gums, starches and proteins. These substances are absorbed by the disperse phase and are stabilized by strong salvations. Hydrocolloids are more commonly called gums (Sharma, 2009).

1.3. Hydrocolloids

Hydrocolloids or gums are a diverse group of long chain polymers characterized by their property of forming viscous dispersions and/or gels when dispersed in water. These materials were first found in exudates from trees or shrubs, extracts from plants or seaweeds, flours from seeds or grains, gummy slimes from fermentation processes, and many other natural products. Occurrence of a large number of hydroxyl groups, noticeably, increases their affinity for binding water molecules rendering them into hydrophilic compounds. Further, they produce dispersions, which are intermediate between a true solution and a suspension, and exhibit the properties of a colloid. Considering these two properties, they are, appropriately, termed as 'hydrophilic colloids' or 'hydrocolloids' (Milani and Maleki, 2012). Food hydrocolloids are high molecular weight hydrophilic biopolymers used as functional ingredients in the food industry for the control of microstructure, texture, flavor and shelf-life. The term "hydrocolloid" embraces all polysaccharides that are exuded or extracted from plants, seaweeds and microbial sources, as well as gum derived from plant exudates, and modified biopolymers made by the chemical or enzymatic treatment of starch or cellulose. In addition, due to its polydispersity and highly hydrophilic character, the unique protein gelatin has become accepted as an exceptional member of this polysaccharide club. But other food proteins, like casein and gluten, are, traditionally, not classified as hydrocolloids- even though they, certainly, do exhibit functional properties that overlap, considerably, with those of food polysaccharides (Dickinson, 2003; Mirhosseini, Tan, and Naghshineh, 2010).

1.4. Bioemulsifiers

Bioemulsifiers have been recently attracting the industrial community as natural and promising candidates for the replacement of synthetic commercial surfactants due to their intrinsic properties such as lower toxicity, higher biodegradability, higher foaming capacity and higher activity at extreme temperatures, pH levels and salinity. These compounds are biological molecules with surfactant properties similar to the well-known synthetic surfactants and include microbial compounds, natural polymers, such as Gum Arabic (GA) which has been extensively exploited and used in the food industry as a surfactant agent, and other amphiphilic polymer surfactants, usually, based on polysaccharides. Gum Arabic is among the most studied and widely used hydrocolloid due to its excellent emulsifying capacity, ample spectrum of applications and millenary use (Trindade et al., 2008).

1.5. Classification of gums

It has been customary, in the past, to classify most of the gums as polysaccharides and to group them according to plant origin. Thus, the seaweed group comprised the extracts known as agar, alginates, and carrageenan; tree exudates such as gum Arabic, gum karaya, gum tragacanth, and gum chatty; and the seed gums included locust bean and guar gum. Other gum like materials such as pectin and starch were treated as separate groups, while gelatin, being a protein was not included at all. In addition, there was no room for the synthetic gums such as the cellulose derivatives which are carbohydrate gum, or for the synthetic vinyl polymers such as polyvinylpyroldinone (PVP) which require a completely new category. The use of botanical origin as a basis for the classification of important plant gums is valid and useful, since gums of similar origin and functionality frequently have similar properties and chemical structures, and can, occasionally, be employed for the same purpose. Thus, locust bean gum and guar gum, which are both derived from similar plant- seed sources, have the similar chemical structure of neutral Galacto-mannans, and differ only in the ratio of Galactose to mannose molecules. Their thickening properties are sufficiently similar and of the same magnitude to allow the interchange of the gums in certain specific applications, but not, indiscriminately, and not in all applications (Whistler and Miller, 1959). For a general classification to be useful, it should embrace all types of gums that are used in the food industry, and it should leave room for the new gums that are certain to be developed in the future. Following this line of thought it has been proposed that the following all-inclusive classification composed of three main categories. (1) natural gums – those found in nature; (2) modified natural , or semi synthetic, gums – those based on chemical modifications of natural gums or gum like materials ; (3) synthetic gums – those prepared by total chemical synthesis. Specific gums comprising these categories are shown in Table 1.2. As a further aid to identification each category is broken down into subgroups based, where possible, on the common origins, functions, or properties of the particular gums.

