AN OVERVIEW OF THE IMPORTANCE OF GUM ARABIC EXUDATES TO FOOD INDUSTRY

BY

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Abstract

Gum Arabic/Arabic gum (E414,) also known as acacia gum has a complex molecular structure that contains arabinose, galactose and glucuronic acid. It is agum from a natural plant condensed from the juice extracted from a tree called Acacia. A Good-quality Gum Arabic is amber in color, and have a characteristically large round granule. It is often used in providing favorable adhesion and soft elasticity in chewing gum. It can naturally form knots on the bark of tree, known as gummosis. If the bark is cut, the colloid will be produced to seal the "wound" and the process needs 3-8 weeks. Furthermore, the colloid is secreted from the stem of wattle and Acacia Senegal. Gum Arabic is often used to make powdered oils and usually with gelatin together. Since it has favorable water solubility and emulsifying property, it helps to improve the microencapsulation efficiency of embedded substance in the embedding process. When Gum Arabic meets carbonated beverage containing carbonate, it will be easier to achieve the breakthrough in the surface tension of water molecules, releasing more carbon dioxide at an alarming rate. Gum Arabic can also be widely used in beverage production. For example, it helps to stabilize the flavor and essential oil in the production of soft drinks or concentrated juice. With favorable emulsifying property, Gum Arabic is particularly suitable for emulsification system of oil-in-water type and widely used as emulsion stabilizer in the emulsion flavor. Gum Arabic/Arabic gum helps to hinder the formation of sugar crystals, so it can be used as the anti-crystallizing agent in candies to prevent crystallization. Furthermore, it can effectively emulsify milk and cream in milk candies to avoid overflow and in chocolate, it is used for surface glazing to make chocolates melt only in the mouth but not in the hand. Gum Arabic can also be used in many other industries. In conclusion, its application in the food industry can be summarized as natural emulsion stabilizer, thickening, suspending, adhesion and film-forming agents as well as water-soluble dietary fibre.

Keywords: *Gum Arabic, Exudates, Food Industry*

1.0 Introduction

Plants gum exudates are naturally produced from plants and shrubs when injured in tear like, striated nodules or amorphous lumps, and then dried up to form hard, glassy exudates in many colours. Such exudates were used in different ways for centuries in food applications, as emulsifiers, stabilizers, and thickeners date back many years ago their non-food related uses in herbal medicine, cosmetics, textiles, lithography, and minor forest products can also be traced back through history (Anderson and Stoddard, 1996).It is among the oldest natural gums that have been used as thickening and stabilizing agents 5000 years ago. The three major exudates gums are, gum Arabic, gum tragacanthin, and gum karaya, which have unique range of functionalities (Philips and Williams, 2001). They have been useful items of international trade, in the food, adhesive, paper, textile, and other industries for centuries.

Gum Arabic is the oldest and best known of all-natural gums. Its use can be traced back to the third millennium B.C., the time of the ancient Egyptians. The early Egyptians fleets shipped gum Arabic as an article of commerce. It was used as pigment binder and adhesive in paints for making hieroglyphs, and ancient inscriptions known as *kami*. It was used as a binder in cosmetics and inks and as an adhering agent to make flaxen wrapping for embalming mummies. Introduced in Europe through various Arabian ports, it was called gum Arabic after its placed of origin. Gum Arabic have been defined by the FAO/WHO Joint Expert Committee for Food Additives (JECFA) as a dried exudate obtained from the stems and branches of *Acacia Senegal* (L.,) Willdenow or *Acacia seyal*(Fam. Leguminosae). In wider sense, the name gum Arabic is also used to dominate gums produced by other *Acacia species* for example *A. karoo,* and is some time referred to as gum acacia (FAO, 1999).

Gum Arabic (GA) is one of the biopolymers gotten from stems and branches of *Acacia* tree composed of galactose, rhamnose, arabinose and glucuronic acid. It is widely used in various industries e.g., favour fixation, confectionary, bakery products, pharmaceutical and cosmetics. This polysaccharide is very essential as a potential film or coating component because of its unique emulsifying properties (Ali *et al.,* 2010).It is estimated that more than 1000 species of the genus *Acacia* (subfamily Mimosoideae, family luguminosae) totalled in the world. Half of the

species grows in the Sahel regions of Africa. Among this one, the exudates of both species, *Acacia Senegal* and *Acacia seyal*, present a commercial interest and are used in various industries: foods, cosmetics, herbal medicine, adhesives. These exude called also gum Arabic, come from the stems and branches of these two *Acacia species*(FAO, 1999).

