بسم الله الرحمن الرحيم

**Sudan university of Science and Technology**

**College of Agricultural Studies**

**Department of Food Science and Technology**

# Comparison Study of the Polarization of some Edible Gums

## دراسة مقارنة للاستقطاب لبعض الأصماغ القابلة للأكل

A dissertation submitted to Sudan University of Science and Technology in Partial fulfillment of the requirements of the degree of B. Sc. (Honors) in Food Science and Technology

**By**

**Bayan Musa Hassan Musa**

**Mathany Ibrahim Abd-Elgader**

**Supervisor**

**Dr. Ebrahim Alfaig Alnoor**

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# الآية

قال تعالى:

(فَتَعَالَى اللَّهُ الْمَلِكُ الْحَقُّ وَلَا تَعْجَلْ بِالْقُرْآنِ مِنْ قَبْلِ أَنْ يُقْضَى إِلَيْكَ وَحْيُهُ وَقُلْ رَبِّ زِدْنِي عِلْمًا)

صدق الله العظيم

سورة طه الآية (114)

# DEDICATION

*To our Family*

*To our Teachers*

*To our Friends*

# ACKNOWLEDGEMENTS

First of all our praise goes to Allah Almighty for giving us strength and helps to complete this work.

I would like to thank **Dr. Ebrahim Alfaig Alnoor** for supervision and advice during the performance of this work. My appreciation extends to all teaching staff of department the Food Technology and Science for their Technical Support.

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# Abstract

The aim of this study was to determine the optically active compounds in deferent edible gum types. In this study Sengal, Seyal and Neem Gums and the mixtures of Sengal/Neem, Seyal/Neem and Sengal/Seyal were used. Polax-2l apperatus was used in the polarization determination.

The polarization of the 5% aqueous solution of these gums were determined. The angle of rotation results for the tested gums Sengal, Seyal and Neem were -3.47, 4.317 and -5.867, respectively. The angle of rotation results for the tested gums mixtures were -4.717,-1.223, 0.5 for the mixture of Sengal/Neem, Seyal/Neem and Sengal/Seyal, respectvely.

The calculated polarization results for Sengal, Seyal and Neem were -34.7, 43.17,-58.67, respectively, while the polarization results for tested gum mixtures of Sengal/Neem, Seyal/Neem and Sengal/Seyal were -47.17,-12.23 and 5, respectively. According to the obtained results the mixing of gums has a great effect on both the angle of rotation and the polarization results, Thus polarization is powerful tool can be considered any adulteration or mixing of gums.

# الملخص

الهدف من هذه الدراسة هو مقارنه المكونات النشطة ضوئيا في أنواع مختلفة من الصمغ. في هذه الدراسة تم إستخدام كل من صمغ الهشاب والطلح والنيم وخليط بنسبة 1:1من كل من صمغ الهشاب والنيم ،والطلح والنيم والهشاب والطلح.

تم تقدير الاستقطاب في 5% من المحلول المائي لهذه الاصماغ .جهاز البولاكس استخدم تقدير درجة الاستقطاب.

وجد أن قراءة زاوية الدوران لكل من صمغ الهشاب ،الطلح والنيم -3.47،4.317،-5.86علي التوالي وأيضا قراءة زاوية الدوران -47.17 ،-12.23 و5 لكل من خليط الهشاب والنيم ،والطلح والنيم والهشاب والطلح علي التوالي.

تم حساب نتائج الاستقطاب للهشاب ، والطلح والنيم وكانت-34.7،-43.17و58.6 علي التوالي، بينما نتائج الاستقطاب لكل من خليط الهشاب والنيم ،الطلح والنيم والهشاب والطلح كانت-47.17، -12.23 و5 علي التوالي.

خلط الاصماغ أثر بصوره كبيره في كل من زاوية الدوران ودرجة الاستقطاب مما يعني أن نتائج الاستقطاب للاصماغ تعتبر طريقه مهمة جدا لكشف أي عملية خلط أو غش تجري علي الاصماغ المختلفة.

