



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



**Sudan university of Science and Technology**  
**College of Graduate Studies**

# **Formulation of a Shoe polish using Activated Charcoal and Gum arabic**

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**A Dissertation Submitted in Partial Fulfilment of the Requirement of the  
Degree of Master of science (Chemistry)**

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**August 2018**



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## إستهلال

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(وَقُلْ اَعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ وَسَتُرَدُّونَ إِلَىٰ عَالَمِ الْغَيْبِ  
وَالشَّهَادَةِ فَيُنَبِّئُكُمْ بِمَا كُنْتُمْ تَعْمَلُونَ)

صدق الله العظيم

سورة التوبة الاية (١٠٥)

## Dedication

*This thesis is dedicated to my*

*parents,*

*brother*

*and sisters.*

## **Acknowledgment**

First and foremost, my sincere gratitude goes to Almighty Allah.

My profound gratitude goes to my supervisor prof. Mohammed Elmubark Osman for his patience and untiring supervision coupled with the valuable advices and information.

I also want to express my most profound gratitude to the staff at the chemistry departments at Sudan University of Science and Technology, and Alnilain University, Mr. Zahir A.salam and Miss.Marwa Salahaldien at the Natural African Forest Products (NAFOP), Dr. Fayza Sabri Ahmed, Almohandis Paints for technical support.

My completion of this project could not have been achieved without the moral support of my friends at the Sudan University of Science and Technology, and English cultural centre for moral support.

### **Abstract:**

The aim of this project is to produce two types of black shoe polish, one for cleaning the shoes and the second for shining it.

The two types have been produced from the Activated Carbon as colorant agent, *Acacia senegal* var *senegal* Gum as emulsifying agent and oily phase from paraffin oil, white wax and Vaseline.

The measurements of the cleaning shoe polish show that the product has conductivity of 0.995 millisemens/centimeter at 26.2°C, pH of 5.71, specific gravity of 0.970 gram/cubic centimeter, and viscosity of 6.10 poise.

## مستخلص البحث

هذا البحث يهدف إلى إنتاج نوعين من الطلاء الأسود للأحذية احدهما لتنظيف الأحذية والآخر لتلميعها. حيث تم تحضير النوعين باستخدام محلول الكربون المنشط كمادة ملونه، صمغ الهشاب كعامل إستحلاب، وطور زيتي من زيت البرافين والشمع الأبيض و الفازلين. 7% من البنزين أضيفت إلى الطلاء الملمع للأحذية لتحسين خاصية اللمعان.

تم تقدير الخواص الفيزيائية للطلاء المنظف حيث وجد أن للمنتج توصيليه كهربيه تعادل 0.995millisemens/centimete عند درجة حرارة 26.2°C ، الرقم الهيدروجيني يعادل 5.71 ، الكثافة تعادل 0.970 gram/cubic centimetre، ولزوجة قدرها 6.10 poice .

**Abbreviations:**

PAG :powdered Activated Carbon.

GAC: Granular Activated Carbon .

EAC: Extruded Activated Carbon .

AG: Arabinogalactan .

AGP: Arabinogalactan protin.

GP: Glycoprotin.



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# **Chapter One**

## **Introduction and Literature Review**

# Chapter One

## Introduction and Literature Review

### 1.1 Introduction:

The history of the shoe polish was started before the year 1900 using the wax, ash and tallow. After 1900 it was replaced by using different liquids and suspended solids (Moral; 2017). Various substances have been used as shoe polish for hundreds of years starting with natural substances like wax and tallow. Modern polishes formulated were introduced early in 20<sup>th</sup> century and some products from that era are still in use up till today (Mohammed and Dawaki, 2013). Wax and polishes are used for many purposes they have their principal use in waterproofing; they are mainly consumed industrially as components of complex formulations, often for coatings. Most polishes depend on wax or oil for their polishing properties. Wax polishes are however more long lasting (Okanlawon, 2005).

### 1.2 Literature Review:

#### 1.2.1 Shoe polish

##### 1.2.1.1 Definition:

Shoe polish is, usually, a waxy paste or cream used to shine, waterproof and restore the appearance of leather to make the finished leather smooth and glossy by gentle rubbing and enhancing its performance and durability, Figure 1:1 (Turner, 1993; Mohammed and Dawaki, 2013;). It applies on leather products to repel other solvents or dust from the film surface and impart elasticity and gloss to the film without destroying the hardness of leather (Guthrie, 1994).



**Figure 1.1 Shoe polish when it has applied on shoes**

It is expected also that a polish will clean the surface and prevent deterioration. Due to surface tension forces, a glossy surface is created after polishing. This will dry to give the object the required lustre, the polish has to be resistant to corrosion, smooth, transparent, uniform in colour, be adhesive, glossy and also thin (Okanlawon, 2005).

#### **1.2.1.2 Shoe polish content:**

Shoe polish consists of a waxy colloidal emulsion, a substance composed of a number of, partially, immiscible liquids and solids. It is usually made from ingredients including water, naphtha, lanoline, turpentine, wax (often Carnauba wax), Gum arabic, ethylene glycol and if required a colorant such as carbon black or an azo-dye (such as aniline yellow). Typically it has a specific gravity 0.8, it is negligibly soluble in water, and is made of between 65 and 77% volatile substance, which helps shoe polish to dry out and harden after application while retaining its shine. (Hilditch, 1999; Household products database, 2007).

Lanoline, hydrophilic grease from wool bearing animals such as sheep or goats, acts as both water proofing wax and a bonding agent, giving the shoe polish its greasy feel and texture, it prevents the naphtha from evaporating until the polish has been spread and buffed into a thin film on the leather surface. An essential ingredient in shoe polish manufacture is thickener, without this the polish will be too runny making it difficult to use. Gum arabic, a substance which is commonly used to increase the viscosity of the product. Water acts as a solvent while different dyes can be used to give it the coloration (De Bussy 1972). Shoe polishes contain chemical substances which can be absorbed through the skin or inhaled, during application; one should ideally wear gloves and stay in a well-ventilated area while applying it. And will cause irritation to the eye if there is direct contact (Mohammed and Dawaki, 2013).

#### **1.2.1.3 Types of shoe polish**

Basically there are two types of polish:

- i. Waterless:

The paste polished is non-aqueous and clear or translucent

- ii. Water based:

The emulsion polish is milky in appearance and aqueous

Oil polishes are easy to apply but the polished surface, easily, attracts dust and finger marks. However, wax polishes are more difficult to apply on the surface and are more

reliable in that little or on dust is attracted and no finger marks are shown. Nevertheless, it is better to use wax polish on shoes rather than oil polishes. (Krik and Othmer, 1947) .

A number of companies that manufacture shoe care products also sell a liquid shoe polish in a squeezable plastic bottle, with a small sponge applicator at the end to decrease its viscosity. Bottled polish, usually, has very low wax content.

#### **1.2.1.4 Properties of shoe polishes**

- Gloss: forms the basis for the decorative and protective properties of polish.
- Quick-Drying: the precipitation of dust on the polished surface occurs when there is low drying rate.
- Thin-Layer formation: this serves as a barrier between the polished surface and the moisture filled environment. Which a smart look inhibits corrosion.
- Decorative: The polish must look smart and nice (Hans-George 1977).

### **1.2 .2 Activated Carbon:**

#### **1.2.2.1 Definition:**

Activated carbon, also widely known as activated charcoal or activated coal is a form of carbon which has been processed to make it extremely, porous resulting from the processing of raw materials under high temperature reactions and thus to have a very large surface area available for adsorption or chemical reactions (CPL Caron Link, accessed 2008-05-02).

It can be distinguished from elemental carbon by the oxidation of the carbon atoms found on the outer and inner surfaces (Mattson and Mark 1971).

It composed of 87% to 97% carbon but also contains other elements depending on the processing method used and raw material it is derived from. Activated carbon's porous structure allows it to adsorb materials from the liquid and gas phase (Jankowska , 1991).For these reasons, activated carbons are ,widely, used as adsorbents for the removal of organic chemicals and metal ions of environmental or economic concern from air, gases, potable water and waste water (El-Hendawy, 2003). The word active is, sometimes, used in place of activated. Due to such high degree of micro porosity, just 1 gram of activated carbon has a surface area in excess of  $500m^2$ , as typically determined by nitrogen (gas) adsorption. Sufficient activation for useful application may come, solely, from the high surface area, though further chemical treatment, generally, enhances the adsorbing properties of the material (Subhashree, 2011).