Gum Arabic is heterogeneous and polydisperse (Anderson and Stoddard, 1996). The gum composition varies according to the age of trees, the location and the conditions of the soil. It also shows variability base on the nature of species, *A. seyal* gum has a higher weight average molecular weight than that of *A. senegal*. The two gums *Acacia* are made of three neutral sugars: D-galactose, L-arabinose units and two uronic acids: glucuronic and 4-O-methyle glucuronic acids. The proteinaceous matter consists mainly of hydroxyproline, serine and proline (Vauloot*et al.,* 2012).

2 Literature Review

2.1 Brief history of gum Arabic

Gum Arabic is acquired from variety of *Acacia* tree; the most important is *Acacia Senegal,* grown mainly in Sudan where the yearly production of gum is about 40,000 tones with expected increases to 600,000-800,000 ton by 2020. It is stated that a reserve of 90,000 tones is maintained to avoid fluctuation and incentive compensation is provided to farmers for planting and producing of *Acacia* tree (Daqan and Abdullahi, 2013).Many other higher plants exude gums, such as *Anacardium, Pithecellobium, Spandias, Prosopis and Enterolobium* (De Paula et al, 2001). The chemical composition of gums is complex and varies to some extend depending on the source and its age. Therefore, it is not always possible to provide defined structural formulas of these biopolymers (Verbeken*et al,* 2003).

Gum Arabic was imported from Arab ports coined by European traders. People from Egypt named it as 'kami' and purportedly used it from the third dynasty onwards (around 2650BC) to protect bandages around mummies. This gum was apparently utilized to fix pigment into hieroglyphic paintings. Sudan researchers, named this gum as manna, which means the best food available for man, as mentioned in the Holy Qur'an in sural Al'baqarah (surah of cow). The word manna is directly referring to gum Arabic in the Torah where it was described as essential

food and designated by Moses to the Israelis as God given bread (Dauqan and Abdullahi, 2013).

2.2 Factors affecting the Growth and Health Condition of Gum Arabic

Many factors affect growth and health condition of gum Arabic. These factors include physical, biological, traditional constraints and socio-economic. Physical factor affecting the growth and health condition of the gum Arabic (climate, water balance, soils and topography), biological factors (diseases and pest, in which insect attacks, browsing by livestock and game are included), socio-economic factors (working opportunities, migration, infrastructure, and transport) (Eisa*et al.,* 2008).

2.3 Production of Gum Arabic

Gum Arabic is widely distributed in in the dry region of the tropical Africa including West, north and South Africa. It can be obtained from Senegal, Mauritania, Nigeria in the West African region, Eritrea and Ethiopia in the North-east up to the South Africa. Gum Arabic can also be found in the outside African countries, such as India, Pakistan and Oman and has also been introduced in to Egypt, Virgin Islands, and Australia. Other varieties such as var. kerensis Schweinf can be found in other regions of Africa such as Somalia, Uganda, Tanzania, Kenya as well as Angola (Eisa et al., 2008).

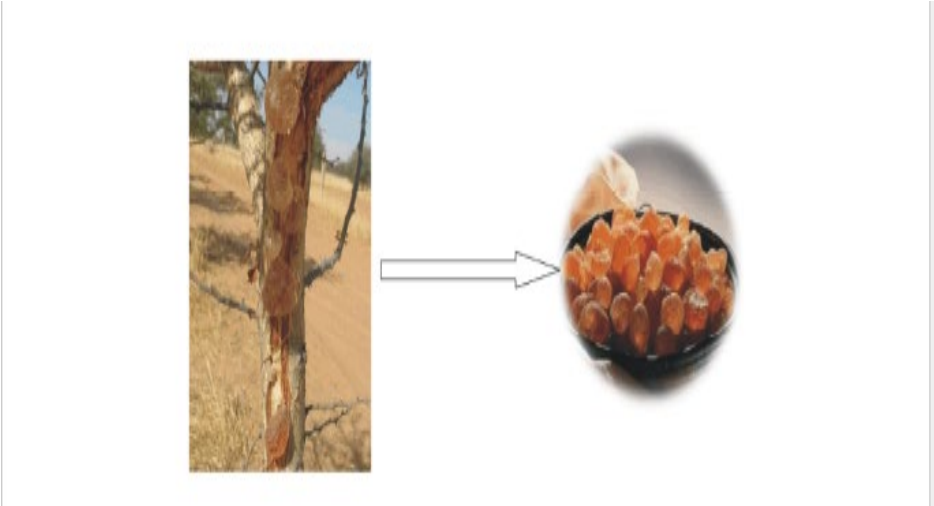


Figure 1: showing collecting gum Arabic from low branches of *Acacia* tree
Source: *Dauqan and Abdullahi, (2013).*