# CHAPTER ONE

# INTRODUCTION

Gum Arabic is the oldest and best known of all trees gum exudates and has been used as an article of commerce for over 5000 year (Whistler, 1993). It is the exudation from certain Acacia trees which occur in a wide melt of semi-arid land stretching across sub-saharan Africa.

Gum arabic, also known as acacia gum, arabic gum, gum acacia, acacia, Senegal gum and Indian gum, and by other names (Mortensen, et *al* 2017) .is a natural gum consisting of the hardened sap of various species of the acacia tree. Originally, gum arabic was collected from Acacia nilotica which was called the "gum arabic tree";( Centre for Agriculture and Biosciences International 2016 ) in the present day, gum arabic is collected from acacia species, predominantly Acacia Senegal(Royal Botanic Gardens, 2018) and Vachellia (Acacia) seyal; the term "gum arabic" does not indicate a particular botanical source. In a few cases so-called "gum arabic" may not even have been collected from Acacia species, but may originate from Combretum, Albizia or some other genus (Mortensen, *et al* 2017) Producers harvest the gum commercially from wild trees, mostly in Sudan (80%) and throughout the Sahel, from Senegal to Somalia though it is historically cultivated in Arabia and West Asia. Gum arabic is a complex mixture of glycoproteins and polysaccharides. It is the original source of the sugars arabinose and ribose, both of which were first discovered and isolated from it and are named after it.

Gum arabic is soluble in water. It is edible and used primarily in the food industry as a stabilizer. Gum arabic is a key ingredient in traditional

lithography and is used in printing, paint production, glue, cosmetics and various industrial applications, including viscosity control in inks and in textile industries, though less expensive materials compete with it for many of these roles.

It consists mainly of high molecular mass polysaccharides and their calcium, magnesium and potassium salts which on hydrolysis yield arabinose, galactose, rhamnose and glucuronic acid. Toxicological monographs were prepared in 1978, 1982, 1986, and 1990; and an ADI not specified was granted in 1982 and confirmed in 1990. In the most recent review the limilts of specific rotations and the nitrogen content were deleted from the specifications, and the definition refers to A. *senegal* and A. seyal. Other Acacia species not included (FAO).

Many substances possess the inherent property to rotate the plane of the incident polarized light; this property is called optical activity. The measurement of optical activity is used for establishing the identity of the substances, it may also be employed to test the purity of the substance, the optical rotation is angle through which the plane of polarization rotates when polarized light passes through a layer of a solution

Commercially the gums have different prices in the world trade, thus the mixing and the adulteration of these gums is possible. The polarization is the important factors in detecting the adulteration or mixing of gums and because the polarization of these gums is determined be the specification and the gums batch can be rejected if it is not complying with the specification.

## The objectives

The main objective was to determine the optically active compounds in edible gum types and the effect of the mixing of these gums on the polarization.

## Specific objectives

1. To determine the optical rotation and the polarization of the gum samples
2. To determine the effect of the mixing of gums one the optical rotation and the polarization of the edible gums.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Definition of Gum

Gum Arabic was defined by the 31st Codex Committee for Food Additives, held at The Hague, The Netherlands, from 19–23 March 1999, as the dried exudate from the trunks and branches of *Acacia senegal* or *Vachellia (Acacia) seyal* in the family Leguminosae, Fabaceae (Natural Gums and Resins in Africa (NGARA), 2004 ). In 2017 safety re-evaluation by Panel on Food Additives and Nutrient Sources of the European Food Safety the Authority (EFSA) said that the term "gum arabic" does not indicate a particular botanical source; in a few cases so-called "gum arabic" may not even have been collected from *Acacia* species (Mortensen *et al.*, 2017) .

Gums are polysaccharides either hydrophobic or hydrophilic, of a high molecular weight, 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 .al, 1968). Thus, the term gum is applied to a wide variety of substances of gummy characteristics and cannot be precisely defined. Hydrophobic substances which are often called gums are high molecular weight hydrocarbons and other substances which also considered petroleum products, rubbers, certain synthetic polymers, and the resinous saps which often exude from plants and which are sometimes tapped 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 solutions. Usage would classify as not included. In addition, synthetic gums such as

cellulose derivatives which are gums all polysaccharides or their derivatives which dispersed in water at low, dry, substance content, swell to produce gels, highly viscous dispersions.