### **1.2.2.2 History of Activated carbon and present day application:**

The useful properties of activated carbon have been known since ancient times. This traces to 1500 B.C. when Egyptians used charcoal as an adsorbent for medicinal purposes and a purifying agent. Around 420 B.C. it was observed that Hippocrates dusted wounds with powdered charcoal to remove their odour. Ancient Hindu societies purified their water by filtration through charcoal (Bansal, 2005).

In 1773, the Swedish chemist Karl Wilhelm Scheele was the first to observe adsorption of gases on charcoal. A few years later activated carbon began being used in the sugar industry as a decolourizing agent for syrup. Since then, major developments have occurred in the technology relating to the manufacture of activated carbons, which are currently employed commercially, in a wide range of industries (Mcdougall , 1991). In the early 20<sup>th</sup> century the first plant to produce activated carbon industrially was built for use in sugar refining industry in Germany. Many other plants emerged in the early 1900's to make activated carbons, primarily, for decolourization. During the First World War activated carbon was used in gas masks for protection against hazardous gases and vapours. Today, activated carbon is used to remove colour from pharmaceutical and food products, as air pollution control devices for industrial and automobile exhaust, for chemical purification, and as electrodes in batteries. 500,000 tons per year of activated carbon are produced globally (Jankowska, 1991). 80% of this is used for liquid phase applications, and 20% is used for solid phase applications.

### **1.2.2.3 Classification:**

Pradhan (2011) reported that activated carbons are complex products which are difficult to classify on the basis of their behaviour, surface characteristics and preparation methods. However, some broad classification is made for general purpose based on their physical characteristics.

#### **i. Powdered Activated Carbon(PAC):**

Traditionally, active carbons are made in particulate form as powders or fine granules less than 1.0 mm in size with an average diameter between 0.15 and 0.25mm, Figure1.2. Thus they present a large surface to volume ratio with a small diffusion distance.

PAC is not commonly used in a dedicated vessel, owing to the high head loss that would occur. It is generally added directly to other process units, such as raw water intakes, rapid mix basins, clarifiers, and gravity filters.





**Figure 1.2: Powdered activated carbon (PAC)**

**ii. Granular Activated Carbon (GAC):**

Granular activated carbon has a, relatively, larger particle size compared to powdered activated carbon ,Figure 1.3 and consequently, presents a smaller external surface. Diffusion of the adsorbate is thus an important factor. These carbons are therefore preferred for all adsorption of gases and vapors as their rate of diffusion are faster. Granulated carbons are used for water treatment, deodorization and separation of components of flow system.



**Figure 1.3: Granular activated carbon (GAC)**

**iii. Extruded Activated Carbon (EAC):**

Extruded activated carbon combines powdered activated carbon with a binder, which are fused together and extruded into a cylindrical shaped, activated carbon block with diameters from 0.8 to 130mm, Figure 1.4. These are, mainly, used for gas phase applications because of their low pressure drop, high mechanical strength, and low dust content (Pradhan, 2011).



**Figure 1.4: Extruded activated carbon (EAC)**

**iv. Impregnated Carbon:**

Porous carbons containing several types of inorganic impregnant such as iodine, silver, cations such as Al, Mn, Zn, Fe, Li, Ca have also been prepared, Figure 1.5 for specific application in air pollution control especially in museums and galleries. Due to antimicrobial/antiseptic properties, silver loaded activated carbon is used as an adsorbent for purification of domestic water. Drinking water can be obtained from natural water by treating the natural water with a mixture of activated carbon and  $\text{Al}(\text{OH})_3$ , a flocculating agent. Impregnated carbons are also used for the adsorption of  $\text{H}_2\text{S}$  as 50% by weight have been reported (Pradhan, 2011).



**Figure 1.5: silver- impregnated activated charcoal**

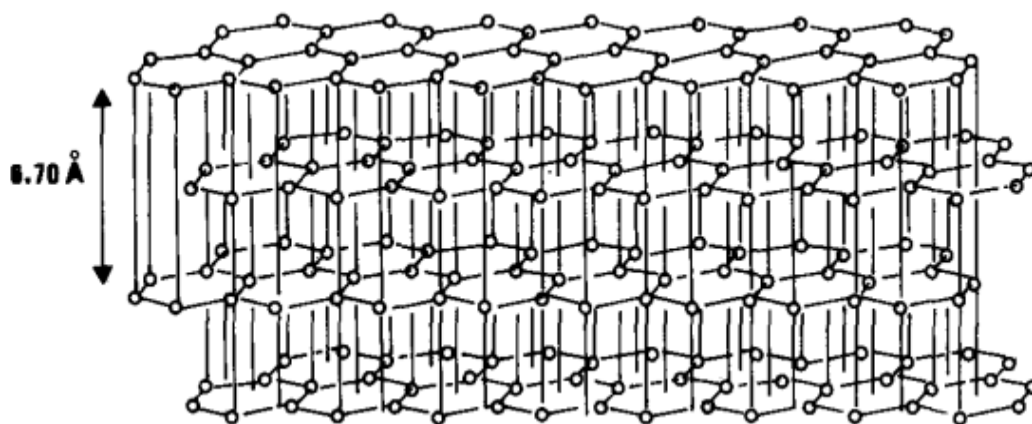
**v. Polymer Coated Carbon:**

This is a process by which a porous carbon can be coated with a biocompatible polymer to give a smooth and permeable coat without blocking the pores. The resulting carbon is useful for hemoperfusion. Hemoperfusion is a treatment technique in which large volumes of the patient's blood are passed over an adsorbent substance in order to remove toxic substances from the blood.

Others: Activated carbon is also available in special forms such as cloths and fibres. The "carbon cloth" for instance is used in personnel protection for the military.

#### 1.2.2.4 Structure:

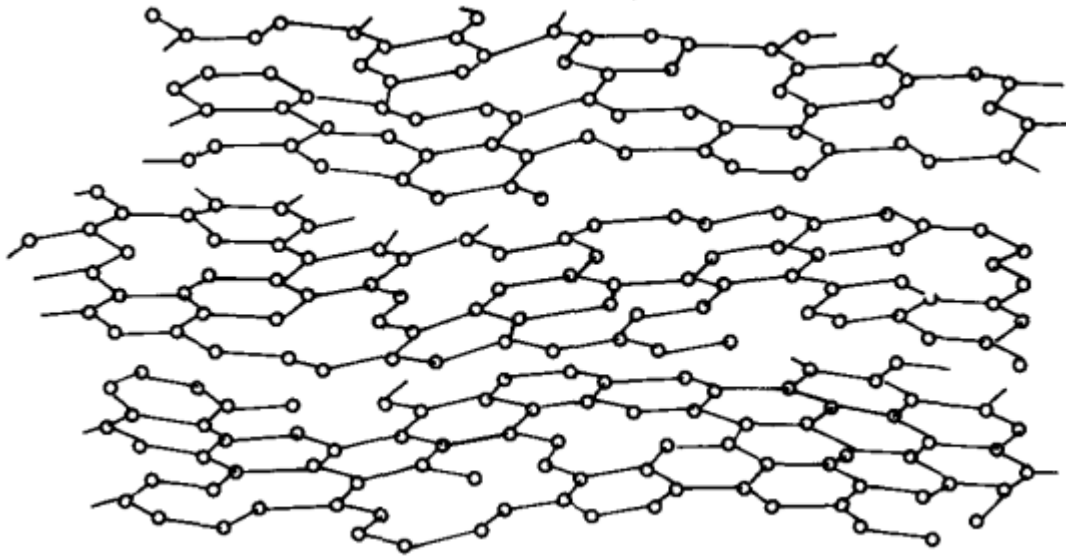
X-ray-diffraction studies have shown that the structure of thermally activated carbon is similar to that of graphite, Figure 1.6 consists of layers of fused hexagons held approximately 3.35Å apart by Van der Waals forces, so that the carbon atoms in anyone plane lie above the centres of the hexagons in the layer immediately below it. The lattice is of the ABAB type (Bockris ,1969; Mattson and Mark, 1971).



**Figure 1.6: Representation of the structure of graphite**

\*The circles denote the positions of carbon atoms, while the horizontal lines represent carbon to carbon bonds.