Structure of Gum Arabic

Gum Arabic is a polysaccharide which is naturally obtained from the *A. Senegal* and *A. seyal*tree; this is the one of the most commonly used hydrocolloids. Gum Arabic serve efficiently as emulsifier and long-term stabilizer in food and cosmetic products containing oil-water interfaces.

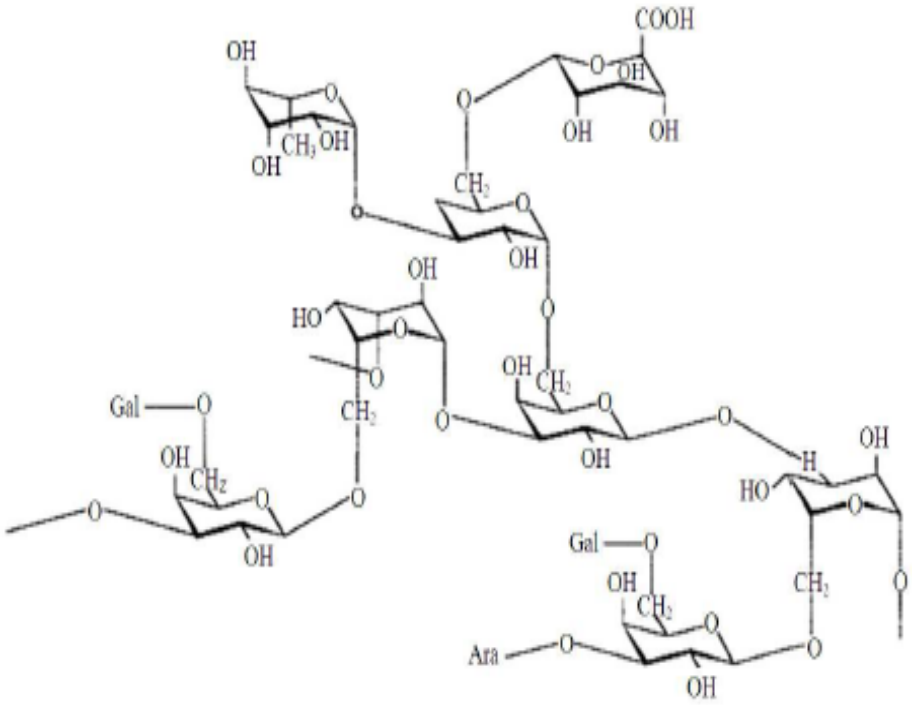


Figure 2:*Showing the structure of gum Arabic*

Source: *Dauqan and Abdullah, (2013)*

2.3 Molecular Association and Characterization ofgum Arabic

The molecular composition of the gums harvested from *A. Senegal* and *A. seyal* differ, but the molecular structure recorded for the most abundant molecular constituent of both gums, consist of core of β 1, 3 linked galactose units with branches linked

through the 6 position consisting of galactose and arabinose terminated by rhamnose and glucuronic acid (Siddig*et al.,* 2005).

Essentially, gum Arabic is a complex, polysaccharides-based plant exudate, obtained from trees of selected *acacia* specie as mentioned earlier, which are indigenous to the Sahelian region of Africa, and for which Sudan is the world's leading producer. This gum is widely used in the food industry as an emulsifier, for favour oils present in soft beverages, it also extensively used in confectionary products in which it is used to control texture and inhibit sugar crystallization (William and Phillips, 2009).

