بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Preparation and Physicochemical Characterization of Magnesium Glucuronate from *Acacia tortilis* Subspecia *randiana* gum

تحضير وتوصيف جلوكورنات الماغنيسيوم من صمغ السيال

A Thesis Submitted Partial Fulfillment of the Requirement for Master Dgree in Chemistry

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إستهلال

قال تعالى :

أَمَّنْ خَلَقَ السَّمَاوَاتِ وَالْأَرْضَ وَأَنْزَلَ لَكُمْ مِنَ السَّمَاءِ مَاءً فَأَنْبَتْنَا بِهِ حَدَائِقَ ذَاتَ بَهْجَةٍ مَا كَانَ لَكُمْ أَنْ تُنْبِتُوا شَجَرَهَا ۗ أَإِلَٰهٌ مَعَ اللَّهِ ۚ بَلْ هُمْ قَوْمٌ يَعْدِلُونَ

صدق الله العظيم

سورة النمل الاية : (60)

Dedication

My father Mohamed who has in me the love of learning and knowledge and who has an endless help support .

My mother siham who taught me the rudiments of the alphabet , who surrounded me with her love , care and tenderness .

My sisters and my brother .

Acknowledgements

My special praise and thanks be to the Almighty Allah, most Gracious and most Merciful who gave me the health, strength and patience to product this research

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Abstract

In this study anti acid tablet was formulated from *Acacia tortills* var *raddiana* gum.

Glucuronic acid was prepared by ion exchange chromatography, then magnesium glucuronate was prepared by adding magnesium bicarbonate to the eluate.

Physicochemical characterization of *acacia tortills* var *raddiana* and magnesium glucuronate show the moisture content of gum sample was 9.92% and for magnesium glucuronate was 10.3%, the total ash and inorganic content of magnesium glucuronate 1.85% which is less than in gum sample, the gum sample is dextrorotatory when the magnesium glucuronate is levorotatory, the viscosity of magnesium glucuronate is slightly lower than gum's viscosity.

The gum sample is moderately acidic, when the magnesium glucuronate neutral, and mineral composition of gum sample and magnesium glucuronate show the major cations are Na, Mg, and Ca, all minerals values decreased in magnesium glucuronate in compared with gum sample except Mg and Ca which are increased.

المستخلص

في هذه الدراسة تم تحضير جلوكورنات الماغنيسيوم من صمغ السيال صنف الراديانا .

تم تحضير حمض الجلوكرونك باستخدام كروماتوغرافيا التبادل الايوني وتحضير جلوكونات الماغنيسيوم باضافة بيكربونات الماغنيسيوم.

التشخيص الفيزوكيميائي لصمغ السيال صنف الراديانا وجلوكيورونات الماغنيسيوم اوضح ان محتوى الرطوبة لعينة الصمغ(9.92%) ولجلوكورنات الماغنيسيوم(10.3%) وان محتوي الرماد والمحتوى غير العضوي لجلوكورنات الماغنيسيوم تعادل(1.85) وهو اقل من محتوى عينة الصمغ, جلوكورنات الماغنيسيوم تدير الضوء الى اليسار بينما تدير عينة الصمغ الضوء الي اليمين, لزوجة جلوكورنات الماغنيسيوم منخفضة مقارنة بعينة الصمغ.

عينة الصمغ متوسطة الحموضة بينما جلوكونات الماغنيسيوم متعادلة,المحتوي الكتيوني اوضح ان العناصر الاكثر وفرة هي الصوديوم,الماغنيسيوم والكالسيوم, متحوى العناصر انخفض في الجلوكونات الماغنيسيوم ماعدا الكالسيوم والماغنيسيوم زاد تركيزهما.

Chapter one

Introductio and literature review

Chapter One

Introduction and literature

1.1 Introduction

1.2 Anti acids

Anti acid is alkaline compounds used to neutralize hydrochloric acid in the stomach. Antiacids have been used for more than 100 years in medical in the treatment of acid related diseases and gastrointestinal tract. For a long time sodium carbonate was used as an alkalinizing agent.(Belousov Y, et al .,2010).

According to the digestive absorption classification antiacids are divided into two main categories, absorbable and non absorbable. Absorbable antiacids are rapidly dissolving substances that immediately react with hydrochloric acid in the stomach forming carbon dioxide and water. Carbon dioxide causes gastric distention which provokes gastroesophageal reflux and stimulates gastric secretion enhancement. Most antiacid used in medical practice are non absorbable, without systemic pharmacokinetics.(Veber V, et al., 2009).

1.3 Acacia gum

In fact the name *Acacia* is from the Greek akis meaning a sharp point; describing the thorns and Australian *Acacias* have no thorns, though to be fair a good few of their some 1 000 species do have rather sharp spine-tipped leaves, but that is hardly an issue (Ali, et al., 2014) .

Gum Arabic is dried exudate obtained from the stems and branches of certain species from the *Acacia* genus, *Acacia* is one of the most popular vegetation of the plant kingdom. Although there are 1100 *Acacia* species world wide, *Acacia senegal* and *Acacia* seyal remain the most commercially, exploited species of the whole *Acacia* resource (Christian, et al., 2001)

The genus *Acacia* comprises over a thousand species spread the world. Most of them grow in the arid and semi-arid regions, with an average temperature of 40-45 °C in summer and less than 5°C in winter. *Acacias* equipped with most of the features required to withstand severe climatic conditions, therefore they considered as the most successful "survivors" in the arid regions (Ibrahim, et al., 2003).

It is mainly produced in sub-desert region of Africa including countries such as Sudan, Senegal, Mauritania, Mali, Cameroon and Chad (Vanloot, et al., 2012).