The proposed structure of thermally activated carbon is depicted in Figure 1.7



**Figure 1.7: Proposed structure of the activated carbon**

\*Oxygen-containing functional groups are located at the edges of broken graphitic ring systems

Carbon is believed to be composed of tiny graphite-like platelets, only a few carbon atoms thick and 20 to 100 Å in diameter, which form the walls of open cavities of molecular dimensions, i.e. the pore system. However, the hexagonal carbon rings, many of which have undergone cleavage, are randomly orientated, and lack the directional relationship with one another that is present in single graphite crystals. The overall structure is therefore very disordered, and is often referred to as 'turbostratic'. Furthermore, the separation between the layers is greater than that found in graphite. Because of the level of structural imperfections in activated carbons; there are many possibilities for reactions with carbon atoms at the edges of the planar layers.

As results, Oxygen-containing organic functional groups located mostly at the edges of broken graphitic ring systems are present on the carbon's surface.

Although the exact chemical structures of these surface oxides are not known with certainty, it has been suggested that the surface oxides depicted in Figure 1.7 are the oxides most often present in, thermally, activated carbons (Mattson and Mark, 1971). Basic surface groups have also been identified, and it appears that the nature of the surface groups depends upon conditions during and after manufacture (Cheremisinoff and Ellerbusch, 1978).

### 1.2.2.5 Activated Carbon production processes:

Subhashree (2011) reported that activated carbon is nothing but carbon produced from carbonaceous materials like nutshells, peat, wood, coir, lignite, coal and petroleum pitch. It can be produced by any one of the following processes:

- i. Physical reactivation: by this process precursor is developed into activated carbons using gases. This is ,generally, done using one or a combination of the following process:
  - a) Carbonization: It is a heat treatment at 400-800°C in the, absence of oxygen (usually in inert atmosphere with gases like argon or nitrogen) which converts raw materials to carbon by minimizing the content of volatile matter and increasing the carbon content of the material. This increases the materials strength and creates an initial porous structure which is necessary if the carbon is to be activated.

Adjusting the conditions of carbonization can affect the final product significantly. An increased carbonization temperature increases reactivity, but at the same time decreases pore volumes. This decreased volume of pores is due to an increase in the condensation of the material at high temperatures carbonization which yields an increase in mechanical strength. Therefore, it becomes important to choose the correct process temperature based on the desired product of carbonization (Jankowska et. al., 1991).
  - b) Activation/oxidation: in this process raw material or carbonized material is exposed to oxidizing atmospheres( carbon monoxide, oxygen, or steam) at temperatures above 250°C, usually in the temperature range of 600-1200°C, To create micropores (Beguin and Frackowiak, 2010). Typically, these micropores have a width of less than 2 nanometers, where the majority of adsorption occurs. (Leimkuehler, 2010)
- ii. Chemical activation: Before carbonization, the raw material can be impregnated with certain chemicals. The chemical needs to be typically an acid, strong base, or a salt (phosphoric acid, potassium hydroxide, sodium hydroxide, zinc chloride, respectively) to eliminate the majority of hydrogen and oxygen from carbon structure. After impregnation, the raw material needs to be carbonized at lower temperature (450- 900°C).

It is believed that the carbonization/ activation proceeds simultaneously, with the chemical activation. Chemical activation is preferred over physical activation owing to the low temperature and short time needed for activating material.

### **1.2.3 Gum Arabic:**

#### **1.2.3.1 Plant source:**

*Acacia* trees belong to the botanical family Leguminosae, a predominant species of the group of Mimosaceae. There are more than 1300 species of *Acacias*, but only a few of them produce gums.

FAO (1990) defines Gum arabic as the dried exudation from stems and branches of *A. senegal*, and closely related species. The only species producing Gum arabic, as per FAO definition, are *Acacia senegal* and *Acacia seyal* which have different properties and also divided into several varieties: for instance *senegal*, *kerensis*, *leiorhachis* or *rostrata* for *Acacia senegal* and *fistula* and *seyl* for *Acacia seyal* (FAO, 1971; Cossalter, 1991; JECFA, 2006).

In Sudan, the term Gum arabic is used in a wider context to include two types of gum which are produced and marketed, nevertheless, they are clearly separated in both national statistics and trade: "Hashab" (from *A. Senegal*) and "Talha" (from *A. seyal*). In a still wider sense, Gum arabic is often taken to mean the gum from any *Acacia* species (and is sometimes referred to as "*Acacia Gum*") (Coppen, 1995).

#### **1.2.3.2 History of Gum arabic:**

Gum arabic is the oldest and best known of all the natural gums, its uses are dated to about 4,000 years B.C. in inks, painting, cosmetics, clothing, medicine, mummification process and it was also consumed as food on its own (Alland, 1944 ; CNI, 2008)

#### **1.2.3.3 Countries producing Gum arabic:**

Worldwide, Sudan is the largest producer and exporter of Gum arabic, followed by Chad, Nigeria, Mali, and Senegal. Chad and Nigeria, together produce 45,000 tons of Gum arabic to the market each year (PARTOS, 2009). Europe and USA are the most important Gum arabic markets, while Japan is the largest Asian consumer.

The Gum belt in Sudan covers the gross area estimated to cover 520,000 square Kilometres which is roughly one fifth of Sudan's total area. This area extends across Central Sudan in 12 states that lie within the low-rainfall savannah zone.

The belt covers parts of the clay and sandy plains characterized by a short rainy season of five months with an average rainfall of 300 to 800mm (ZAROUG, 2006).

#### **1.2.3.4 Description of Gum Arabic:**

Gum arabic is a pale to orange-brown solid (Figure 1.8) which breaks along a glassy fracture. The best grades are whole, spheroidal-tear shaped, orange brown, with a matt

surface texture. *Acacia senegal* var; *senegal* Gum can be used in the form of flakes, granulates, powder and spray dried material.



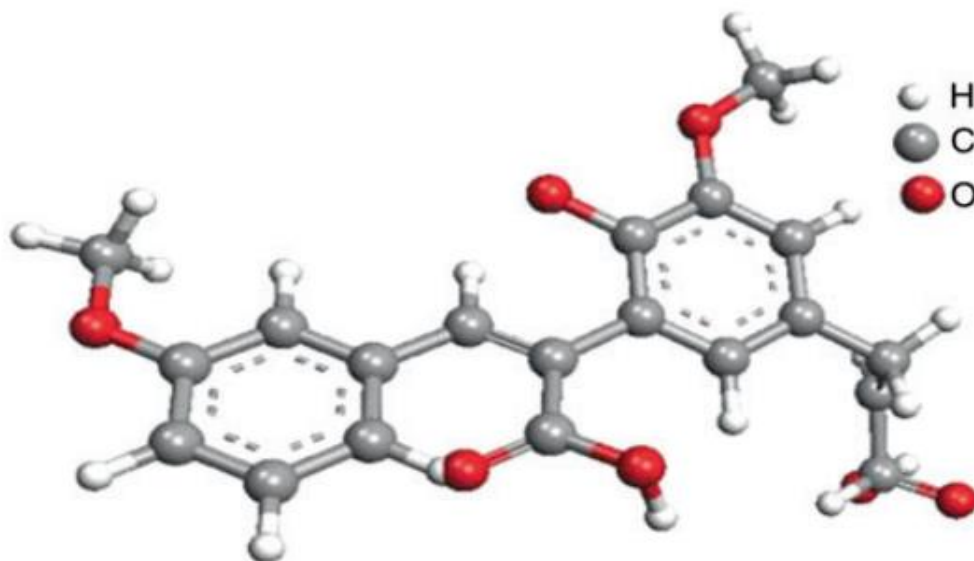
**Figure 1.8: Gum Arabic (*Acacia senegal* var; *senegal* gum)**

#### **1.2.3.5 Structure of Gum Arabic:**

FAO (1990) stated Gum arabic as a natural product complex mixture of hydrophilic carbohydrate and hydrophobic protein components.

Hydrophobic protein component functions as an emulsifier which adsorbs onto surface of oil droplets while hydrophilic carbohydrate component inhibits flocculation and coalescence of molecules through electrostatic and steric repulsions in food additives (Anderson et al., 1990).

The backbone of Gum arabic is composed of 1,3-linked $\beta$ -D-galactopyranosyl units Figure 1.9. The side chains are composed of two to five 1,3-linked $\beta$ -D-galactopyranosyl units, joined to the main chain by 1,6- linkages. Both the main and the side chains contain units of  $\alpha$ -L-arabinofuranos,  $\alpha$ -L-rhamnopyranosyl,  $\beta$ -D-glucopyranosyl, and 4-O- methyl- $\beta$ -D-glucopyranosyl, the last two mostly as end units (Islam et al., 1997).