1.6. Gum Arabic

Gum Arabic is defined as the dried exudation obtained from the stems and branches of natural strains of *Acacia senegal* (L), family Leguminosae (FAO, 1990). It consists mainly of high molecular mass polysaccharides and their calcium, magnesium and potassium salts, which on hydrolysis yields arabinose, galactose, rhamnose and glucuronic acid. Gum arabic, is the oldest and best known of all plants gum exudates and has been used as an article of commerce for over 5000 years (Glicksman and Sand, 1973). Gum arabic has a wide range of uses in foods and pharmaceutical industries, where it's stabilizing, thickening and gel forming properties are the main physical requirements. Gum arabic is also used in the mining industry and in the manufacture of textiles, ink and paper. It is also used in bakery, meat products, beverages, confectionery adhesives, cosmetics, printing, fertilizers and binder to explosives (Glicksman and Sand, 1973).Sudan is the world's largest producer of gum Arabic, with production reaching 40,000 tons in 2000. Chad is the second largest producer, followed by Nigeria, Mali and Senegal. In Sudan more than thirty distinct *Acacia* species are found (El Amin, 1990), but the great majority of commercial gum comes from *Acacia senegal* var. *senegal*. Sudan is the world's largest producer of gum arabic with various grades gum, including handpicked selected, cleaned and sifted, cleaned, siftings, dust and red. Following export to Europe and the US, some grades of gum are processed providing greater quality and convenience to the users (Islam, Phillips, Sljivo, Snowden, and Williams, 1997). This may be by mechanical grinding (kibbling) which breaks up the gum nodules into various sizes for faster dissolution. Further processing may involve dissolution and filtration of the gum to remove impurities, followed by spray drying or roller drying (Phillips and Williams, 2009) . Gum arabic is a naturally occurring exudate collected from *Acacia senegal* trees and, to a lesser extent, from *Acacia seyal* trees (Islam et al., 1997). It is one of the oldest and most important industrial gums. The Ancient Egyptians used gum arabic as an adhesive when wrapping mummies and in mineral paints when making hieroglyphs (Verbeken, Dierckx, and Dewettinck, 2003). In modern times, the most important applications of gum arabic have been not as an adhesive but as an emulsifier in the food and pharmaceutical industries. Gum arabic is considered to be the best gum in use in dilute oil-in-water emulsion systems (Garti, 1999), one important example of which is the use of citrus oils as flavoring agents in soft drinks where the oils are converted into a water-dispersible emulsion (Verbeken et al., 2003).

Table 1. 2

Table 1.2 Classification of gums (Ahmed, 2012)

Natural gums	Modified (semi-synthetic) gums	Synthetic gums
Plant exudates	**Cellulose derivatives**	**Vinyl polymers**
Arabic		
Tragacanth	Carboxymethyl cellulose	Poly vinyl pyrrolidone
Karaya		
Gatti	Methylcellulose	(PVP)
Plant extracts		
Pectins	Hydroxypropylmethyl- Cellulose	Polyvinyl alcohol (PVA)
Arabinogalactan		
(larch gum)	Methylethylcelulose	**Carboxyvinyl polymer**
Plant seed flours		
Locust Bean	Methylethylcelulose	(carbopol)
Quar		
Psyllium seed	Hydroxypropylcellulose (klucel)	**Ethyleneoxide polymers**
Quince seed		
Seaweed extracts	Low methoxy pectin	Polyox
Agar		
Alginates	**Microbial fermentation gums**	
Carrageenan		
Furcellaran	Dextran	
Cereal starches		
Seed starches	Xanthan gum	
Corn		
Wheat	Pregelatinized starches	
Rice		
Waxy maize	**Modified starches**	
Sorghum		
Waxy sorghum	Carboxymethyl starch	
Tuber starches		
Potato	Hydroxethyl starch	
Arrowroot		
Tapioca	Hydroxypropyl starch	
Animal		
Gelatin		
Albumen		
Casein		
Vegetable		
Soy protein		