## 2.2 Classification

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 comprise the extracts know as agar, alginates the tree exudates, and carrageenan; the tree exudates are gum Arabic, gum karaya, gum tragacanthin, gum gatti, seed gums include locust bean and guar gum. Other gum like materials such as pectin and starch where treated as separate groups. While gelatin, being a protein was carbohydrates gum, or for synthetic vinyl polymers such as poly vinyl pyrrolinone (PVP) which form 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 been gum and guar gum, which are both derived from plant-seed sources, have the similar chemical structure of a neutral Galactomannans, and differ only in the ratio of Galactose and Mannose molecules. 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 for new gums that are certain to be developed in the future. Following this line of those it has been proposed that the following all-inclusive classification composed of three main categories. Natural gums-those found in nature, modified natural or semi synthetic gums those based on chemical modifications of a natural gum or gum like materials, synthetic gums –those *produced* by chemical.(Abeer, A. (2017). Thermodynamic Properties of *Azadirachta indica (Neem gum).*

## 2.3 Production of gum arabic

While gum arabic has been harvested in Arabia, Sudan, and West Asia since antiquity, sub-Saharan acacia gum has a long history as a prized export. The gum exported came from the band of acacia trees that once covered much of the Sahel region: the southern littoral of the Sahara Desert that runs from the Atlantic to the Red Sea. Today, the main populations of gum- producing *Acacia* species are harvested in Mauritania, Senegal, Mali, Burkina.Faso, Niger, Nigeria, Chad, Camer oon, Sudan, Eritrea, Somalia, Ethiopia, Kenya,and Tanzania. *Acacia senegal* is tapped for gum by cutting holes in the bark, from which a product called *Kordofan* or Senegal gum is exuded. *Seyal* gum, from *Acacia seyal*, the species more prevalent in East Africa, is collected from naturally occurring exudations on the bark. Traditionally harvested by seminomadic desert pastoralists in the course of their transhumance cycle, acacia gum remains a main export of several African nations, including Mauritania, Niger, Chad, and Sudan. The hardened exudations are collected in the middle of the rainy season (harvesting usually begins in July), and exported at the start of the dry season (November). Total world gum arabic exports are today (2008) estimated at 60,000 tonnes, having recovered from 1987–1989 and 2003–2005 crises caused by the destruction of trees by the desert locust (Navarro and Alain 2008).

### 2.3.1 Production in Sudan

Although from the 1950s to the early 1990s, Sudan accounted for roughly 80% of gum arabic production, today, that figure is under 50%. (Policy Note 2008 ). However, hundreds of thousands of Sudanese are dependent on gum arabic for their livelihoods and it is still the world's largest single producer. The production of gum arabic is heavily controlled by the Sudanese government (Gerstenzang *and Sanders*., 2007).

### 2.4 Composition

Arabinogalactan is a biopolymer consisting of arabinose and galactose monosaccharides. It is a major component of many plant gums, including gum Arabic. 8-5' noncyclic diferulic acid has been identified as covalently linked to carbohydrate moieties of the arabinogalactan-protein fraction. (Renard *et al*, 2006).

### 2.5 Structural unit

Gum arabic is a complex and variable mixture of arabinogalactan oligosaccharides, polysaccharides, and glycoproteins. They are mainly formed by chains of 3,6-linked β-D-Galactopyranose substituted in position 6 by side chains of 3-linked α-L-arabinofuranose. There are structural differences dependent on the source with *A. senegal* having greater branching (78.2% vs. 59.2%) than *A. seyal* with more D-galactose relative to L-arabinose, more branched galactopyranoses, shorter arabinosyl side branches, and more rhamnopyranoses in the terminal positions. The gum from *Acacia seyal* also contains significantly more 4-O-methyl-D-glucuronic acid but less L-rhamnose and unsubstituted D-glucuronic acid than that from *Acacia senegal* .