**Figure 1.9: Chemical structure of the *Acacia senegal* Gum**

Gum arabic consists mainly of high-molecular weight polysaccharides and their calcium, magnesium, and potassium salts, which on hydrolysis, yield three main fractions of polysaccharides and proteins, including arabinogalactan(AG), arabinogalactan protein(AGP), and glycoprotein(GP), which differ from their molecular weight and chemical composition according to the botanical origin of the Gum, and these differences are reflected in some of the analytical properties of the Gum. As a result, the functional properties and uses to which Gum arabic can be put (and its commercial value) are also very dependent on its origin (Desplanques et al., 2012).

### 1.2.3.6 Physical properties of Gum Arabic:

The international specifications used to assess the quality of Gum arabic in the world market are based on the Sudan Gum obtained from *A.senegal* var; *Senegal*, Table 1.1 (Beshai, 1984; Larson and Bromley, 1991; Macrae and Merlin,2002).

**Table 1.1: International specification of *A.senegal* var; *senegal* \***

property	Rang
Moisture content (%)	13 - 15
Ash content (%)	2 - 4
Volatile matter (%)	51 – 65
Optical rotation (degrees)	-26 - -34
Nitrogen content (%)	0.26 – 0.39



Source of Gum arabic: Kordofan gum belt region, Sudan. Species var. *senegal* and its varieties.

\*Ref:FAO 1990

- i. **Moisture content:** facilitates the solubility of hydrophilic carbohydrates and hydrophobic proteins in Gum arabic (Elmqvist, 2003).
- ii. **Total ash content:** is used to determine the critical levels of foreign matter, acid insoluble matter, salts of calcium, potassium and magnesium (Mocak et al., 1998). The cationic composition of ash content are used to determine the specific levels of heavy metals in quality of Gum arabic (FAO, 1990, 1996).  
The moisture and ash contents can be determined by using clean crucible of known weight and oven dried at 105°C for 6 hours. Moisture content is taken as a percentage ratio of the change in weight to the original sample weight. The dry weight of ash is ignited at 550°C in furnace for one hour, contents removed, cooled in a desiccator for 30 minutes and weight after ignition that of the original sample.
- iii. **Volatile matter:** determines the characteristics and the degree of polymerization contained in sugar composition (arabinose, galactose and rhamnose) which exhibits strong emulsifying properties functioning as binders and stabilizers in the making of cough syrups in pharmaceutical industry (Philips and Williams, 2001; Philips et al., 2006).  
Volatile matter determine as percentage ratio of the change in weight to the original sample weight according to the methods of Anderson and Ingram (1993) and Okalebo et al., (2002).
- iv. **Optical rotation:** is used to determine the nature of sugars in Gum arabic obtained from *A.senegal* var; *senegal*. The specifications state that the best quality of gum arabic must have negative optical rotation with the range of -26° to -34° as it has been showed in Table 1.2.
- v. **Nitrogen content in Gum arabic:** determines the number of amino acid compositions with the range of 0.26 to 0.39% (FAO, 1990).
- vi. **Viscosity:** is determined using a suitable capillary viscometer at a room temperature by measuring the time required for the level of the liquid to drop from one mark to the other (European Pharmacopoeia).  
The only test which it has been measured in this research is the moisture content.

### 1.2.3.7 Uses of Gum arabic:

Gum arabic is currently widely used in three main areas: food, pharmaceutical and technical. where it functions as an emulsifier, stabilizer, thickener, flavouring or coating agent (Wickens et al., 1995). These functions are associated with certain quality requirements fulfilled by Gum properties such as absorption, tastelessness, odourlessness, solubility, viscosity and rheological behaviour (Glicksman, 1969).

i. Food industry:

As noted earlier, the FAO specification for Gum arabic intended for food use stipulates that it should come from *A.Senegal* or closely related species. Even apart from legislative requirements, the quality and technical performance of Gum arabic from this source makes it the material of choice in most cases. In Europe, the food additive number of Gum Arabic is E414.

Confectionery remains a major use for Gum arabic, (Table 1.2) The role of Gum arabic in confectionery products is usually either to prevent crystallization of sugar or to act as an emulsifier. It finds wide application as a means of encapsulating flavours and is also used in a range of dairy and bakery products. And also it is used in soft and alcoholic drinks, either as a vehicle for flavouring or as a stabilizer or clouding agent (Coppin, 1995).

**Table 1.2: Function of gum Arabic in food products**

Function	Food product
Adhesive	Bakery
Crystallization inhibitor	Sugar syrups, pastilles, candies
Clarifying agent	Intoxicating drinks
Coating agent	candies
Emulsifier	Caramels, toffees, soft drinks
Encapsulating agent	Powdered fixed flavours
Flocculating agent	Intoxicating drinks
Foam stabilizer	Whipped toppings, marshmallow
Gelling agent	Pudding, desserts, mousses
Mold release agent	Gum drops, jelly candies
Protective colloid	Flavour emulsion (e.g. orange, lime, beer, cola)
Stabilizer	Mayonnaise, ice cream, sherbet
Suspending agent	Chocolate milk
Swelling agent	Processed meat
Syneresis inhibitor	Cheese, frozen foods
Thickening agent	Jams, sauces, gravies

Source: Glicksman,(1969);Williams and Philips, (2009); Idris and Haddad(2012).

ii. Pharmaceutical uses:

Gum Arabic is also used in non-food industries for instance in modern pharmacy where it is commonly employed as a demulcent, binder, or for film-forming. It is manufactured in tablet form, where it functions as a binding or coating agent (Glicksman and Sand 1973). Its primary use is in emulsion stabilization, and tablet and pill formulation. Gum Arabic is also included in cosmetics as an adhesive for masks and powders, and to provide a smooth feel to lotions (Coppen, 1995).

iii. Technical uses:

Gum Arabic is used in partial destruction of many alkaloids including atropine, hyoscyamine, scopolamine, homatropine, morphine, apomorphine, cocaine, and physostigmine (Khan and Abourashed, 2010).

Ali et al., (2009) suggest a possible use of gum Arabic in dentistry because it enhances dental remineralisation and has some antimicrobial activity. Other commercial uses of gum Arabic are found in ink production, pottery pigments and glazing for colour thickening in water-colours and paints, wax polishes or for giving lustre to silk and crepe in textiles and lithography (Wickens et al., 1995). Because gum Arabic is allergen free and lacks dermatological effects, it is preferred for use by the cosmetics industry. It is used in the preparation of glues and adhesive for paper products, and it sometimes serves as binder for water cement used in foundry. The primary functions of gum Arabic as a technical ingredient include use as a texturizer in sugar and polyols medium; a film former avoiding fat, water and gas migration; a binder for sugar and polyols compressed products; an emulsifier for oil in water emulsion, a carrier for encapsulation; and as a stabilizer for colloidal systems( Omer and Wasila , 1993). In addition, it is used as a sensitizer for lithographic plate solution, to moisten the plate during printing, and as a protector during plate storage. The main function in lithography is to act as a suspending and binding agent. It is also used in the manufacture of matches, ceramic pottery, and as a coating to prevent metal corrosion, among many other applications (Factory manual, 2002).

## **1.2.4 Emulsions:**

### **1.2.4.1 Definition:**

An emulsion is a biphasic liquid preparation having two immiscible liquids (usually oil in water), which cannot be dispersed for a long period. An emulsifying agent is added, which form film around the globules, so that a stable emulsion is produced.

Emulsions are thermodynamically unstable and revert back to separate oil and water emulsion (Mehta, 2010).

In emulsions, the two liquids are present in two different forms. One forms the continuous phase in which the other dispersed phase forms spherical droplets.