1.7. *Acacia* species

Over 1350 species of *Acacia* exist around the world. About 185 are endemic to the Americas, 95 to Asia and the Pacific, nearly 1000 are native to Australia, and 150 are African native (Kull and Rangan, 2008). The genus *Acacia* is the second largest within the Leguminosae family and contains at least 900 species. With their extensive root system, *Acacia* trees can be found in semi-arid areas in Australia, India, and America, but mainly in the Sahelian region of Africa. They are multipurpose trees, not only producing gum, but also preventing desert encroachment, restoring soil fertility, and providing fuel and fodder. Almost all commercial gum comes from the so-called gum belt of Africa, a vast area which extends over Mauritania, Senegal, Mali, Burkina Faso, Benin, Niger, Nigeria, Chad, Sudan, Eritrea, Ethiopia, Somalia, Uganda, and Kenya (Coppen, 1995). Sudan is the world's largest producer of gum arabic, followed by Nigeria, Chad, Mali, and Senegal. Gum from the Sudanese Kordofan region is known as the best quality gum and is used as the standard to judge gums obtained from other areas. Commercial gum arabic 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. *Acacia laeta*, *Acacia karoo*, and *Acacia gourmaensis* are some other gum yielding species with a more limited distribution (Islam et al., 1997). In Sudan, the gums from *Acacia senegal* var. *senegal* and *Acacia seyal* var. *seyal* are referred to as hashab and talha respectively, the former considered of higher quality (Baldwin, Quah, and Menzies, 1999). Most of these species grow scattered in the wild and gum from these untended trees is collected by semi-nomadic people. Cultivation is only practiced for *Acacia senegal* var. *senegal*. Particularly in Sudan, wild stands of *Acacia* trees are replaced by monocultures of *Acacia senegal* var. *senegal* in order to facilitate collection and obtain a more consistent quality(Verbeken et al., 2003). Gum arabic from other African countries may be variable in quality, because it may contain gums obtained from different species which occur jointly in the collection area. *Acacia senegal* var. *senegal* is a thorny tree that reaches a height of 4.5–6.0 m. It is very drought-resistant and grows on sites with annual rainfall of 100–950 mm and dry periods of 5–11 months. It also tolerates high daily temperatures of up to 45C or more, dry winds, and sandstorms. After 5 years, trees reach maturity and are tapped. Although gum can be tapped from the trees after 3 years, the quality and yield are consistent only after 5 years, suggesting that gum biosynthesis and tree growth are in competition with each other (Joseleau and Ullmann, 1990).

1.8.*Acacia senegal* var. *senegal*

Acacia senegal var. *senegal* is a shrub or small tree 2 – 12 m tall, with a yellowish or grayish white, rather rough bark. The species has a wide distribution in Sudan gum belt (Awouda, 1974) in sandy soils under annual rainfall of 280 – 450 mm and on dark clays under rainfall > 500 mm (Badi, Ahmed, and Bayoumi, 1989).

The trunk may vary in diameter up to about 30cm. The bark is grayish-white; although in old trees growing in the open it may be dark, scaly and thin, showing the bright green cambium layer just below the surface if scratched with a nail. The slash is mottled red. Powerful hooked thorns, 3-5 m long, with enlarged base appear at the nodes of the branches, usually in3s. They are sharp, with some pointing forwards and others backwards. Leaves bipinnate, 3-8 pinnae (glands between uppermost and lowermost pinnae); rachis up to 2.5 cm long; pinnacles are pairs of 8-15, green; 2 stipular spines strongly re-curved with a 3rd pseudo-stipular between them. Flowers yellowish-white and fragrant, in cylindrical, axillary pedunculate spikes, 5-10 cm long; calyx of each flower has 5 deep lobes, 5 petals and a mass of short stamens; pistil inconspicuous. The pods are straight, thin, flat, shortly stipulates and oblong (7.5 x2 cm), green and pubescent when young, maturing to shiny bronze, often with dark patches and bearing prominent veins; seeds 3-6, smooth, flat, rather small, shiny, dark brown. Varietal differences in *Acacia senegal* are based on variation in natural distribution as well as differences in morphological characteristics such as the presence of or absence of hair on the axis of the flower spike, color of the axis, shape of pod tips, number of pinnae pairs, occurrence of a distinct trunk and shape of the crown. Four different varieties of *Acacia senegal* are recognized: var. *senegal,* var. *kerensis Schweinf.,* var. *rostrata Brenan and* var. *leiorhachis Brenan*. The generic name ‘*Acacia*’ comes from the Greek word ‘akis’, meaning a point or a barb.