## 2.6 Functionality

As with many other hydrocolloids, gum arabic is a useful prebiotic promoting beneficial physiological effects. As a food additive, it is a useful if rather an expensive hydrocolloid emulsifier, texturizer, and film-former, widely used in the drinks industry to stabilize flavors and essential oils, for example in soft drink concentrates. The simultaneous presence of hydrophilic carbohydrate and hydrophobic protein enables its emulsification and stabilization properties. Emulsification, which is dependent on the amount of arabinogalactan protein present, is particularly enhanced due to molecular flexibility which allows greater surface interaction with the oil droplets. Gum arabic is used in confectionery such as traditional hard (wine) gums, pastilles and as a foam stabilizer in marshmallows. It has also been used to gum the back of postage stamps.

The gum arabic glycoprotein possesses a flexible but compact conformation. It is readily soluble to give relatively low viscosity Newtonian solutions even at high concentrations (20-30 % wt/wt). However, and rather confusingly, molecular aggregation can cause both shear thinning and time-dependent thickening behavior at low shear.

## 2.7 Definition of neem tree:

The Neem trees a tropical evergreen tree native to Indian sub- continent (Roxburgh, 1874); it has been used in Ayurvedic medicine for more than 4000 years due to its medicinal properties. Most of the plant parts such as fruits, seeds, leaves, bark and roots contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, antiulcer and antifungal uses.

*Azadirachta indica* gum, which belongs to the Family of galactan gums, it is a very complex condensate of hetero polysaccharides and proteins. The Proteins are tightly linked to the polysaccharides, which constitute the major component. Drastic degradation of a smaller gum complex component shows that it contains D-glucose, D-glucuronic acid, L-arabinose, L-fucose, mannose and xylose. Investigation of the amino acid composition of the gum shows a aspartic acid as the most abundant, aspartic acid in *Azadirachta indica* gum were reported by few authors (Anderson and Hendrie,1971). *Acacia gum* (gum Arabic) consists of a group of macro molecule characterized by a high proportion of carbohydrates (approximately about 97%), which are predominantly composed of D-galactose and L- arabinose units and a low proportion of proteins (< 3%). However, Neem gum has unusual structural features in that it contains appreciable amount of D-glucosamine and proteins unlike other plant gums. *Azadirachta indica (Neem)* gum occupies a special position among plant gums in that, it contains about one-third of its weight as proteins (Anderson and Henrie, 1971), the highest concentration reported for any plantgum. Thus, Neem gum is an excellent experimental material for the study of the biological activities of proteins in exudates gums (Anderson *et al*, 1968).

Gum arabic's mixture of polysaccharides and glycoproteins gives it the properties of a glue and binder that is edible by humans. Other substances have replaced it where toxicity is not an issue, and as the proportions of the various chemicals in gum arabic vary widely and make it unpredictable. Still, it remains an important ingredient in soft drink syrup and "hard" gummy candies such as gumdrops, marshmallows, and M&M's chocolate candies. For artists, it is the traditional binder in watercolor paint, in photography for gum printing, and it is use as a binder

in pyrotechnic compositions. Pharmaceutical drugs and cosmetics also use the gum as a binder, emulsifying agent, and a suspending or viscosity increasing agent Wine makers have used gum arabic as a wine fining agent ( Vivas *et al* .2001).

It is an important ingredient in shoe polish, and can be used in making homemade incense cones. It is also used as a lock able adhesive, for example on postage stamps, envelopes, and cigarette papers. Lithographic printers employ it to keep the non-image areas of the plate receptive to water(dynodan.com..2012) Tis treatment also helps to stop oxidation of aluminium printing plates in the interval between processing of the plate and its use on a printing press

## 2.7 Gum Arabic in food applications

Gum Arabic is mainly used in the confectionery industry, where it is incorporated in a wide range of products. It has a long tradition of use in wine gums, where it produces a clarity that is higher than can be obtained with other hydrocolloids. Furthermore, it prevents sucrose crystallization, provides a controlled flavor release and slows down melting in the mouth, making the wine gum long lasting. It also provides the appropriate texture to these candies, which are easily deformed in the mouth but do not adhere to the teeth (Arja *et al*., 2011).