#### 1.2.4.2 Types of Emulsions:

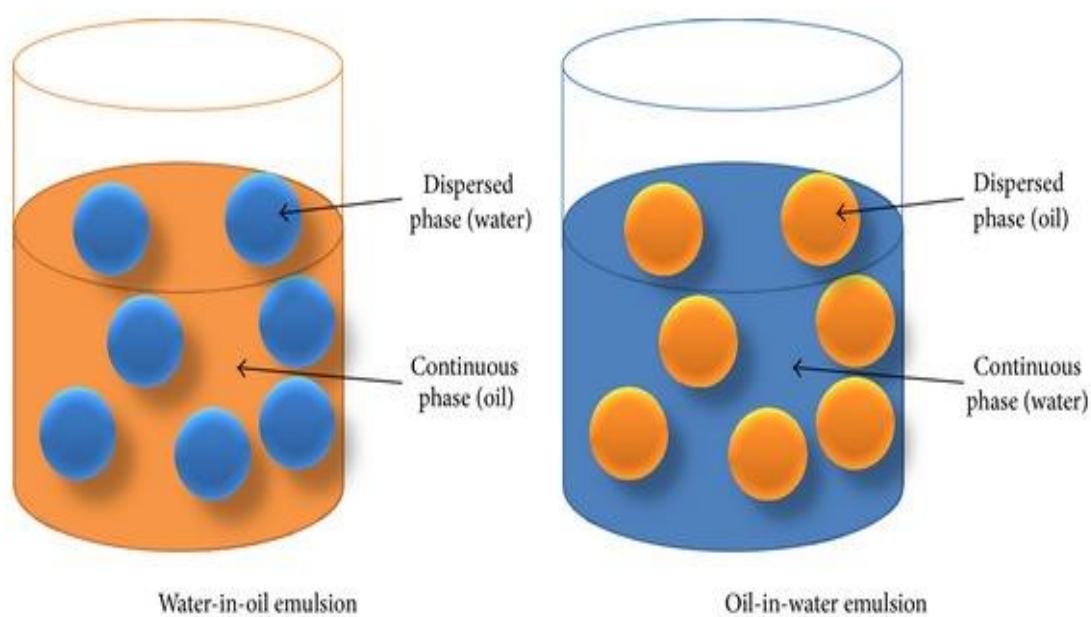
There are two main types of emulsions, Figure 1.10 that can be formed:

i. Oil-in-water (o/w) :

Here oil is dispersed phase and water is continuous phase. These are mostly used internally. Emulsifying bases used in this type is gum acacia, tragacanth, methyl cellulose, saponins, synthetic substance, etc. An oil-in-water emulsion is formed if the aqueous phase constitutes more than 45% of total weight and if a hydrophilic emulsifier is used (Mehta, 2010).

ii. Water-in-oil (w/o):

In this type water is dispersed phase and oil is continuous phase. Emulsifying bases in this type is wool fat, resins, beeswax and soaps (Jain and Sharma, 2010).



**Figure 1.10: Water-in-oil and Oil-in-water emulsions**

#### 1.2.4.3 Determining the type of Emulsion:

It is difficult to determine the type of emulsion produced by using naked eye. Therefore, to determine the type of emulsion created there are five simple tests:

i. Dilution:

This is based on the solubility of the continuous phase. O/w emulsions can be diluted with water and w/o emulsions can be diluted with oil.

ii. Dye-solubility:

The dye-solubility test uses either a water-soluble or oil-soluble dye and then observes the emulsion. If a water-soluble dye is used then an o/w emulsion will have a dyed continuous phase and a w/o will have a dyed dispersed phase.

iii. Filter paper ( $\text{CoCl}_2$ ):

This involves impregnating filter paper with  $\text{CoCl}_2$ . After the paper is dried it should be a blue tint, if dipped in an o/w emulsion the paper will change from blue to pink.

iv. Fluorescence:

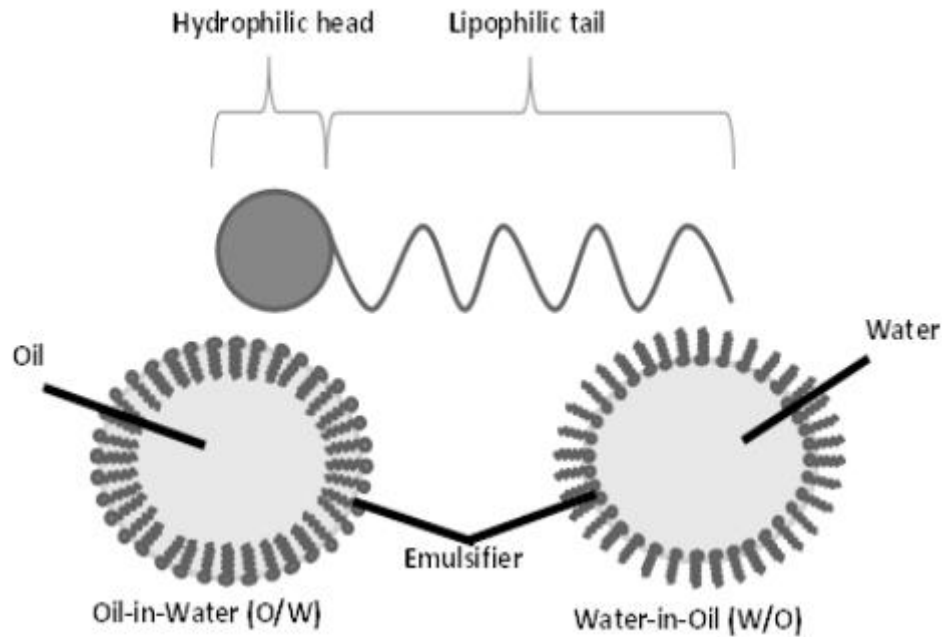
The fluorescence test operates on the idea that under UV light some oils are fluorescent. When using this test o/w emulsions show spotty patterns, while w/o emulsions are fluorescen.

v. Conductivity:

The conductivity test requires a light bulb attached with wires to two electrodes. When the electrodes are dipped in the emulsion a o/w emulsion will cause the bulb to glow due to waters ability to be a good conductor, While a w/o emulsion will not glow due to oils low conductivity (Tauer, 2006).

#### **1.2.4.4 Formulation:**

To form a stable emulsion, in addition to oil and water an emulsifier must be present. Due to the immiscibility of oil and water the emulsion is naturally unstable. However, if an emulsifier is added the emulsion can become kinetically stabilized. Emulsifiers improve stability by lowering the interfacial tension. The lower the interfacial tension is the less energy required to form the emulsion (Everett, 1988). Emulsifiers are structured to have a hydrophobic or lipophilic tail attracted to the oil phase, pictured at the top of Figure 1.11.



**Figure 1.11: Structure of o/w and w/o emulsion**

Emulsifiers act as a protective layer between the droplet phase and the continuous phase that prevent the droplet from being broken (Mollet and Grubenman; 2001). The composition, type of emulsifier, and formulation process all help determine the type of emulsion produced. If the ratio of two phase volume is low, the phase that has the lowest volume is typically the dispersed phase, while the phase with the larger volume is the continuous phase. However, if the phases are roughly equal in volume, then other factors can influence which phase is the continuous and which phase is the dispersed phase (Everett, 1988).

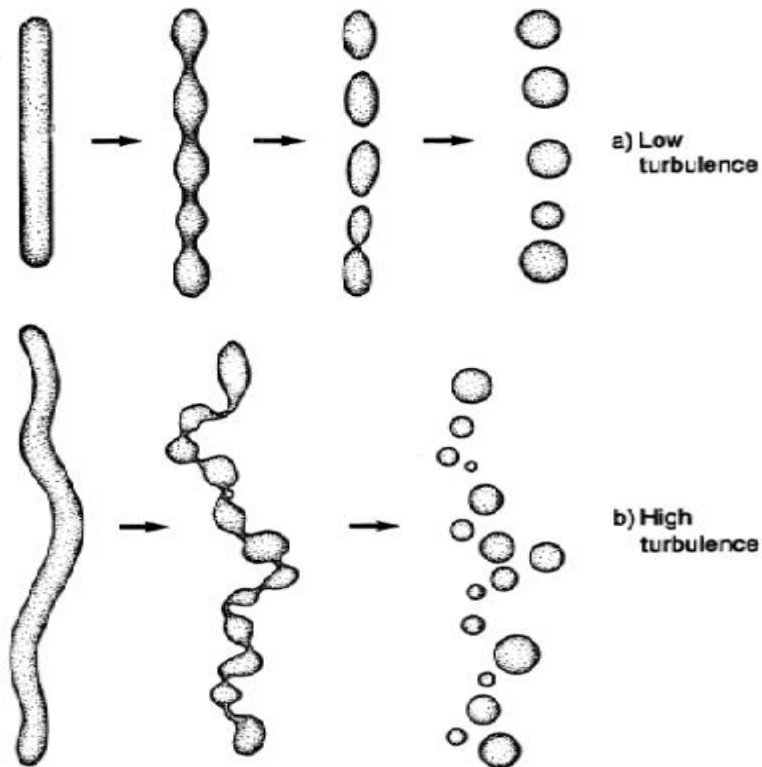
The process of emulsification, or droplet break-up is governed by surface forces. The energy required to form droplets from bulk liquid can be described by the free energy of formation, illustrated in Figure 1.12 and given by Equation 1.1 (Isaacs, 1992) where  $\Delta A$  is the increase in interfacial area,  $\sigma$  is the interfacial tension and  $\Delta S_{\text{conf}}$  is the entropy increase when large number of droplets are formed (Isaacs, 1992).