The Sudanes gum belt extends from latitude 4 to 14 North, due to the extensive area of the gum Arabic belt Sudan is the dominant producer of gum Arabic with over 80% of world production and share around 60% of gum arabic market (Anon., 2013).

1.4 Chemical structure of gum Arabic

Gums are branched hetro polysaccharide composed of Glactopyranose units and small quantities of glycoprotein (FAO, 2018).

Acacia Gums consists of a mixture of polyelectrolytes associated with calcium , magnesium and potassium salts. This hybrid polyelectrolytes contains both proteins and polysaccharides sub-units. It is composed of six carbohydrate moieties (Fig1.1) (galactopyranose, arabinopyranose, arabinofuranose, rhamnopyranose glucuropyranosyl uronic acid and 4-O methyl glucuropyranosyl uronic acid) and also contain a small proportion of proteins .

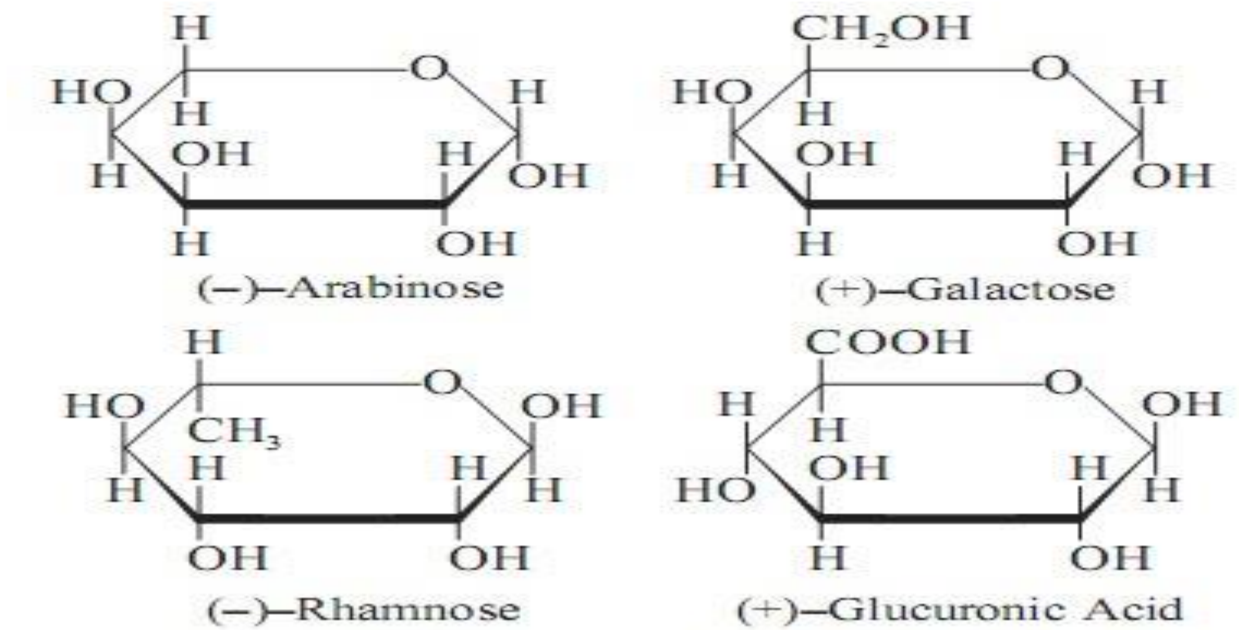


Fig (1.1): Structure of some sugars in gum Arabic

The main chain is composed of 1,3-linked β,D-glacopyranosyl units (Fig1.2).These 1,3-linked β,D-glacopyranosyl units are composed of side chains linked to the main chain by 1,6- linkages. Both the main chain and side chains contain units of the carbohydrates moities presented before, Uronic acid moities being mostly end units (Islam, et al., 1997) , (Y, et al., 2006), (Caslettani, et al., 2010) , (Nakauma, 2008), (Atgie, 2018) .

Gum Arabic is approximately composed of 39 to 42 % glactose units, 24 to 27 % of arabinose units, 12 to 16 % of rhamnose units, 15 to 16 % of glucuronic acid units, 1.5 to 2.4 % of pronein moities and finally 12 to 16 moisture (Atgie, 2018) .

These percentages vary for gums regarding *Acacia* trees ages or location (Willims & Phillips, 2000), (Mariana, et al., 2012) .

