كلية الدراسات العليا

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

Determination of *Acacia* A-*seyal* color from different locations at different seasons

تقدير لون صمغ الطلحة من مناطق مختلفة لمواسم مختلفة

A Thesis Submitted in Partial Fulfillment of the Requirements for Master degree in Chemistry

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الآيـــــة

قال تعالي:

((يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ

بِمَا تَعْمَلُونَ خَبِيرٌ**))**

صدق الله العظيم

سورة المجادلة الاية ((11))

Dedication

To

The soul of my parents,

To

My beloved brothers and sisters.

ACKNOWLEDGMENT

My praise and thanks to Allah, Almighty, The most Gracious and most Merciful for giving me health, strength and patience to complete this research.

Deep gratitude and thanks to my supervisor Prof. Mohammed Elmubark Osman for his guidance, and help during this study.

Special thanks and acknowledgment is also due to Kerry representative in Sudan Mr Zahir Abdelsalam for his valuable technical support.

Also would like to thank my precious friend Khansa Kamal and all my colleagues for their strong moral support.

Abstract

In this study, talha gum was collected from four different productive areas in Sudan : Buram, Al-Deain, Blue Nile and Hejleej for season(2019-2020). The color of the collected samples were measured using the Standard method (Lovibond type F). The results were compared with the results obtained and recorded previously by NAFOP Lab in Khartoum for seasons (“2017/ 2018 and2019).

The results of the study showed a significant variations among the different areas. In Buram the color readings for a season vary between (47-95).

In Hejleej area the readings of color were range between (27-40).

The readings of color for Aldain samples in one season give results range between(20-35).

The readings of color for Blue Nile samples in the same season range between (20-37).

The study also showed slight variations within one area in accordance to the date of collection (the beginning and the end of the season). The study showed also a reverse relationship between the moisture and the intensity of the color.

المستخلص

تم في هذه الدراسة جمع صمغ الطلحة من أربع مناطق إنتاجية مختلفة في السودان وهي برام الضعين،والنيل الأزرق ، الخليج في موسم (2019–2020) ، وتم قياس لون العينات التي تم جمعها باستخدام الطريقة القياسية,عن طريق جهاز lovibondمن النوع f ، وتم الحصول على النتائج تمت مقارنة النتائج المتحصل عليها بنتائج ثلاثة مواسم سابقة (2018/2016 و 2019) مأخوذة من معمل"NAFOP"في الخرطوم.

أظهرت الدراسة تبايناً كبيرًا بين المناطق. ففي برام تتراوح قراءات اللون للموسم بين (47_95)

.وتراوحت قراءات اللون في منطقة هجليج بين (27-40) .أما عينات الضعين فقد أعطت قراءة اللون مدى بين (20_35) وتراوحت قراءة لون عينات منطقة النيل الأزرق بين (20–37).

كما أظهرت الدراسة تبايناً طفيفاً ضمن المنطقة واحدة مع الأخذ في الاعتبار تاريخ جمع العينات (بداية الموسم ونهايته).

بالإضافة إلى ذلك ، أوضحت الدراسة العلاقة العكسية بين الرطوبة وكثافة اللون .

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Chapter One

Introduction

Chapter One

Introduction

1.1. Introduction:

Exudates gums are among the oldest natural gums used as thickening and stabilizing agent. Exudates gums are produced by many trees and shrubs as natural defense mechanism, particularly in semi-arid regions of Africa (Renard *et* al.,2006). When the plants bark is injured, anqueous gum solution exudes to seal the wound, preventing infection and dehydration of the plant. The solution dries in contact with air and sunlight, to form hard, glassy lumps which can easily be collected (Verbeken 20**03).**

1.1.2. Definition of gums:

Gum definitions is based on the American Food Chemical codex, published in 1969; WHO, 1969), the joint Expert Committee for Food Additives (JECFA) of the FAO/WHO monograph on gum Arabic in 1978 (JECFA, 1978), which has been reviewed every four years (1982, 1986, 1990, 1995). In 1990 (JECFA. 1990), significant changes were made to definitions e.g. ranges for specific rotation (-26 to -34) and nitrogen content (0.27 to 0.39%) were introduced However, in 1995 JECFA, further recommended that specific rotation and nitrogen content are to be deleted from the definitions.