$$\Delta G_{\text{form}} = \Delta A\sigma - T\Delta S_{\text{conf}} \quad (1.1)$$

Normally  $\Delta A\sigma \gg T\Delta S_{\text{conf}}$ , and thus emulsification is non-spontaneous. However, the actual energy required for emulsification is much larger than  $\Delta A\sigma$ . This is because there is an additional energy requirement for creating a curved interface with a smaller radius. This additional energy can be described by the Young-Laplace equation given in Equation 1.2 (Isaacs, 1992).

$$\Delta P = \sigma \left[ \frac{1}{R} \right] \quad (1.2)$$

Where  $\Delta P$  the Laplace pressure difference and  $R$  is the principle radius of the curvature. However, in the presence of an emulsifier the emulsification energy can be significantly lowered. In emulsion preparation the phenomenon of droplet breakup plays a very important role. The energy provided for emulsion formation highly influences the droplet size, Figure 1.12.



**Figure 1.12: Droplet formation, influence of turbulence**

If a liquid is introduced into another liquid in which it is immiscible, it may form an unstable cylinder that breaks up into droplets. If the introduction rate is high enough to produce turbulence or if the liquid impinges against a surface, then smaller droplets are produced. The dispersion process is also influenced by the shear in the system, viscosity of the phases, interfacial energy, the pressure of solid particles, and dissolved substances (Isaacs, 1992).

Droplet breakup can be determined by the critical Weber number. The critical Weber number for turbulent flow is also dependent on the density and viscosity of the dispersed phase, as well as, the droplet diameter and interfacial tension. The Weber

dimension is defined by Equation 1.3 (Isaacs, 1992), where  $\tau_{def}$  is the deformation stress,  $r$  is the radius of the droplet, and  $\sigma$  is the interfacial.

$$We = \frac{\tau_{def}r}{\sigma} \quad (1.3)$$

When the following two conditions are met droplet breakup takes place (Isaacs, 1992). First, when the weber number exceed its critical value. The second condition is that the deformation time must be longer than the critical deformation time. The critical deformation time is shown in Equation 1.4, where  $\eta_d$  is the viscosity of the dispersed phase and  $\Delta P$  is the Laplace pressure difference

$$t_{def,cr} = \frac{\eta_d}{\tau_{def} - \Delta P} \quad (1.4)$$

Emulsion formulation and droplet size are heavily dependent on the method used, the emulsifier concentration, dispersed phase concentration, energy input, and temperature.

#### 1.2.4.5 Emulsifier:

In emulsion the emulsifier plays a very important role. The type and properties of the emulsifier greatly impact the stability, both mechanical and kinetic. There are currently different methods for selecting emulsifiers. However, even with previous researches there are gaps of knowledge on the exact role the emulsifier plays in creating a stable emulsion. Therefore, more researches need to be conducted relating physical and chemical properties that are used in selection methods to get a desired emulsion's properties (Edelen, 2012).

##### ➤ *Classification:*

Edelen (2012) has reported commercially, emulsifiers are usually classified according to their use. However, this causes confusion due to multiple uses for the same emulsifier. From scientific standpoint, most emulsifiers are classified based on their dissociation in water.

There are four main groups of emulsifiers: non-ionic, anionic, cationic and amphoteric (zwitterionic) (Mollet and Grubenman; 2001).

##### i. Non-ionic Emulsifiers:



Do not ionize in aqueous solution due to the hydrophilic group being non-dissociable. The hydrophilic portion usually has a polyethylene chain which makes the head group hydrophilic. The lipophilic group is usually an alkyl or alkyl benzene. Many non-ionic emulsifiers exhibit an inverse temperature-solubility relationship. This means that as the temperature of the emulsion increases the solubility will decrease due to decreased solubility in water.

ii. Anionic Emulsifier:

This dissociates into anion (which it has a negative charge and moves toward an anode during electrolysis) and a cation (which it has a positive charge and moves toward a cathode during electrolysis) in water. The cation is usually either an alkaline metal or quaternary ammonium (Salager, 2002).

iii. Cationic Emulsifiers:

This dissociates into a cation and an anion in water. They generally correspond to nitrogen compounds like fatty amine and quaternary ammoniums. Cationic emulsifiers tend to be more expensive than anionic emulsifiers because during their synthesis a high pressure hydrogenation reaction must be carried out (Salager, 2002).

iv. Amphoteric (Zwitterionic):

It exhibits both cationic and anionic dissociation. Amphoteric emulsifiers are insensitive to pH, while others change between cationic at low pH and anionic at high pH. Amphoteric emulsifiers are generally very expensive and thus only used in specialized cosmetics (Salager, 2002).

➤ ***Selection Process:***

Choosing a suitable emulsifier is difficult due to a wide variety of choices and many factors that help determine what makes a potential emulsifier a good candidate. Factors include the chemical structure, economics, regulations, ecological impacts and input energy. It is important to evaluate the relative role of the emulsifier in the emulsion and the emulsifier's physiochemical characteristics.

Things to consider when selecting an emulsifier are:

- 1- The surface and interfacial properties that must be controlled in the specific application
- 2- Relationships between structural properties of the emulsifiers and their effects on the interfacial surface properties.

- 3- The chemical and physical properties of available emulsifiers.
- 4- Specific biological or chemical compatibility requirements.
- 5- Regulation that might prohibit the use of certain materials due to toxicity, ecological impacts, or allergenic reaction (Meyer, 2006).

#### **1.2.4.6 Stability of Emulsion:**

Thermodynamic stability of emulsions differs from stability as defined by the formulators or the consumers on the basis of entirely subjective judgments. Acceptable stability in the pharmaceuticals dosage form does not require thermodynamic stability. If an emulsion rises or cream down or sediments. It may still be pharmaceutically acceptable as long as it can be reconstituted by modest amount of shaking. According to this the instability of the emulsion can be divided into two parts (Jain and Sharma, 2010).

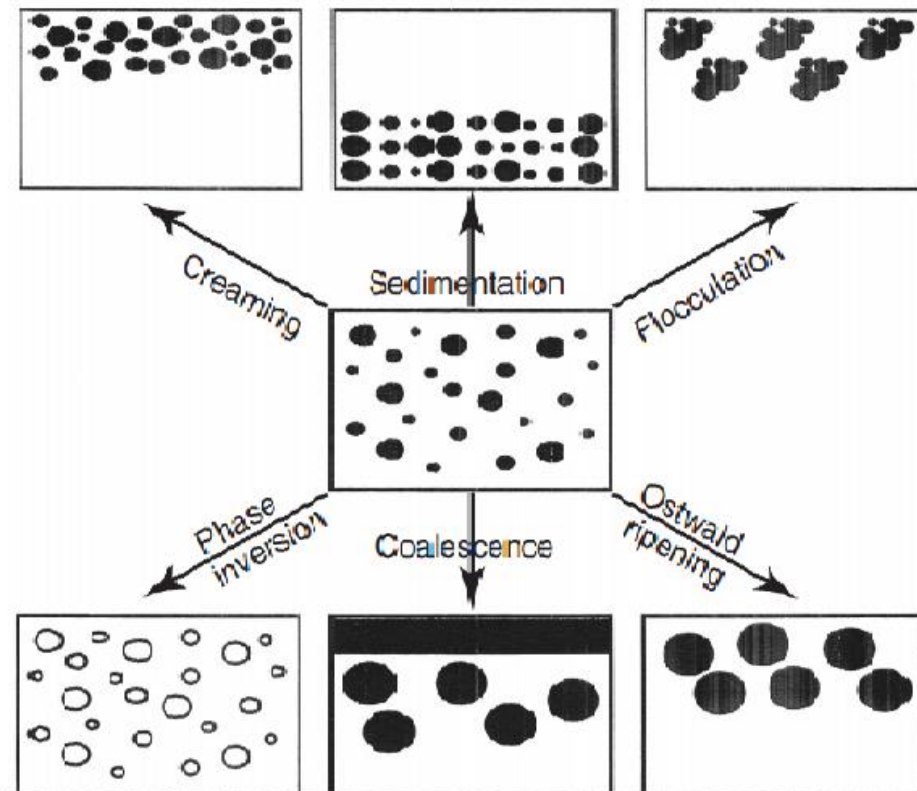
##### **i. Physical instability of Emulsion:**

Probably the most important consideration with respect to pharmaceutical and cosmetic emulsions is the stability of the final product. The stability of a pharmaceutical emulsion is characterized by the absence of coalescence of the internal phase, absence of creaming and maintenance of elegance with respect to appearance, odour, colour, and other physical properties. Some workers define instability of an emulsion only in terms of agglomeration of the internal phase and it is flocculation and concentration of globules of the internal phase, sometimes, is not considered as a mark of emulsion (Jain and Sharma, 2010).