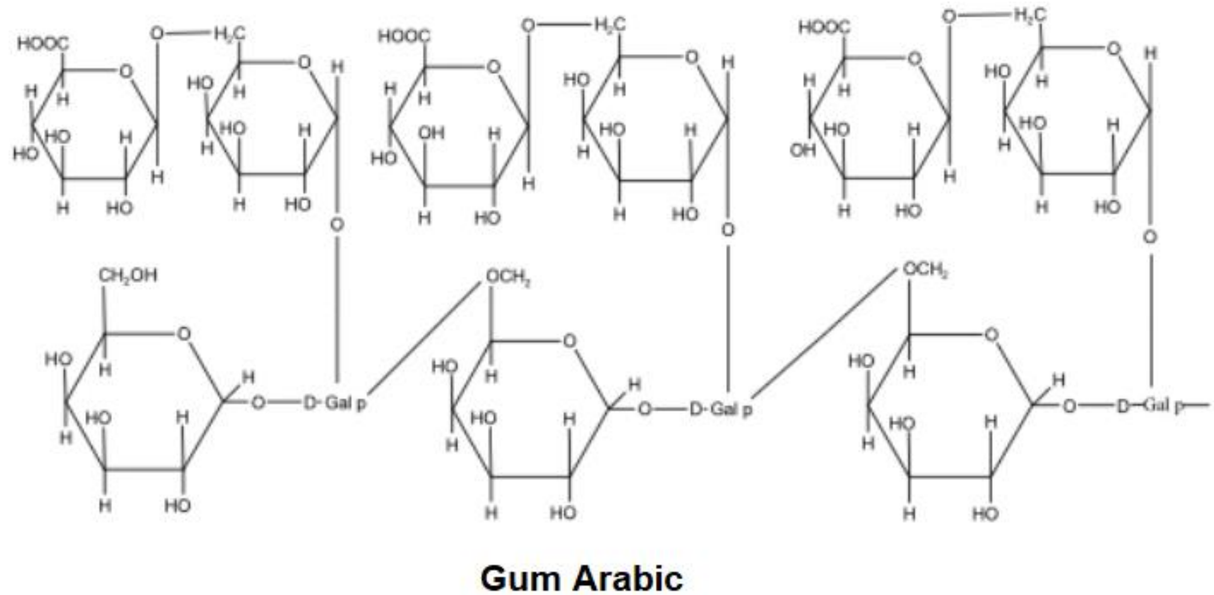


Fig (2.1) Chemical structure of gum Arabic

1.5 Physicochemical properties

Solubility

Acacia tortilis var *raddiana* gum is highly soluble in water forming transparent solution, and classified as soluble gum.

Gum Arabic is pale white orange brown solid that breaks with glassy fracture (Anon., 2013) .

Highly soluble in water and solution upto 55% can by obtained (Anon., 2013) .

It is insoluble in oils and most organic solvents (Anon., 2013) .

It is regarded as 95% soluble fiber (Anon., 2013) .

Moisture content

The moisture content is percent weight lost due to the evaporation of water (Benjamin & Laterite, 1970). It facilitates the solubility of hydrophilic carbohydrates and hydrophobic proteins in gum Arabic (Thomas, et al., 2003). The moisture content of good quality gum dose not exceed 15 and 10% for granular and spray dried material respectively (F.A.O, 1999) (Daoub, et al., 2016), reported that the moisture of A.*tortills* var *raddiana* gum to be around 8.49%.

Total ash

Ash content is a measure of inorganic residue remaining after organic matter has been burnt, it used to determine the critical levels of foreigen matter, acid in soluble matter, and salts of calcium, potassium and magnesium. The inorganic residues exist as elements.

(Daoub, et al., 2016) reported that the ash content of A.*tortills* var *raddiana* is about 2.05%.

Optical rotation

The gum of natural origin, e.g. A.*tortills* var *raddiana* gum, has the property of rotating the plane of the polarized light. The direction of the rotation, as well as the magnitude is considered as a diagnostic parameter (Biswas, et al., 2000). The optical activity of organic molecules (saccharides and carbohydrates) is related to their structure and a characteristic property of the substance (Eugene &

Banlacorek, 1987). (Daoub, et al., 2016) reported that the optical rotation of A. Raddiana is about +86.75 .

Nitrogen content

(Dickinson, 1988) studied the emulsifying behavior of gum Arabic and concluded that there is strong correlation between the proportion of protein in the gum and it is emulsifying stability. (Idris, 1989) showed that the protein contents of fresh samples were fairly constant (2%) irrespective of the age of the tree. Intensive investigation (Anderson, et al., 1985); (Gammon, et al., 1968) show the role of nitrogen and nitrogenous component in the structure, physicochemical properties and functionality of gum. A. *tortills* var *raddiana* nitrogen content is about 1.549% and the protein content about 10.375% (Daoub, et al., 2016) .

Viscosity

The viscosity of liquid is its resistance to shearing, to stirring or to flow through a capillary tube (Bancraft, 1932).It was considered as one of the most important analytical and commercial parameter (Anderson et al., 1969) because the study of gum solutions flow play an important role in identification and characterization of their molecular structure, Since it involves the size and the shape of the macromolecule. The viscosity of a solution may have a complicated variation with composition, due to the possibility of hydrogen bonding among the solute and solvent molecules (Pimental & MC cellen, 1960) , eg more hydroxyl groups makes high viscosities, because a network of hydrogen bonds is formed between the molecules, this net work extends throughout the liquid, thus making flow difficult.They also found that the viscosity of gum solutions changes with pH, but they found a maximum viscosity at pH 6-7,and it is inversely proportional to temperature.

Acidity and pH measurement

The hydrogen ion concentration is very important in chemistry and industry of gums, the functional properties such as viscosity, emulsifying power are affected by pH value ,Arabic acid substance is a major component of commercial gum , it decomposed to give arabinose and hence the gum solution moderately acidic (Ahmed, 2007), Daoub reported that the pH value of A.*tortills* var *raddiana* was 4.45.

Uronic acids

Uronic acids are widely distributed in animal and plant tissues and constitute a major component of many natural polysaccharides (Ahmed, 2007) , A number of methods have been developed for determination of uronic acids. They include colorimetric, decarboxylation and acid base titimetric methods. Gums differ widely in their equivalent weight and uronic acid content (Karamalla, 1965).

Molecular weight

The molecular weight of the polymers can be determined from physical measurement or by application of chemical methods, physical methods frequently used for establishing polymer molecular weight are osmometry, polymer viscosity, measurement of coefficient of diffusion, ultra centrifugation and light scattering (Fatima, 2016) . on line to multi angle laser light scattering (MALLS) has been demonstrated to be a very powerful method for characterizing. molecular weight of A.*tortills* var *Raddiana* was calculate by (Daoub, et al., 2016) and found 2.06×10^{6}.