In (1993) Philips and William suggested that characterization of gum Arabic is possible using four parameters, e.g. specific rotatio, viscosity, lysine and hydroxyproline composition. In 1996 (European Union, 1996) introduced the molecular weight limits. In 1997 A. *seyal* var. *seyal* was accepted as closely related species (FAO, 1997). In 1998

Codex A1limentarius Meeting, the JECFA proposed specification for gum Arabic, prepared at the JECFA meeting (1997), due to objection from Sudan, was sent back to JECFA for further consideration. In spite of sudan objection to include A. *seyal* gum in the specification of gum arabic. Another recommendation for the specification of gum arabic, where A. *seyal* as gum arabic, has been adopted, but gums from other *Acacia* species are not included in these specifications. In March 1999 the Codex Committee for Food Additives and Contaminants gave acceptance to the specification in category 11 (recommended for adoption after editorial changes, including technical revisions).

1.2.1. Chemical structure of gums :

Gums are branched, neutral or slightly acidic, complex polysaccharide obtained as a mixed calcium, magnesium, and potassium salts, The backbone consists of 1,3- linked b – d-galactopyranosyl units. The side chains are composed of two to five 1,3–linked b-d- galactopyranosyl units, joined to the main chain by 1, 6-linkages. Both the main and the side chains contain units of a-1-arabinofuranosly, a-1-rhamnopyranosyle,d-glucuronopyranosyl, and 4-O-methyl -b-d-g lucuronopyranosyl, the latter two mostly as end-units (Anderson and stoddart, 1966).

They further analyses the product by methylation and gel permeation chromatography and found that the uronic acid and the rhamnose residues eliminated first which proved that they are located at the periphery of the molecule and the core was consisted of a β1,3-galactopyranose chain with branches linked through1,6 position. Also found that the protein component was associated with the high molecular weight fraction and lower molecular mass fraction was virtually exclusively polysaccharides.

Figure (1) shows the polysaccharides in gum Arabic.(street *et* al., 1983) used computer modeling to analyze the previous data.(churms *et* al.,1983) subjected the gum to smith degradation leaving the reaction to reach completion after each stage of degradation procedure. They obtained different values for the composition and size of the molecule of each degradation product than those previously obtained by (Anderson, 1966b), and proposed amore regular structure than the previous one proposingthat the galactan core consisted of 13β-, 3-D- galactopyranosyl residues Fig (1.4) having two branches which give single repeating subunits having molecular mass of 8× 10^3.As the whole gum was found to have molecular weight of 560,000 thus it was proposed that the molecule consists of 64 of these subunits and that they were symmetrically arranged.(Defye and Wang, 1986) in their structural studies of gum Arabic using A25.182MHz 13C-NMR (Alaa.M.M, 2015)

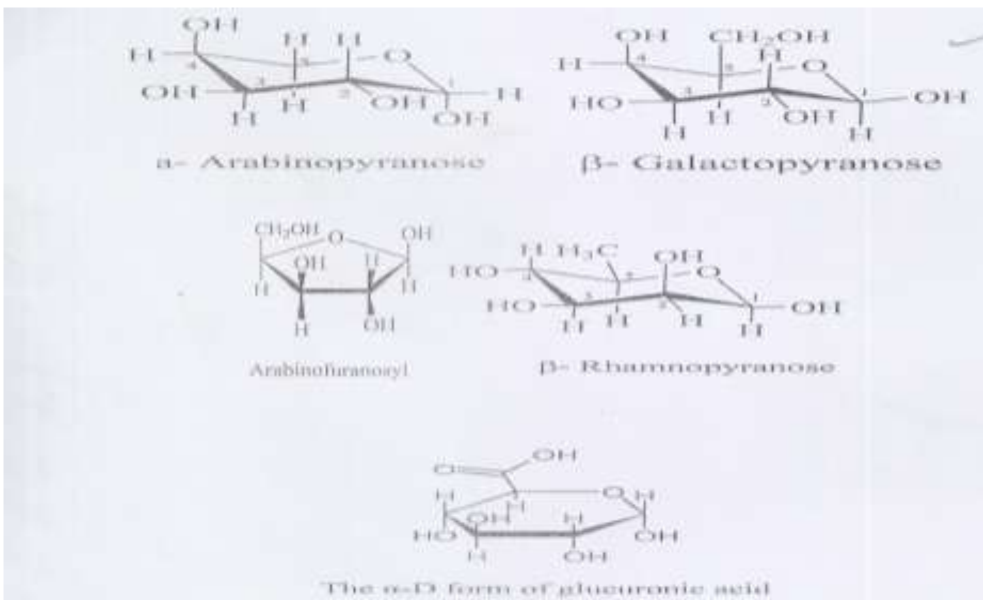

Figure 1.1 structural of carbohydrates units of gum molecule (Alaa.M.M, 2015).