##### **Symptoms of Instability:**

As soon as an emulsion has been prepared, time and temperature dependent processes occur to effect its separation during storage; an emulsion's instability is evidenced by creaming, reversible aggregation and irreversible aggregation, Figure 1.13.

- Cracking
- Creaming
- Phase inversion
- Flocculation



**Figure 1.13: Representation of the various breakdown processes in emulsions**

➤ **Cracking:**

Cracking of an emulsion refers to separation of dispersed phase and continuous phase, due to coalescence of dispersed phase globules which are difficult to re-disperse by shaking. Any chemical, physical or biological effects that change the nature of the interfacial film of an emulsifying agent may cause cracking.

➤ **Creaming**

Creaming may be defined as the; upward movement of dispersed globules to form a thick layer at the surface of the emulsion. Creaming is a temporary phase because it can be re-distributed by mild shaking or stirring to get again a homogenous emulsion; as far as possible creaming of an emulsion should be avoided because it may lead to cracking with complete separation of two phases. Under the influence of gravity suspended particles or globules tend to upward movement, known as creaming while downward movement of particles or droplets is called sedimentation. Creaming or sedimentation depends on the differences in specific gravity between the phases. The rate at which a spherical droplets or particle sediments in liquid is governed by

Stroke's law equation (1.5). According to Stroke's law, the rate of creaming depends on the number of factors which can be explained by the following Equation

$$V = \frac{r^2(\Delta\rho)g}{9\eta} \quad (1.5)$$

Where:

V= rate of creaming

r = radius of globules

g= gravitation constant

$\Delta\rho$  = density difference between the two phases

$\eta$ = viscosity of the continuous phase.

The rate of creaming is

- Directly proportional to the density difference between the oil and water phase ( $\Delta\rho$ ).
- Directly proportional to the square of the radius of globules  $r^2$
- Inversely proportional to the viscosity of dispersion medium  $\eta$ .

#### ➤ **Phase inversion:**

When controlled properly during the preparation of an emulsion, phase inversion often results in a finer product, but when it gets out of hand during manufacturing or is brought about by other factor after the emulsion is formed it can cause considerable trouble. Phase inversion means the change of one type of emulsion into the other type. The temperature at which the inversion occurs depends on the emulsifier concentration and is called phase inversion temperature (PIT). An o/w emulsion stabilized by non-ionic surfactant. Inversion often can be seen when an emulsion prepared by heating and mixing the two phases, it being cooled. This takes place presumably because of the temperature dependent changes in the solubility of the emulsifying agents. It may be due to following reasons:

- By the addition of an electrolyte
- By changing the phase-volume ratio
- By temperature change
- By changing the emulsifying agent

The phase inversion can be minimized by keeping the concentration of dispersed phase between 30 to 60 %, storing the emulsion in a cool place and by using proper emulsifying agent in adequate concentration.

➤ **Flocculation:**

Flocculation involves the aggregation of the dispersed globules into loose clusters within the emulsion. The individual droplets retain their identities but each cluster behaves physically as a single unit. This would increase the rate of creaming. As flocculation must precede coalescence, any factor preventing or retarding flocculation would therefore maintain the stability of the emulsion.

**ii. Chemical instability of an emulsion:**

Chemical instability of an emulsion causes coalescence of the emulsion's particles. It is necessary to insure that any emulgent system use is not only physically but also chemically compatible with the active agent and with the other emulsion ingredients. It has already been demonstrated that the presence of electrolyte can influence the stability of the emulsion either by

- Reducing the energy of interaction between adjacent globules
- A salting out effect by which high concentration of electrolyte can strip emulsifying agents of their hydrated layers and so cause their precipitation.

Change in pH may also lead to the breaking of emulsion. Environmental conditions, such as the presence of light, air, contaminating microbes adversely affect the stability of an emulsion. For light sensitive emulsion, light resistance container is used. For emulsion susceptible to oxidative decomposition, anti-oxidants may be included in the formulation. Many molds, yeasts, and bacteria can decompose the emulsifying agent, disrupting the system. Even if the emulsifier is not affected by microbes, the product can be rendered unsightly by their presence. Commonly, combinations of methylparaben are generally included in the aqueous phase of an o/w emulsion.

**1.2.5 Formulations of shoe polish:**

Ameh [2011] has studied the thermodynamic properties of shoe polish which has been manufactured from pure water sachet. Three different formulations have been prepared as it has shown in Table 1.3, and compared with two standard polishes which are Kiwi and Lude.

**Table 1.3: preparation of the samples**

<b>Constituent</b>	<b>Sample (1)</b>	<b>Sample(2)</b>	<b>Sample(3)</b>
<b>Sachet wax</b>	11.90	33.30	21.40
<b>Paraffin wax</b>	21.40	-	11.90
<b>Stearic acid</b>	12.10	12.10	12.10
<b>Turpentine</b>	54.50	54.50	54.50

The results of different thermodynamic properties have shown in the Table 4.1:

**Table 1.4: Results of different thermodynamic properties**

<b>properties</b>	<b>Sample(1)</b>	<b>Sample(2)</b>	<b>Sample(3)</b>	<b>Kiwi</b>	<b>Lude</b>
<b>Melting point</b>	28	26	26	32	39
<b>Pour point</b>	-8	-18	-12	-7	-5
<b>Density(g/ml)</b>	0.63	Too hard	0.68	0.62	0.62
<b>Relative density</b>	0.63	Too hard	0.68	0.62	0.62
<b>Viscosity at 40°C</b>	2.39	Too hard	0.57	Too viscous	8.24
<b>Viscosity at 50°C</b>	2.03	Too hard	0.33	Too viscous	3.67
<b>Viscosity at 60°C</b>	0.35	Too hard	0.19	0.69	3.14

Abdullahi [2010] has produced black shoe polish using spent carbon black photocopier tonner. It has observed that the shoe polish produced in the research was qualitative as that manufactured by the standard one (Kiwi brand) which gave a better water resistant surface appearance and nourishment.

### **1.2.6 Objective:**

The main objectives of this research is to:

- Formulate a base emulsion for cleaning the shoes using Gum arabic ,Activated Carbon solution and oily phase from the paraffin oil, white wax and Vaseline and to measure some physical parameters for the product
- Formulate a base emulsion for shining the shoes using Gum arabic, Activated Carbon solution and oily phase from White wax.

# **Chapter Two**

## **Materials and Methods**

## Chapter Two

### Materials and Methods:

#### 2.1 Materials:

- Dried samples of *Acacia senegal* var. *senegal* were obtained from Natural African Forest Products (NAFOP) in Al-sahafa; 15<sup>th</sup> street, Figure 1.2



**Figure 2.1: sample of Gum Arabic**

The samples were ground in to powder using mortar and pestle, Figure 2.2 Then kept and stored at room temperature.



**Figure 2.2: The grounded sample**



- Activated charcoal and paraffin oil were obtained from ALPHA CHEMIKA.
- White wax and petroleum gel were bought from Abo Nakhla pharmacy, and Al-wadi pharmacy at Omdurman.
- Benzene from SCOTT SCIENCE UK.