In lower-calorie candy, gum Arabic is used to compensate for the loss of texture, mouthfeel and body, resulting from the replacement of sugars by artificial sweeteners. It is also used in chewing gum as a coating agent and as a pigment stabilizer. In aerated confectionery products, such as marshmallows, nougats and meringues, gum Arabic acts as a whipping and stabilizing agent. It is also used in toffees and caramels as an emulsifier, to maintain a uniform distribution of the fat across the product. In jelly products, it is used to provide a fibrous, fruit-like texture (Tadesse *et al*., 2007).

Gum Arabic is widely used as an emulsifier in the manufacture of soft drinks. Due to its stability in acid.

## 2-8 Gum Arabic in Non-Food Applications

Gum Arabic was once extensively used in the pharmaceutical industry, but is now replaced by celluloses and modified starches in many applications. It is still used as a suspending agent, emulsifier, adhesive and binder in tabletting and in demulcent syrups.

## 2-9 Applications of Neem Gum

Food Industry: Used as a stabilizing agent, gels and thickening agent.
Bakery: *Azadirachta indica* gum used in the baking industry for its low water absorption properties, its cold water soluble and has adhesive properties.
Cosmetic Industry: Used in facial masks, lotions, face powder, protective creams.
Paper Industry: Used as an adhesive and strengthening the paper.
Pharmaceutical Industry: Used in antiseptic creams, tablet binder, and coater.
Textile Industry: Used in dyeing and printing of fabrics.
Personal Hygiene Industry: Used in soaps, tooth paste, tooth powders.

## 2-10 Polarization (optical rotation)

Many substances possess the inherent property to rotate the plane of the incident polarized light; this property is called optical activity. The measurement of optical activity is used for establishing the identity of the substances, it may also be employed to test the purity of the substance, the optical rotation is angle through which the plane of polarization rotates when polarized light passes through a layer of a solution.

The measurement of optical activity is used for establishing the identity of the substances, it may also be employed to test the purity of the substance, the optical rotation is angle through which the plane of polarization rotates when polarized light passes through a layer of a solution Compounds which rotate light clockwise are said to be dextrorotary, and correspond with positive specific rotation values (+ve), while compounds which rotate light counterclockwise are said to be levorotary, and correspond with negative values (–ve). If a compound is able to rotate plane-polarized light, it is said to be “optically active”. (Makka, 2011)

# CHAPTER THREE

# MATERIAL AND METHOD

## 3.1 Material

The gum (*sengal and seyal*) used in this study were obtained form Elnaser company (spray dryed), while, neem gum was collected form trees in college of agricultural studies campus, Sudan University of Since and Technology (SUST).

## 3.2 Apparatus

Polax-2L apparatus was used in determination of the degree of rotation and polarization of the gums.

## 3.3 Method

### 3.3.1Sample preparation

The aqueous solutions of the gums were prepared by dissolving of g5 from each gum in distilled water in a volumetric flask, then the volume was completed to 100 mL.

### 3.3.2 Angel of rotation

The measurement tube 2 dm was filled by the aqueous solutions of the gum and then the angel of rotation was obtained from the instrument polax-2L and the instrument reading was registered as angel of rotation (optically active compounds).

### 3.3.3Polarization

In practice the angle of rotation (α) is measured in degrees. However, α depends on the number and nature of the molecules, the distance through which light travels and varies only slightly with temperature and solvent. The parameter calculated from rotation measurements is the specific

rotation (α) (polarization) is given by:

$$\{\alpha\}\ d=\frac{100\ \alpha}{L.C}$$

Where:

A: is the measured rotation in degrees.

D: is the wavelength of the light (sodium line, 589 nm).

C: is the concentration of solution in g/100ml.

L: is the path length in decimeters.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Angel of Rotation:

The polarimeter readings for the aqueous solution of the tested gums showed in figure (1).