1.6 Applications

Due to their emulsification, microencapsulation, thickening and stabilization properties Gum Arabic has wide applications.

Food application

Gum Arabic is extensively utilized in the food industry due to its biocompatibility, low cost, low toxicity and relatively wide spread availability (Nep & Conway, 2010)

Confectionery

Gums are recognized, preffered, natural constituent for the production of high quality soft candies, here the Gum in mainly used in the raw form, which enables the manufacture of soft, chewy candy, they are an excellent flavour carrier and are used by formulators for impartiong a clean, long lasting frish test (Anon., 2013) .

Gums are may be used to emulsify the flavour oils or fats in confections or retard crystallisation in high sucrose confections, the film forming ability of Gums makes it a useful ingredient coatings including the pan-coating of fruits and nuts, in addition, speciality anti cariogenic (anti tooth decay) cadies have contained Gum Arabic, which is resistant to degradation by micro-organisms in the human mouth responsible for such effects (Anon., 2013) .

Bakery Applications

Wherever film forming and emulsifying properties with out affecting product taste or rheology are needed, Gums are an ingredients that must be considered .

Baverages

As the emulsifing agent of choice as essintial ingradient due to completness of stability of the emulsifying produced even in normally difficult low acid environments (Anon., 2013), Gums are widely used in a broad range of Beverages.

In the manufacture of soft drinks, it is suitable for use in flavour oil emulsions, where it prevents flocculation and coalescence and inhibits destabilization caused by creaming (Tadesse, et al., 2007), (Wyasu & Okereke, 2012) .

It can also be used as a clarifing agent in the production alcoholic beverages such as high quality wines (Anon., 2013).

Flavours Encapsulation

They are used as a flavour encapsulator in dry mix products such as puddings, desserts, cake and soup mixes and is also used to emulsify essential oils in soft drinks and to prevent sugar crystallization in confectionary products (CNI, 2005)."Of-the-shelf" spraydried flavours may be formulated using gum arabic (Anon., 2013). Influence on the viscosity, body and texture of food, it is nontoxic, completely soluble in water and does not affect the flavour, odour, colour of the food to which it is added (Tewari, 2010). Gum Arabic is an ideal material in flavour encapsulation due to its emulsifying and surface-active, as it has shown to conform to the properties (Microencapsulation is the process whereby particles of an active ingredient are formed and covered with a thin layer of another material, thus providing protection and controlled release). It is used as a fixative in spray drying applications to protect the flavour compound against oxidation and volatilization (Kanakdande, et al., 2005) .

Flavour protection, desirable flavour release, long shilf life and high dispersibility are the advantages offered by Gums (Anon., 2013) .

Pharmaceutical Application

Gums are used as a carrier of drugs since it is considered a physiologically harmless substance, it used as diluents, binders, disintegrants in tablets, thickeners in oral liquids, protective colloids in suspensions, gelling agents in gels, and bases in suppository (Zatz & Kushla, 1989). It has some biological properties as an antioxidant (Trommer & Neubert, 2005) (Hinson, et al., 2004) (Ali & AL Moundhri, 2006) on the metabolism of lipids (Evans, et al., 1992) (Tiss, et al., 2001) , and in treating many diseases such as kidney (Ali, et al., 2008) (Matsumoto, et al., 2006), cardiovascular (Glover, et al., 2009) and gastro-intestinal diseases (Wapnir, et al., 2008). Gum Arabic reduces glucose absorption, increases fecal mass and bile acids, and has the potential to beneficially modify the physiological state of humans (Adiotomre, et al., 1990). One of its oldest and best known uses has been in cough syrups (Anon., 2013). In cosmetic it is used as smoothener in lotions and protective craems, and adhesive in facial masks or face powders (Verbeken, et al., 2003) , and in product such as face masks ,and hair creams (Anon., 2013) .

Dietary Fiber Formulations

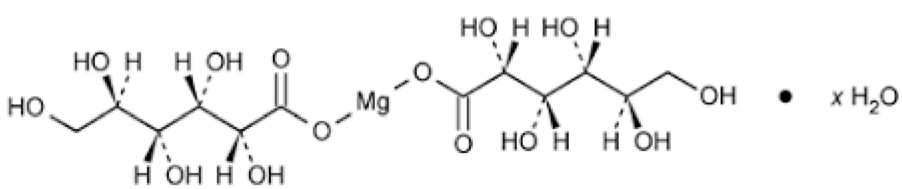
Gum Arabic in the hands of creative food technologists, may by formulated as part of the natural nutritional supplements that help to add soluble fiber in palatable form (Anon., 2013), The classification of dietary fibre as formally agreed by the European Union and Codex Allimentarius, (Phillips, et al., 2008) (Phillips & Phillips, 2011) .

Miscellanous Industrial Applications

The ability of gums to form highly uniform films and to "carry numerous ingredients through co-spraydrying, has made it a recognised option in sprayed glazes, also high technology ceramics and as a flocculating agent in ore refining of certain minerals (Anon., 2013).

Gums is used in textiles, lithography, paints, and paper- making (Verbeken, et al., 2003) (Elmanan, et al., 2008),Gums are widely used in textile industries to impart luster to certain materials (silk), as thickeners for colors and mordant in calico printing (Omer, 2004). Due to its adhesive properties gum have been used in the manufacturing of adhesives for postage stamps and also in the formulations of paints and inks (Ahmed, 2007) .

1.7 Magnesium glucuronate



Glucuronic acid is one of the most important uronic acids. The presence of carboxylic group in the structure of uronic acids renders these compounds potential metal binding site for both toxic and essential metals .

Molecular formula : $C_{12}H_{26}MgO_{16}$.