Botanical classification**:**

1.2.2 Family Leguminosae (Mimosoideae):

Acacia spp., especially: A. *Senegal*(L.) Willd. A. *seyal* Del.Numerous *Acacia* species yield gum, either by natural exudation or aftre-tapping, but almost all gum Arabic of commerce originates either from A.

Senegal or A. *seyal*. There is disagreement over some aspects of *Acacia* taxonomy but A. *Senegal* is generally regarded as occurring as four

1.2.3.Varieties:

A. *Senegal* (L.) Willd. var. *Senegal*(syn. A. *verek* Guill. And Perr.) A. *senegal*(L.) Willd. var. *kerensisSchweinf*.
A. *Senegal* (L.) Willd. var. *rostrata* Brenan A. *senegal*(L.) Willd. var. *leiorhachis Brenan* (syn. A. *circummarginataChiov*.)
A. *seyal* occurs as two varieties:
A. *seyal* Del. var. *seyal* A. *seyal* Del. var. *fistula* (Schweinf.) Oliv.
Other species of *Acacia* from which gum is, or has been, collected for local use or as minor components of poorer quality shipments for export

include A.karroo HayneA. Paoli Chiov. A. polyacantha Willd. A.*ieberana*DC.

1.2.4. Botanical Classification of A. seyal:

Kingdom: *Plantae*

Division: *Magnoliophyta*

Class:*Magnoliopsida*

Subfamily: *Mimosoideate*

Order: *Fabales*

Family: *Fabaceae*

Genus: *Acacia*

Species:*A.seyal var. seyal l Var. fistula*

Binomial name: *Acacia seyal*

Local name: Talha

1.2.5. *Acacia seyal* description:

Acacia A-*seyal* trees are up to 17 m tall in Sudan, with a flat top crown. It has a distinctive smooth powdery bark, from white to greenish yellow or orange red, with a green layer beneath. In some population both red and yellow barked trees can be found. There are two varieties ,A.*seyal* var .*seyal* and A.*seal* var.*fistula* differing primarily in whether or not pseudo-galls ("ant galls") develop and in bark color.

1.2.6.The Gum Arabic Belt:

The gum Arabic belt in Sudan extends across the central region, lies between latitudes 10-16, covering about 520,000Km2, accounting for one fifth of the country's total area before separation. The area accommodates around one fifth of the population of the Sudan and two thirds of its livestock population.

It has a distinctive smooth powdery bark, from white to greenish yellow or orange red, with a green layer beneath. In some population both red and yellow barked trees can be found. There are two varieties, differing primarily in whether or not pseudo-galls ("ant galls") develop and in bark color. In A. *seyal* var. *seyal*, there are no pseudo-galls and reddish bark color prevails, although periodic bark exfoliation exposes a pale powdery surface which darkens slowly. In *A. seyal* var.*fistula* pseudo-galls are present and the powdery bark typically remains whitish or greenish-yellow.