Drought-tolerant, *Acacia senegal* var. *senegal* is the characteristic species in the drier parts of Sudan and the northern Sahara and is to be found throughout the vast area from Senegal to the Red Sea and to eastern India. It extends southwards to northern Nigeria, Uganda, Kenya, Tanzania and southern Africa. In India it is found chiefly in Sind and Ajmer. In Sudan, the tree exists both in the wild and is cultivated -mainly on sandy hills, but is also grows well in cotton soil.

Figure (1.1): *Acacia senegal* var. *senegal* Tree.

Figure 1. 1

1.8.1. Botanical classification

Kingdom: Plantae

Division: *Magnoliophyta*

Class: *Magnoliopsida*

Order: *Fabales*

Family: *Fabaceae (Leguminosae)*

Subfamily: *Mimosoideae*

Tribe: *Acacieae*

Genus: *Acacia*

Species: *senegal*

English name: Gum Arabic tree, three thorned *Acacia.*

Arabic name: Hashab (El Amin, 1977; Vogt, 1995).

1.9.*Acacia mellifera*

Acacia mellifera is a low, branched tree with a more or less spherical crown. Black bark on stem becomes ash-grey to light brown on the branches, bearing small, short, sharply hooked spines in pairs. It has shallow but extensive rot system radiating from the crown, allowing the plant to exploit soil moisture and nutrients from a large volume of soil. The roots rarely penetrate more than 1m. Leaves characterized by2 pairs of pinnulae, each with a single pair of leaflets. Leaflets are elliptic 0.6-2 cm long and 0.6-1.2 cm wide, glabrous and highly coloured beneath.

Flowers are sweetly scented, especially at night, in elongated spikes, cream to white in spiciform racemes, up to3.5 cm long; pedicels 0.5-1.5 m long; calyx up to 1m long; corolla 2.5-3.5 m long. The papery pods with 2-3seds are reticulate, flat, elongated, 2.5-.5 cm long, 6cm wide, hemmed, sometimes more or less narrowed between the seeds. The specific name *mellifera* means 'honey-bearing'.

Acacia mellifera is a commonly occurring shrub on rangelands throughout the savannah in western, eastern and southern Africa. The train preference is rocky hillsides with rainfall along seasonal watercourse, mixed with other trees. If left unattended, especially if grazing is heavy and no fires check its spread, it may form dense, impenetrable thickets, 2-3 m high and sometimes hundreds of meters across, slowly taking over good grazing land. This species is drought-tolerant.

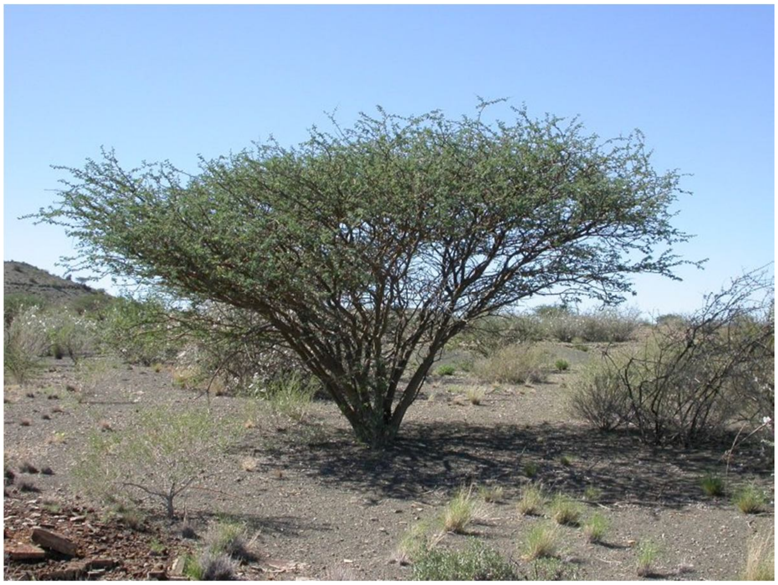

Figure (1.2): ***Acacia mellifera*** **Tree.**
Figure 1. 2

1.9.1. Botanical classification

Family: Leguminosae

Subfamily: *Mimosoideae*

Genus: *Acacia*

Species: *mellifera*

English name: Black thorn

Arabic name: Kitir (El Amin, 1977; Vogt, 1995).