Molecular Weight : 450.63 g/mol .

1.8 *Acacia tortills* var *raddiana*

Botonical classification

Kindom : *Plantae* .

Division : *Mangoliophyta* .

Class : *Mangoliophsida* .

Order : *Fabales* .

Family : *Fabaceae* .

Subfamily : *Minosoideae* .

Tribe : *Acacieae* .

Genus : *Acacia*.

Species : *A.Tortilis* .

Binomial name : *Acacia tortilis* savi .

Local name : *sayal* .

(Elamin, 1981)

History and morphology of *Acacia tortilis*

The generic name '*Acacia*' derived from the Greek word 'akis', meaning a point or a barb. The name '*tortilis*' means twisted and refers to the pod structure. It is also known as umbrella thorn due to it umbrella like structure and in India it is commonly known as Israeli baboo .

Description

The tree occasionlly reaches 7-21m high, crown irregular or round one main stem from base, leaves are dark green, margin not alliolate or if so, only at the apex pods 6-9mm wide, glabrous to, pubescent, hairs not seen through the naked eye (Elamin, 1981).

The bark is slightly cracked to fissured brown, sleshpinky-brown, with dark brown outerbark. Stems are reddish to blackish purple, more or less glabrous or puberulous, thorns are mostly straigh, upto 5-10 cm long , and the others are more or less curved reaching 0.5 cm long , set pairs in the leaf axil, white ,leaves are alternate. bipinnate upto 2.5 - 4.5 cm long with 2-10 pairs of pinnae and 6 -20 pair of leaflets per pinna, leaflets are oblong, glabrous or more or less pubescent 3-4 cm long and 0.5 -1 cm across, petioles are 2-4 cm long often with crateriform gland above before the first pair of pinnae and some time others, the flowering happened in the rainy season after the first leaves appear . The inflorescence in a fascicle , set in the leaf axil composed of 1-6 glomerules, about 2-5 cm long, whitish pedunculate, 0.5 - 1 cm in diameter (Bo, 1981) (F.A.O, 1991) (F.A.O, 2002) , .

- Fruits are pods more or less coild in to a spiral, 7- 12 cm long and 0.5 - 0.7 cm across pale green to yellowish when rip, containing up to 10 seeds (Bo, 1981) (F.A.O, 1991) (F.A.O, 2002).
- Seeds are brown, more or less convex elliptic or round, 4 - 7 mm in diamter (Arbonnier, 2004) .

Distribution

Central, northern and from south Africa northwards to Algeria and Egypt, also in west and north estrn Africa (Elamin, 1981) .

In sahil zone from Algaria - Senegal to Egypt -Sudan –Ekenya Fig (3.1).

From senegal to cameroon, as far as somalia, Topical Africa, North Aftica, Middle- East and Arabia (Bo, 1981) (F.A.O, 1991) (F.A.O, 2002) .

Figer (1.3) : Gum

1.9 Objective of the study

The main objective

Formulation of anti acid tablets.

Specific objectives

- To characterisation of *Acacia* ***tortilis*** var ***raddiana*** gum.

- To preparation of glucurnic acid from A.*tortills* var *radiana* gum .

- To preparation and characterisation of magnesium glucuronate.

Chapter Two

Materials and Methods

Chapter two

Materials and Methods

2.1 Materials

- A.***tortillis*** var ***raddiana*** sample collected from sharg Alneel, khartoum North , donated by Prof : Mohamed Elmubark Osman .

-Sulphuric H_2SO_4 , Ar , (98%) *LOBA Chemie* .

-Barium chloride $BaCl_2$.

-Magnesium bicarbonate $Mg(HCO_3)_2$, Ar .

-Cation exchange resin (RH+ 20).

- Deionized water .

- Suger.

- Starch .

- Mg streate .

- Micro-crystallin cellulose .

2.2 Sample pretreatment

Dry sample was cleaned by hand to insure freedom from sand, dust and bark impurities, and then it was ground using pestle and mortar, then kept in labeled (polyethylene) bags.

2.3 Preparation of glucuronic acid

Glucuronic acid was prepared using ion exchange chromatography method. A glass column packed with amberlite resin IR 120+H (a strong cation exchange resin) was used. 0.2 molar sulfuric acid was passed through the column many times, the column was then washed with deionized water until no white precepted ($BaSO_4$) by adding Barium chloride. 27.48 g of sample was weighed and dissolved in 500 ml deionized water, after the sample was completely dissolved, the solution was left until it became free from bubbles and insoluble matter. The solution was slowly passed through the column in order to replace its cations by the hydrogen bonded to the resin, the collected eluate was arabic acid (Glicksman and Schachat, 1959). The acidity of the eluate was measured.

2.4 Preperation of magnesium glucuronate

185g of magnesium bi-carbonate were weighed and was added to 200 ml of glucuronic acid solution in beaker (1000ml), the beaker content stirred until the bubble formation end. The precipitate collected and then transferred to Petri dish and left to dry for three days at room temperature and ground to powder.

2.5 Physicochemical properties measurement

Moisture content

One quick and accurate way of determining moisture is thermogravimetric measurement using a Halogen Moisture Analyzer (HB43 from METTLER TOLEDO), the sample was weighted (10g) and heated with an infrared radiator (halogen lamp). The loss in weight continuously recorded and drying end once a defined criterion is reached .

The moisture content is automatically calculated from weight deference .

Total ash

Total ash was determined according to AOAC (1990). Crucibles were heated in an oven for 30 minutes cooled in a desiccator and then weighed (W1). About two grams of sample were placed in the crucible and accurately weighed (W2), then ignited at 550^{O}C in a Heracus electronic muffle furnace for 2 hours, cooled in a desiccater and weighed (W3). Total ash% was calculated as follows:

$$\%\text{Ash} = \frac{\text{w3} - \text{w1}}{\text{w2} - \text{w1}} \times 100$$

Where:

W1: Weight of the empty crucible.