Characterization of gum Arabic using gel permeation chromatography (GPC), coupled to light scattering, refractive index and UV detectors has shown that the gum exudates found from both A. *Senegal* and *A. sayel* consist of three main fractions, refers to as arabinogalactan (AG), arabinogalactan- protein (AGP) and glycoprotein (GP) components, which differentiated mainly in their molecular size and protein composition, (Mahendran et al., 2008). The AG, AGP and GP fractions account for ~ 90% ~10% and 1~ of the total gum respectively. They have molar masses of ~2550 kg/mol, and 200kg/mol and contain <1%, ~10% and 25~50% proteinaceous material. The amino acid content/composition of the three components differs significantly, with that recorded for the GP fraction showing least similarity to other fractions. The major amino acids found in the AG fraction in descending order are *Hyp, Ser, Glu* and Gly (Gashuaet al., 2015). These differences suggested that the glycoprotein(s) present in the GP fraction are less likely to include hydroxyproline-rich glycoproteins (HRGPs) than those present in the other two fractions.

Over the past 30 years' considerable progress has been made regarding our understanding of the molecular structure and composition of gum Arabic, using fraction isolated by hydrophobic affinity chromatography. It is interested to note that the fractions obtained using this separation technique have been shown to have a broad molecular mass distribution, but each fraction contains a predominance of either the AG, AGP, or GP components (Renard *et al.,* 2012).

2.4 Uses of Gum Arabic

Gum Arabic is used as additives in food substances for examples, confectionary, ice-cream industries and bakery products. It is classified as an edible coating and

essentially increase the shelf-life and to enhance microbial safety of fruits (Roony, 2005).It is broadly used as an emulsifier in the production of soft drinks. As a result of its stability in acidic conditions and its high solubility, gum Arabic is well suited for use in citrus and cola flavour oil emulsions. The reasonable amounts of gum Arabic are used in order to have complete coverage of the interface and prevent flocculation and coalescence of oil droplets. Weighting agent is normally added to increase the oil phase density, this is being done to inhibit destabilization due to creaming (Wyasu and Okereke, 2012).

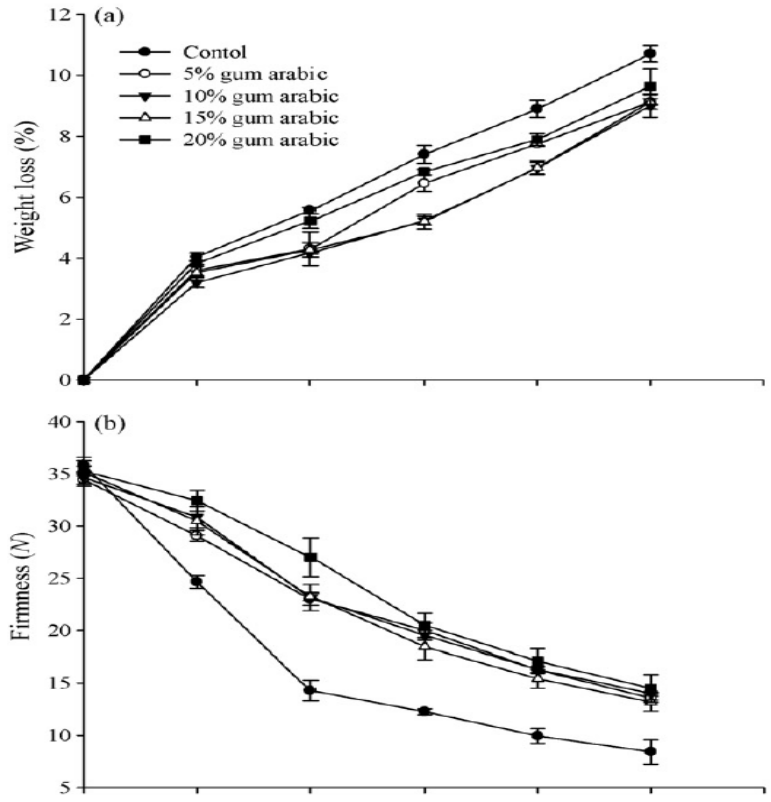
Gum Arabic is said to have long tradition of use in wine gums, as it produces more clarity than the one obtained from other hydrocolloids. *Acacia* gum is unique among the various hydrocolloids because it has a very high solubility in water. They are used mostly in food industry because they modify and control the rheological properties of an aqueous food systems acting as thickeners, stabilizers, flocculants, emulsifiers, film formers as well as suspending agents. *A. Senegal* is the most widely used in food industry this is because of its better emulsifying properties as *A. sayal* gum. Furthermore, *A. Senegal*is generally less colourful than *A. seyal* (Vauloot*etal,* 2012). Arja*et al.,* (2011) has reported that, gum Arabic prevent sucrose crystallization, it also provides a control flavour release and slow down melting in the mouth cavity, making the wine gum long lasting. It also provides the appropriate texture to these candies, which are easily deformed in the mouth but did not adhere to the teeth.