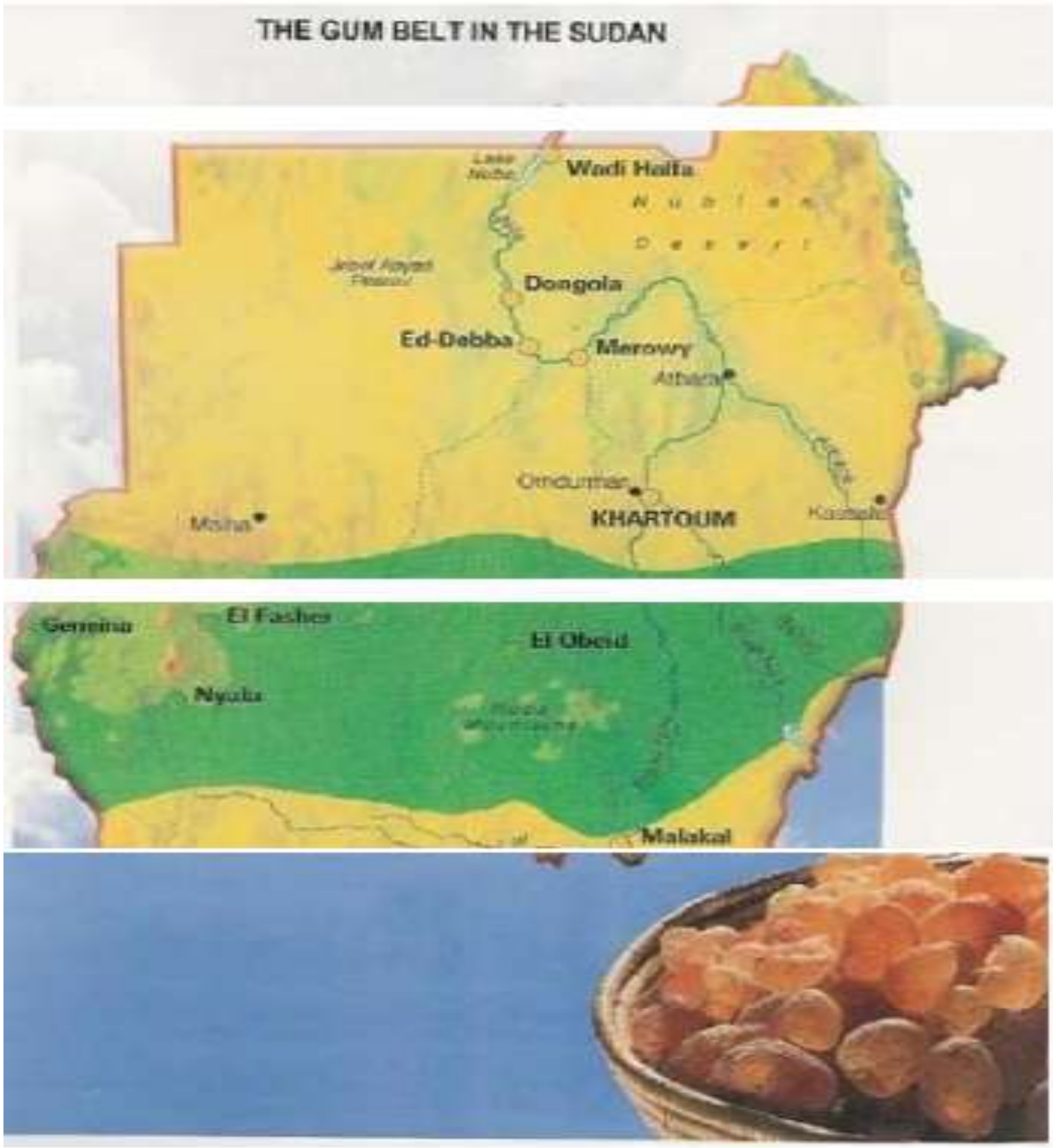

Fig 1.2 The Sudan Gum Belt

1.2.7. Collection and processing of Gum Arabic:

Although natural exudates are sometimes harvested, virtually all

exudates gum is tapped from the tree.

When *Acacia* trees lose their leaves and become dormant at the beginning of the dry season, usually by the end of October or beginning of November, superficial incisions are made in the branches and bands of bark are stripped off. After 5 weeks, gum is manually collected as partially dried tears or nodules. This collection is repeated at 15-day intervals for up to five or six collections in total, depending on the weather conditions and the health of the tree (Imeson ,1992). After the collection, gum is cleaned and graded. This is traditionally, done by women, who, manually, sort the gum according to the size of the lumps and remove foreign matter (FAO, 1995). Since the 1990s, cleaning has also been performed mechanically using conveyor belts and sieving machines. In Sudan, the gum from *Acacia Senegal* (hashab) is presented in various grades. Since 1995; gum from *Acacia seyal* (talha) has been divided into three grades: super, standard clean, and Siftings (FAO, 1995). Grade 1 is gum obtained from *Acacia Senegal* and comparable to cleaned hashab. Grade 2 is produced by other *Acacia* species, such as *Acacia seyal* and *Acacia sieberana.* Grade 3 may contain gum from species other than *Acacia*, like Cum bretum and Albizia. After collection the gum can be further processed into kibbled and powdered forms. Kibbling is a mechanical process which breaks up large lumps into smaller granules with a more uniform size distribution and facilitates the dissolution of the gum in water. Even better solubility characteristics are obtained with powdered gum, which is, usually, produced by dissolving the gum in water, removing impurities by filtration or centrifugation and spray-drying.

1.2.8. Quality of gums:

The quality of gums as received by the importer depends on the source. Gum Arabic (hashab) from Sudan is the highest quality and sets the standard by which other "gum Arabic's" are judged. Not only does Sudanese gum come from a species (*A. Senegal* Var. *Senegal)* which intrinsically produces a high-quality exudate with superior technical performance, but the collection, cleaning, sorting and handling of it up to the point of export is well organized and highly efficient.