## **2.2 Methods:**

### **2.2.1 Determination of physical properties of Gum Arabic:**

#### **2.2.1.1 Identification of colour:**

50g of *Acacia senegal* var. *senegal* Gum sample were weighed using electronic balance (Scichem SL; model SLS1501) in beaker (250ml). 150ml of Distilled water were added to the sample (to obtain a solution of 25% concentration of the *Acacia Senegal* Gum) .The solution was stirred for 60minutes. Then solution was allowed to be stable for two hours (to make sure it does not contain any air bubbles). After that the solution was introduced into the chamber of colorimeter in (Lovibond® Tintometer Model F) in a glass container. The colour of the sample was measured using simple system of sliding racks to compare the colour of light which is reflected from the sample with that transmitted through the glasses. The racks were varied until a visual colour match was found for the light from the sample then the colour was expressed in Lovibond units.

#### **2.2.1.2 Identification of Optical rotation:**

1% solution of *Acacia senegal* var. *senegal* Gum was prepared, by diluting the same solution which it has been used to identify the sample's colour. The concentration (1%) was measured using Refractometer (Atago 3810 PAL-1). Then the optical rotation was determined using polarimeter (Bellingham + Stanyls ADP 410 Polarimeter).

#### **2.2.1.3 Moisture content:**

Moisture content was estimated using the instrument HB43 Halogen Moisture Analyser. 10g of *Acacia senegal* var. *senegal* sample were weighed in the sample pan then the heating module has been closed and the instrument was started drying and measuring process of the sample automatically.

## **2.2.3 Cleaning shoe polish preparation:**

### **2.2.3.1 Water phase preparation:**

Using electronic balance (SHIMADZU UX820S) 19g of the activated carbon were weighed into a beaker (250ml). Then 31g of the *Acacia senegal* var. *senegal* and 150g of distilled water were added to it. The solution was allowed to stand into a save place over night to make sure that all the gum was dissolved.

### **2.2.3.2 Oily phase preparation:**

15g of the petroleum gel were placed into beaker (250ml) then 8g of white wax and 7g of paraffin oil were added to it. The beaker was placed in water bath (WiseBath® Digital water bath) at 80°C until all the contents of the beaker melted.

### **2.2.3.3 Emulsion preparation:**

In separate beakers 70g from water phase and 30g from oily phase were placed in water bath (WiseBath® Digital water bath) until the temperature of both become approximately equal, then with stirring using a glass rod the oily phase was spelled into the water phase slowly. After spelling all the oil phase the emulsion was stirred vigorously. Then the emulsion was allowed to cool to room temperature.

### **2.2.3.4 Conductivity measurement:**

After the instrument (Jenway Conductivity meter4320) was calibrated, the measurement of the sample was carried out by immersing the cell in the sample until the readout was stabilized then the results was recorded

### **2.2.3.5 pH measurement:**

The instrument (Jenway, 3505 pH Meter) was calibrated using pH=4 and pH=7 buffer solutions. Then the electrode was immersed in distilled water and dried very well. After that the electrode was immersed into the sample and the result was noted when the reading was stabilized.

### **2.2.3.6 Specific gravity measurement:**

The Density cup was weighed when it was empty using electronic balance (Setra precision balance BL-410F), then it was filled with the sample of the

shoe polish after that the lid was placed on the cup. The cup was weighed after it was filled with the sample then the weight was divided by the volume to determine the specific gravity.

#### **2.2.3.7 Viscosity measurement:**

Using Viscometer (Digital Rototinner SH455N) at 35°C the rotor was lowered into the sample by pulling the handle down to 250ml of the sample, then the digital reading in poise was noted on the display.

#### **2.2.4 Shining shoe polish preparation:**

##### **2.2.4.1 Water phase preparation:**

Using electronic balance (SHIMADZU UX820S) 19g of the activated carbon were weighed into beaker (250ml). Then 31g of the *Acacia senegal* var. *senegal* and 150g of distilled water were added to it. The solution was allowed to stand into a save place over night to make sure that all the gum has dissolved.

##### **2.2.4.2 Oily phase preparation:**

40g of white wax were weighed into a beaker (100ml). The beaker was placed in water bath (WiseBath® Digital water bath) at 80°C until all the wax melted.

##### **2.2.4.3 Emulsion preparation:**

Separately 60g of water phase and 40g of oily phase were placed in water bath with oily phase until they attend thermal equivalent temperature. Then with stirring using a glass rod the oil phase was spelled into the water phase slowly. After spelling all the oil phase the emulsion was stirred vigorously. Then the emulsion was allowed to cool at the room temperature. After preparing the emulsion 93g was taken from it and 7g of benzene were added to it.

# **Chapter Three**

## **Results and Discussion**

## Chapter Three

### Results and Discussion

#### 3.1 Determination of physical properties of Gum arabic:

**Table 3.1: Some physiochemical characteristic of Gum Arabic**

Measurement	Value
Colour	3.2
Optical rotation	-32.5
Moisture content	10.44%

Table 3.1 presents some of the physiochemical characteristic of Gum Arabic. The colour measurement has been done to make sure that the gum does not have a dark colour (the colour is acceptable until 4 using Lovibond® units), to do not affect the colour of the final product. This measurement is important to know and care about in the food and pharmaceutical industries. However, colour measurement sometimes refers to the purity and the good storing of the gum; that is why the colour has to be measured even in Non-food industries.

Optical rotation is usually carried out to determine the nature of sugars in gum arabic obtained from A.senegal variety senegal. The international specifications of gum state that the best quality of gum arabic must have negative optical rotation with the rang of  $-26^{\circ}$  to  $-34^{\circ}$ , from the results it is clear that the sample which it was used belongs to Acaica Senegl gum complying with the international specifications range with

Gum Arabic contains amount of moisture varies from sample to sample that is why this amount has to be known when preparing any solution of Acacia gum to added what it has lost as a moisture.

#### 3.2 Thermodynamic properties of the Shoe polish:

**Table 3.2: Some of the physical properties of the produced Shoe polish:**

Physical properties	Results
Colour	Black
Conductivity	0.995 mS/ cm at 26.2°C
pH	5.71
Specific gravity	0.970g/cm <sup>3</sup>
Viscosity	6.10p

The cleaning shoe polish was analysed by measuring some physical properties. The results have shown that there is no change in the colour of the shoe polish from the production time and for a period of 3 Weeks.

The Conductivity was found to be equal 0.995 mS/ cm which confirms that the type of the emulsion is oil-in-water emulsion and this is simply because the conductivity requires a light bulb attached with wires to two electrodes. When the electrodes are dipped in the emulsion a o/w emulsion will cause the bulb to glow due to waters ability to be a good conductor, While a w/o emulsion will not glow due to oils low conductivity (Tauer, 2006).

The pH was 5.71; The Uganda National Bureau of Standards (UNBS) which is mandated to coordinate the elaboration of standards and is a member of international organisation (ISO) has noted that the value of the pH for the shoe polish specification has to be in the range from 6.5 to 9.

The value of the specific gravity is high if compered by the values given in table 1.4, however the total amount of the wax which Ameh (2011) has used in his study was larger(33.3g) than the amount of the wax which it has been used in this study (9g) . So it can be said that the difference in the density when compered between this study and the other studies may be due to the use of Gum Arabic as emulsifying agent, Gum Arabic increased the density of the oil droplets through steric stabilization and reduce the surface tension between water and oil, hence, increasing the stability of the emulsion (Elham et al., 2014).

And also the value of the viscosity is too high if compared with the results of Ameh (2011) and this may be due to the use of viscous oil which is the petroleum jelly (Vaseline) and also the Gum Arabic has it is role to increase the value of the viscosity.

### **3.3 Physiochemical properties of the produced shoe polish compared with standard shoe polishes:**

As it has been shown in table 3.3 the physiochemical properties for the produced shoe polish is somewhat near to the physiochemical properties of the standard shoe polishes (Kiwi, Nikwax, and Woly).

Table 3.3: comparison between standard shoe polishes and the produced shoe polish:

<b>Properties</b>	<b>Kiwi</b>	<b>Nikwax</b>	<b>Woly</b>	<b>This study</b>
<b>pH</b>	Not applicable	4	7.00-8.50	5.71
<b>Specific gravity g/cm<sup>3</sup></b>	0.800	1.007	0.80-1.10	0.970
<b>Viscosity</b>	Not applicable	Not determined	Too viscous	6.10



**Figure 3.1: Cleaning shoe polish**



**Figure 3.2: Shining shoe polish**

### **3.4 Conclusion:**

It can be concluded that:

- Two stable emulsion were produced, the first one for cleaning the shoes and the second for shining the shoes successfully.
- The physiochemical properties for the cleaning shoe polish were determined and compared to the values of standard shoe polishes.



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