Gum Arabic is used to compensate for loss of texture, mouth feel and body, resulting from the replacement of sugars by artificial sweeteners in lower-calorie candy. It also uses in chewing gum as a coating agents and pigment stabilizer, in an aerated confessionary product, like nougats, marshmallows and meringues, gum Arabic act as a whipping and stabilizing agent. Gum Arabic also used as toffees and caramels as an emulsifier, to maintain uniform distribution of the fat across the products. In jelly products, it is use to provide a fibrous, fruit-like texture (Tadesse *et al,* 2010).

Gum Arabic has been reported to be used in mango preservation; this is because when the mango was treated with gum Arabic it prevented browning and maintained nutritive value of mango (ascorbic acid) (Abdelgader and Ismail, 2011). Rezaei et al., (2011) has reported that frozen yoghurt produced with gum Arabic had the better overall sensory and physicochemical characteristics.

Gum Arabic also play important role in tomato (*Solanum lycopersicum L.*) preservation, tomato being climacteric fruit, has relatively short postharvest life since many processes affecting quality loss take place after harvest, storage life being shorten by several factors including transpiration, postharvest diseases, increases ripening and senescence. The main factor associated with the tomatoes postharvest shelf-life, particularly in tropical countries where the temperature is high, is increased respiration which results in rapid fruit ripening and deterioration of fruit quality (Ali *et al.,* 2010).

Coating of tomato fruit with gum Arabic has been found to increase their shelf- life and postharvest quality. Gum Arabic in aqueous solution of 5, 10, 15 and 20% was applied as novel edible coating to green mature tomatoes which were stored at 20^{o}C and 80-90% RH for 20d. fruit coated with 10% gum Arabic showed a significant of $P<0.05$ delay in change of weight, firmness, titratable acidity, soluble solid concentration, ascorbic acid content, decay percentage and colour development compared to un coated control fruit (Ali et al., 2010).