W2: Weight of crucible +sample.

W3: Weight of crucible +sample after drying .

pH measurment

pH was determined using 10% aqueous solution using pH meter (H/22/0 from HANNA). Two standard buffer solutions of pH 4.00 and 7.00 were used for the calibration of the pH meter. 25% gum solution was prepared, the device was switched on ,the glass electrode immersed in gum solution with hand shaking , the reading taken after 15 min.

Specific optical rotation

The specific rotation was determined according to FAO (1991). A 1% solution of gum was prepared. The solution was passed through a filter paper before carrying out measurements at room temperature. The Polarimeter (ADP 410 from Bellinghamand Stanley)instrument have been switch on. In 20 cm sample cell the Gum solution was taken, the cell insert in the polarimeter the reading was taken after 10 min and the specific rotation for gum solution was calculated according to the relationship:

$$Specific\ rotation = \frac{\alpha \times 100}{C \times L}$$

Where:

α= Observed angular rotation .

L= Length of the polarimeter tube in decimeters.

C= Concentration of the solution expressed as number of grams substance in 100cm³ of solution.

Determination of viscosity

25% gum solution was prepared, The viscometer (DV1 from AMETEK Brookfeild) device have been switch on and the spindle (62) and speed (60) was selected, the device was started and reading was taken after 10 min.

Colour test

25% solution was prepared, The device (Colourmeter Lovibond L from Tintometer) have been switched on and the solution taken in sample cell, the cell was insert then the light that was transmitted through the sample was compared with that transmitted through a series of glass colour filter in 3 primer colours red, blue and yellow, the slides were adjusted until a visual colour match was found for the light from the sample, the colour was expressed in lovibond RYBN colour units.

2.6 Formulation of anti acid tablet by direct method

Active substance magnesium glucuronate and excipients micro-crystalline cellulose, starch, binder, suger were weighed (0.5g, 2.4g, 1.6g, 0.8g) then softing though mesh to reject all large particles and mixed using blender for 15 min, Mg streate (0.2g) was added and mixed for 5 min, the mixed powder were compressed into tablets using tableting machine.

Chapter Three

Results and Discussion

Chapter three

3.1 Results and discussion

Table (3.1) : physic-chemical properties of gum sample and magnesium glucuronate.

Sample	Moisture	Ash	S.O.R	Viscosity	Ph	Colour
Gum sample	9.92%	2.63%	+79	58cp	4.3	9.1
Mg glucuronate	10.3%	1.85%	-6	16.25cp	6.41	_

The acidity value of eluent

pH = 2.4

A number of physicochemical were used to characterization the studied sample of *Acacia tortills* var *raddiana* gum and magnesium glucuronate .

The moisture content of the gum sample was found 9.92%, and for magnesium glucuronate was 10.3%, the moisture content of a good quality gum should not to exceed 15% for granular and 10% for spray dried (F.A.O, 1999).

The total ash content of the gum sample was found 2.63%, FAO reported that the ash content of gum did not exceed more than 4%. The total ash content of magnesium glucuronate was found 1.85%.

The gum sample is dextrorotatory with S.O.R value equal +79,and magnesium glucuronate is levorotatory with S.O.R value -6.

Viscosity value decreed from 58cp in gum sample to 16.25cp in magnesium glucuronate. When the gum sample is moderately acidic with pH value 4.3, the eluate is slightly acidic with pH value 2.4, and magnesium glucuronate is neutral with pH value 6.41.

Table (3.2) : Minerals content (mg/l) of gum sample and magnesium glucuronate

Element	Na	Mg	Ca	V	Fe	Ni	Cu	As	Al	Pb
Sample	711.45	4.49	15.7	1.79	2.56	1.98	0.64	4.08	2.29	4.38
Product	5.49	17.19	71.89	1.59	1.45	1.79	0.44	3.84	1.49	3.93

Table (3.2), show the mineral composition of the gum sample and magnesium glucuronate, the major cations in the gum sample are Na, Mg, and Ca, 711.45, 4.49 and 15.17 with respect, all minerals value decreased in magnesium glucuronate its clear in sodium , it decreased from 711.45 to 5.49, Magnesium and potassium levels are increased.

Fig (3.1) : Anti acid tablets   **Fig (3.2) : Mg glucuronate**

3.2 Conclusions

On the basis of results obtained , it could be concluded that :

- *Acacia* ***tortills*** var ***raddiana*** is dextrorotatory and magnesium glucuronate is levorotatory .
- The viscosity value of magnesium glucuronate is less than in gum sample.
- A.***tortills*** var ***raddiana*** and magnesium glucuronate have ash content of 2,63 and 1.85% respectively they are in range of good quality gums.
- Glucuronic acid (2.4) is the most acidic, A**.*tortills*** var ***raddiana*** is moderately acidic (4.3) and magnesium glucuronate is neutral (6.41).
- The major cations in the gum sample and magnesium glucuronate are sodium, magnesium, and potassium. Their levels are decreased in magnesium glucuronate.

3.3 Recommendation

- More investigation are needed to study the stability and the effect of magnesium glucuronate as anti acid .
- The gum has high content of Ca and Mg , so that it can be used as supplement .

References

Adiotomre, J., Eastweed, M. A., Edward, C. A. & Brydon, W. G., (1990). Dierty fiber. Vol 46;112-122.

Ahmed, A. E. et al., (2009). Physicochemical Properties of Acacia Polyacantha Gum.University of Hamburg.