The angle of rotation results for the tested gums Sengal, Seyal and Neem were -3.47, 4.317 and -5.867, respectively. The angle of rotation results for the tested gums mixtures were -4.717,-1.223 and 0.5 for the mixture of Sengal/Neem, Seyal/Neem and Sengal/Seyal, respectively.

## 4.2 Polarization

Table (1) showed the polarization results for the tested gums and their mixtures.

The calculated polarization results for Sengal, Seyal and Neem were

-34.7, 43.17 and -58.67, respectively, Sudanese Standard And Metrology Organization (SSMO) specified that the polarization for sengal gum between(-22to35)and polarization for seyal gum between(40to65).

The specific optical rotation of neem gum closed to that reported by (Awad, 2016)(-67.7) and(Salih,2017)( -65.5).

The polarization results for tested gum mixtures of Sengal/Neem,Seyal/neem and Sengal Sengal were -47.17,-12.23and 5 respectively.

The mixing of guns resulted in the polarization reading out of the specification of the three tested gums and that means the polarization was sensitive enough to defect the mixing of gum.

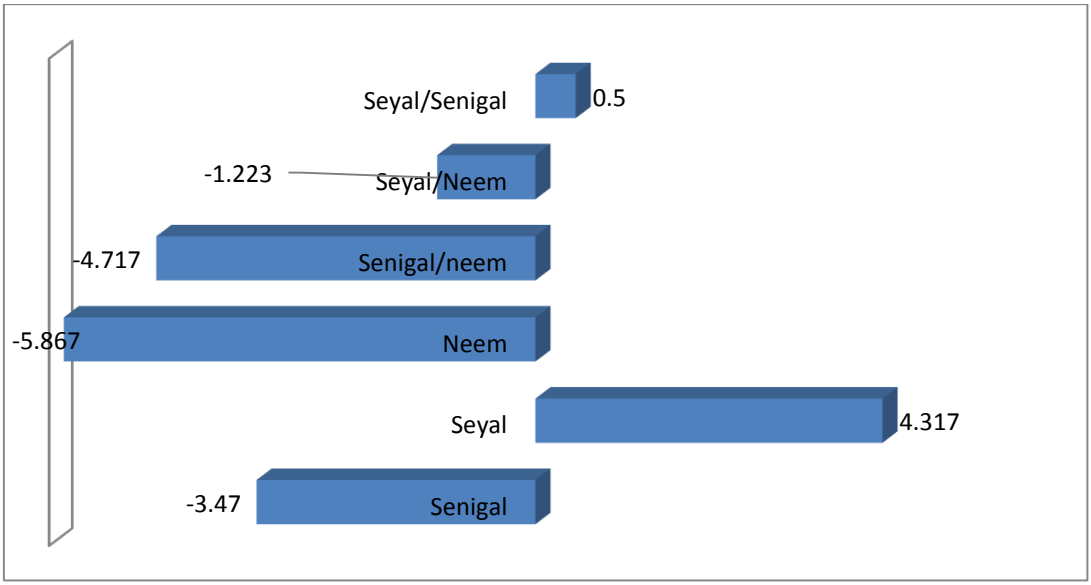


**Figure 1. The angel of rotation for the tested gums**

**Table 1: The polarization for tested gums**

| Gum Samples | Polarization (Degree) |
|---|---|
| Senigal | -34.7 |
| Seyal | 43.17 |
| Neem | -58.67 |
| Senigal/neem | -47.17 |
| Seyal/Neem | -12.23 |
| Seyal/Senigal | 5 |

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusions:

Based on the results obtained in this study it can be concluded that the mixing of gums has a great effect on both the angle of rotation and the polarization results.

The polarization results obtained from the mixing of each two gums were out of the specification of both the mixed gums.

The polarization results are powerful for detection of any adulteration or mixing of gums.

## 5.2 Recommendation:

-The test of polarization should be approved for deception of purity, mixing and adulteration of gums.

- Beside the polarization of gums, other factors should be studied to differentiate between gums.
- Further studies are needed to determine the least percentage for mixed gums that can be detected in polarization.

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# APPENDICES

**Gum Arabic**


**Polax-2L**