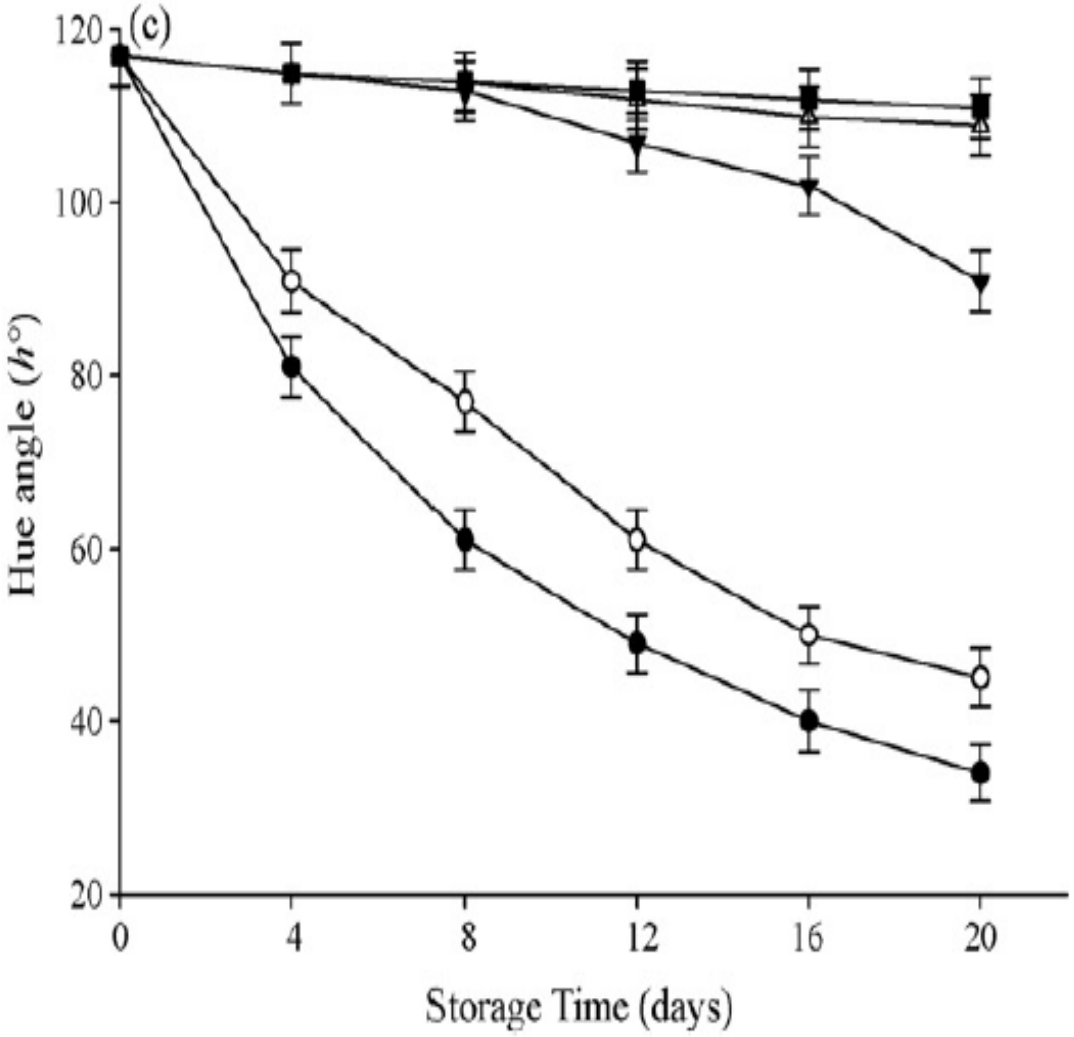


Figure 3: Effects of different treatments on mycelial growth of (a) *C. musae* and (b) *C. gloeosporioides* during a 7-day incubation period. The vertical bars represent the standard error of means for four replicates.

Source: *(Ali et al., 2010).*

Gum Arabic is very useful in the preservation of fruits, banana and papaya fruits treated with GA were observed to had delayed ripening hence resulting in firmer fruit. GA in combination with other plants exudes were reported to serve as better tools in controlling postharvest disease for example anthracnose on banana and

papaya. Therefore, the composite treatment of GA and CM might be particularly useful for banana growers and exporters as a postharvest biopesticides (Maqbool et al., 2011).