Ahmed, A. H., 2007. *Fractionation , physicochemical and functional properties of acacia polycantha.* MSc. Thesis University of khartoum.

Ali, A. A., Ali, K. E., Fadlalla, A. & Khalid, K. E., (2008). The effect of GA oral treatment on the metabolic profile of chronic renal failure patient under regular haemodialysis in central sudan.Nat Prod Res 22:12-21.

Ali, A. et al., (2014). Fabrication and cheracterization of Gum Arabic bonded Rhizophora sppparticleboards. Materials and Design, 60;108-115.

Ali, B. H. & AL Moundhri, M. S., (2006). Agent ameliorating or augmenting the nephrotoxicity of cisplatin and other platinum compound.A review of some recent research. Food Chem. Toxical, 44:1173-1183.

Anderson, D. M., Whowleet, J. F. & MC Nab, G. A., (1985). the amino acid composition of the proteinacaus component of gum arabic A. senegal. *Acts and Ecology,* willd. *Food Additive and Contaminants.* Volume 19, pp. 447-452.

Annoor, A., Idris, M. A., Mayada, J. & Farah, K. F. T., (2019). Phesicochemical Proparties of kakamut Gum (Acacia polycantha) and Hashab Gum (Acacia Senegal). International Journal of Applied Agricultural Sciences. Vol 5:138-143.

Anon., (2013). *Gum Arabic in sudan.* s.l.:SUDAN DRADE POINT.

Anurag, T., (2010). An over view on Chemistry and Application of Acacia Gums. Pharma Chemica, 2(6);327-331.

Arbonnier, M.,(2004). Trees, shrubs and lianas of west Africa dry zones. CIRAD Publishers, GMBH, MNHN, Corte d'voire, 194.

Atgie, M. M.,(2018). Composition and structure of gum arabic in solution and at oil-water interface.Food Hydrocolloids, 91.319-330.

Benjamin, P. S. & Laterite, G., (1970). Spacific relationship between the optical rotation and carbohydrate composition.

Biswas, B., Biswas, S. & Phillips, G. O., (2000). The relationship of Optical Spacific Rotation to structural composition for Acacia and related gums. Food Hydrocolloieds, 14:601-608.

Bo, G., (1981). Tropical Feeds .FAO Animal production anf health series.

Caslettani, O. et al., (2010). Hydrocolloids with emulsifying capacity. Part 1.

Christian, S. et al., (2001). structure and rheolgical properties of acacia gum dispersions. *Elsevier.* Food Hydrocolloieds, 61;257-267.

CNI, (2005). Carbohydrate Polymer. *CNI.* Colloids Nutureles International [Omcnline].

Daoub, R. M. A. et al.,(2016). Characterization and Functional properties of some natural Acacia Gums. *Saudi Society of Agrultural Sciences.* Journal of the Saudi Society of Agricultural Sciences.

Desam, N. R., Abdul Jabbar, A.-R. & Gowkanapalli, R. R., n.d. Biomedical and Pharmaceutical Application of Inductively Coupled Plasma-Mass Spectrometry. (6). 133-138.

Dickinson, E., (2009). *Emulsifying behaviour of gum arabic.* Food Hydrocolloids Vol 2 :pp.47-490.

Elamin, H. M., (1981). *Trees and Shrubs of the Sudan.* Khartoum: University of Khartoum.**I**thaca pass Exeter. 160-163.

Elmanan, M., Al-Assaf, S., Phillips, G. O. & Williams, P. A., (2008). Studies on Acacia exudate gums. Part VI. Interfacial rheologe of Acacia sengal and Acacia seyal. Food hydrocolloids. 22(4), 682-689.

Eugene, S. S. & Banlacorek, S., (1987). A simiemirical Theory of the optical activity of saccharides. Sceince Direct, Vol166(1-2);181-193.

Evans, A. J., Hood, R. L., Oaken, F. D. G. & Sidhu, G. S., (1992). Relationship between structure and function of dietery fiber:acomparative Study of the effect of three glactomannans on cholestrol metabolism in the rate. Br JNutu 68:217-229.

FAO, (1991). Food and Nutrition. *Rome,* pp. 49,83. Spacification of Identity and purity of Certain food Additives.

FAO, (1999). Comoend of food additive spacification addendum. p. 52.

FAO, (2002).

FAO, (2018).

Fatima, O. S., (2016). *Preperation and Characterization of Glocuronic Acid and Magnesium Glucuronate from Acacia Senegal var Senegal.* MSc. Thesis, Sudan University of Science and technology.

Gammon, D., Churm, S. & Stephen, A., (1968). Arabino Glactan Protein Components of Acacia tortilis Gum Carbohydrate.Sudan Foundation, london,Economics.

Glover, D. A., Ushida, K., Phillips, A. O. & Riley, S. G., (2009). Acacia sengal SUPERGUMMT: An evaluation of potential health benefits in human subjects, Food Hydrocolloieds, 23(8);2410-2415.

Hassan, H. M., Abdelkareem, A. A. & Taha, H. M., (2018). Chemistry , Biological , and Pharmacological Properties of Gum Arabic. Springer International publishing AG.

Hinson, J. A., Reid, A. B., Mc Cullough, S. S. & James, L. P., (2004). Acetaminophen-induced hepatotoxicity:role of metabolic activation, reactive oxygen/nitrogen species and mitocondrial permeability transition. Drug Metab. Rev 36(3-4):805-822.

Ibrahim, B. G., (2016). An Investigation of the Molecular Structure , Composition and Biophysical Properties. Ph D thesis, university of wolverhampton.