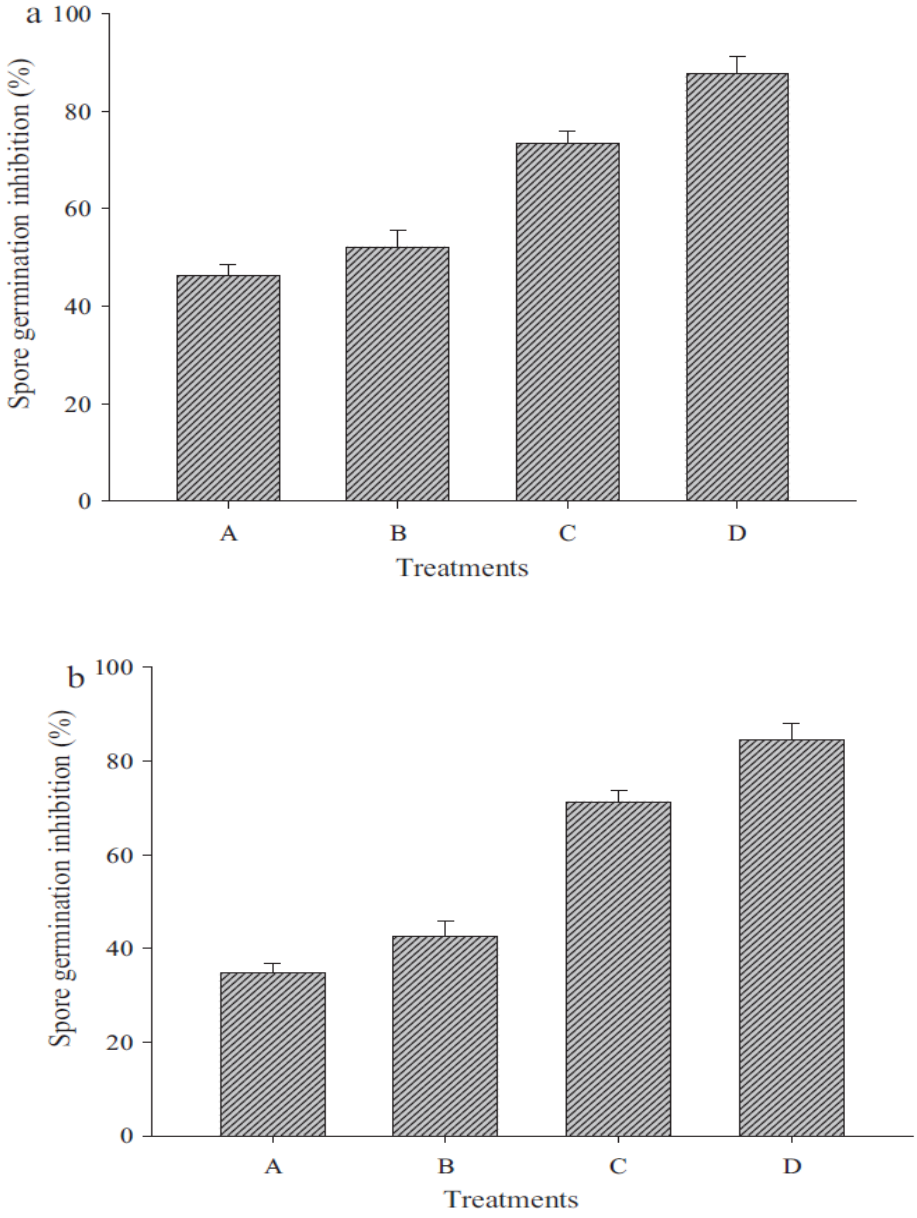


Figure 4: Showing the effects of different treatments on spore germination inhibition (%) of (a) *C. musae* and (b) *C. gloeosporioides*. The vertical bars represent the standard

error of means for four replicates [A: 0.05% lemon grass oil (LG); B: 0.4% cinnamon oil (CM); C: gum arabic (GA) 10%+0.05% LG; D: GA10% +0.4% CM.

Source: *(Ali et al., 2010).*

3. Conclusion

In conclusion, natural gum exudates are products obtained from plants and shrubs when injured in tear like, striated nodules or amorphous lumps, and then dried to form hard glassy exudes in many colours. It composed of highly branch galactane polymers with side chain of galactose or arabinose, ending eventually in rhamnose or glucorinic acid. Gum Arabic has been important commercial exudates for many years and it has numerous uses in many industrial areas and it is mostly used in the different sectors of the food industry particularly in production and preservation. It is a non-digestible food ingredient that has many applications in the food industry. Gum Arabic is widely distributed in in the dry region of the tropical Africa that includes West, north and South Africa. It can be obtained from Senegal, Mauritania, and Nigeria in the West African region, and it can be obtained from Eritrea and Ethiopia in the North-east up to the South Africa. Among the four known varieties, *A. senegal* is the most widely spread and can be goten in all areas whereas *A. senegal* trees are located, along the west coast of central and southern Africa. It can also be found in some certain region rather than Africa.

Gum Arabic is heterogeneous and polydisperse. Gums are arabinogalactan proteins when considering their chemical composition and consist of three large molecular fractions, which differ mainly in their size and protein contents. The gum composition varies according to the age of trees, the location and the conditions of the soil. It also shows variability base on the nature of species, *A. seyal* gum has a higher weight average molecular weight than that of *A. senegal*. The two gums *Acacia* are made of three neutral sugars: D-galactose, L-arabinose units and two uronic acids: glucuronic and 4-O-methyle glucuronic acids. The proteinaceous matter consists mainly of hydroxyproline, serine and proline. Gum arabic has more recent history and has only been used commercially for about 100 years. Gum Arabic is acquired from variety of *Acacia* tree; the most important is *Acacia Senegal,* grown mainly in Sudan.

The molecular composition of the gums harvested from *A. Senegal* and *A. sayel* differ, but the molecular structure recorded for the most abundant molecular constituent of both gums (i.e arabinogalactan), consist of core of β 1, 3 linked galactose units with branches linked through the 6 position consisting of galactose and arabinose terminated by rhamnose and glucuronic acid.Gum Arabic play a vital role in controlling post-harvest disease of food's raw material, this can be achieved by gum Arabic alone or in combination with other plants exudes. Finally, the study concludes that gum Arabic is very essential in food industry in production of confectionary, ice-cream industries and bakery products. It is also used as emulsifier in the production of soft drinks and preservation of some post-harvest food such as mango, papaya tomato and serve as source of income to many people in some countries.

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