Ibrahim, M., Kama, F. & Loutfi, I.-d., (2017). Adendrological key for Identification of Acacia species growing in Saudi Arabia and Northern Sudan. Research Gate, 87-91.

Idris, O. H., (1989). physicchemical and microbiology and characterization of Acacia Senegal willed gum. Food Hydrocolloieds, 12(4): 379-388.

Islam, A. M. et al., (1997). *Food Hydrocolloids.* Vol.11(4),493-505.

Jamal, A. I., Malik, A. A. & Mohammed, E. O., (2014). Physiochemical Characteristics of the Albiziz Amara Gum. SUST, ARPN.

Kanakdande, D., Bhosale, R. & Singhal, R. S., (2005). Cheracterization of starch and gum Arabic-maltodextrin. Research Gate, Carbohydrate polymers 67(4):536-541.

Karamalla, K. A., (1965). *analytical and structural studies in poly saccharide group.* Ph.D.Thesis,University of Edinburgh.

Kauther, S. A. A. & Hussien, M. D., (2018). Phiscochemical and Functional Properties of the Gum Arabic from Acacia Senegal. *Annal. Food Science and technology.*

Lelon, J. K. et al., (2010). Assessment of physical properties of Gum Arabic from Acacia Senegal varieties in Boringo District , Kenya. African Journal of plant sceinces, 4(4):95-98.

Mariana, A. M., Maria, L. B., Lorena, V. & Claudio, D. B., (2012). Gum Arabic : More than an Edible Emulsifier. Intech Open.

Matsumoto, N. et al., (2006). Butyrate modulates TGF-betal generation and function : potential renal benefit for Acacia (sen) super gum (GA). Mol Cells 21(3):318.

Nakauma, M., (2008). comparison of suger beet pectin , soy been soluble polysacharide and gum arabic as food emulsifiers. Food Hydrocolloieds, 22,1254-1267.

Nasreen, J. et al., (2008). Physico-chemical studies of the Gum Arabic. *Natural Product Radiance.* Research Gate. African Journals of Rural Development 2(1):105-115.

Nep, E. I. & Conway, B. R., (2010). Characterization of Grewia Gum , a potential Pharmaceutical Excipient. J. Excipients Food Chem, 1(1):30-40.

Omer, E. A., (2004). *Cheracterization and analysis studies of A polycantha Gum.* Ph.D.Thesis,Sudan University of Science and Technology. Ph D thesis, SUST, Khartoum Sudan.

Phillips, A. O. & Phillips, G. O., (2011). Biofunctional behaviour and health benefits of a spacific Gun Arabic. pp. 25,165-169.

Phillips, G. O., Ogasawara, T. & Ushida, K., (2008). The regulatory and scintific approach to defining gum arabic. *Food Hydrocolloids,* pp. 22,24-35.

Pimental, G. C. & MC cellen, A. L., (1960). The hydrogen bond. 61.Person, D. 1970 The chemical analysis of food, london.

Sacande, M. & Parfondry, M., (2018). *Non timber forest product,* A Biometric and a state of the art review, MDPI, 12(17).

Samar, A. A., n.d. *Preperation and Characterization of Physicochemical and Functional Properties of Potassium Glucuronate from Acacia senegal var Senegal Gum.* Msc thesis, SUST.

Somsubhra, G. et al., (2013). Inductive Coupled Plasma-Optical Emission Spectroscopy. *Asian J, Pharma .*

Tadesse, W., Desalegn, G. & Alia, R., (2007). Natural gum and resin bearing species of Ethiopia and thair potential application. Alimenteria 16:211-221.

Tewari, A., (2010). An over vew on chemistry and application of Acacia Gums. Pharma Chem, 327-329.

Thomas, E. et al., (2003). Response diversity , ecosystem change and resilience. Frontiers in Ecology and the environment, 1(9):488-494.

Tiss, A., Carriere, F. & Verger, R., (2001). Effect of gum arabic on lipase interfacial biding and activity. Anal Bio Chem, 294(1);36-43.

Trommer, H. & Neubert, R. H., (2005). The examination of polysaccharides as potential antioxidative compounds for topical adminisrtation using a lipid model system. Int J Pharm, 298:153-163.

Vanloot, P., Dupuy, N., Guiliano, M. & Artaud, J., (2012). Charactrization and authentication of A Senegal and A.Seyal exudates by infrared spectroscopy and chemometrics.food Chem.135(4);2554-2560.

Verbeken, D., Dierckx, S. & Dewettinck, K., (2003). Exudeate gum : occurrence , production and application. Appl Microbiol Biotechnol. *NIH.*

Wapnir, R. A. et al., (2008). Modulation of rat intestinal nuclear factor NF-kappa B by gum arabic. Dig Dis Sci 53:80-87.

Willims & Phillips, (2000). *Characterization and Functional Properties of son natural Acacia Gums.* s.l.:Food Hydrocolloids, Chapter 21,pp.214-251.

Wyasu, G. & Okereke, N. Z., (2012). Improving the film formation ability of gum arabic. Research Gate.

Xiandeng, H. & Bradley, T., (2000). Inductively Coupled Plasma / Optical Emission Spectrometry. *Ecyclopedia of Analytical Chemistry.*

Yadav, P., Kant, R. & Kothiyal, P., (2013). A review on Acacia Tortilis. eIJPPR, 93-95.

Dor, Y, Cohen, Y and Yerushalmi-Rozen, R,. (2006). Structure of gum arabic in aqueous solution. Journal of Polymer Science: Part B: Polymer Physics, 44;3265-3271.

Zatz, J. L. & Kushla, G. P., (1989). Pharmaceutical dosage forms. Dispers system. Marcel Dekker Inc, New York, 508.