Within Sudan, gum Arabic from Kordofan region has the highest reputation, and traders and end-users in importing countries often refer to "Kordofan gum" when indicating their preferences. Gum talha from Sudan (produced from *A. seyal*) is intrinsically a poor-quality gum than hashab, it has inferior emulsifying properties and even light-colored samples of whole gum sometimes form dark solutions in water due to the presence of tannins and other impurities. It is more friable than hashab.

1.2.9. Physiochemical properties of gum Arabic:

The physical quality properties of natural gum are most important in determining their commercial value and their use. These properties vary with the gum botanical source, and ever substantial differences in gum from the same species when collected from plants growing under different climatic conditions or even when collected from the plant at different season of the year (Hirst *et al.*, 1958). The physical properties may also are affected by the age of the tree and treatment of the gum after collection such as washing, drying, sun bleaching and storage temperature.

1.2.9.1. Solubility:

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

1.2.9.2. Moisture content :

The moisture content of the *A. seyal A. seyal* var. *seyal or* var. *fistula* were falls within the range 7.2– 16.3 %, while *A. senegal* var. *Senegal* falls within the range 7.4 - 15 %.

1.2.9.3. Ash content :

The Ash content of the *A. seyal A. seyal* var. *seyal or* var. *fistula* were falls within the range 0.7 –3.61 %, while *A. senegal* var. *Senegal* falls within the range 2.0 – 3.70%.

1.2.9.4. Nitrogen and protein content:

Nitrogen and hence protein content of the gum has been direct- related to its emulsifying stability (Dickinson *et al.*1988). Protein content was considered as one of the most important analytical and commercial parameters to differentiate between *A. seyal* var. *seyal* and var. *fistula* and *A. Senegal* var. *Senegal* in which nitrogen and hence protein content of *A. Senegal* var. *Senegal* gum account for, almost three folds of that of *A. seyal* from the two varieties.

1.2.9.5. Optical rotation:

Specific rotation is one of the most important criteria of the purity and identity of gum Arabic. It acts as a unique parameter in physio-chemical differentiation between *A. Senegal* var. *Senegal* gum and other botanically related *Acacia* gum. Almost all finding obtained by the authors stated that *A. seyal* var. *seyal or* var. *fistula* gum exhibit dextrogyrate specific rotation, while *A. Senegal* var. *Senegal* gum exhibit laevogyrate specific rotation.

1.2.9.6. Viscosity:

The viscosity of liquid is its resistance to shearing, to stirring or to flow through a capillary tube (Bancraft, 1932). Studies of flow of gum solutions play an important role in identification and characterization of their molecular structure. Since viscosity involves the size and the shape of the macromolecule, it was considered as one of the most important analytical and commercial parameters (Anderson *et al.*, 1969). The viscosity of a solution may have a complicated variation it composition, due to the possibility of hydrogen bonding among in solute and solvent molecules (Pimentel e*t al.*, 1960). More hydroxyl groups make high viscosities, because a network of hydrogen bonds are formed between the molecules, this network extends throughout the liquid, thus making flow difficult. The viscosity can be explained in different terms such as relative, specific, reduced, inherent and intrinsic viscosity; it is also represented ask in ematics or dynamic viscosity. Some Authors reported that intrinsic viscosity of the *A. seyal* (both varieties) ranges between 7.20 – 20.0 cm^-3 g^-1.

1.2.9.7. Molecular weight:

The molecular weight of the polymers can be determined from physical measurement or by application of chemical methods. The applications of chemical methods require that the structure of the polymer should contain well known number of functional groups per molecule and hey invariably occur as end groups. The end group analysis method gives an approximately number of molecules in a given weight of sample; they yield the average number of molecules for polymeric Materials.

This method becomes insensitive at high molecular weight, as the fraction of end groups becomes too small to be measured with precision (Meyer, 1971). This is due to the fact that fraudulent sources of the end groups not considered in the assumed reaction mechanism steadily become consequential as the molecular weight increases and the number of end groups diminishes to such an extent their quantities determination is not feasible. Those reactions confine frequent application of chemical methods to condensation polymers with average molecular weight seldom exceeding 2.5×10^3 (Flory, 1953). Physical methods frequently used for establishing polymer molecular weight are osmometric, polymer viscosity, measurement of coefficient of diffusion, ultra-centrifugation and light scattering. One of the most recent advanced methods is light scattering (LS), which provide and absolute method for polymer molecular weight and size measurement. LS are rapid, accurate and requires small amount of sample. The molecular weight of gums varies greatly in values due to gum heterogeneity as well as variation in techniques used to separate, purify and determine the molecular weight. A 3.0×10^3 was reported by Saver bon (1953) using centrifugal method. Using lights scattering technique gave higher values Veil and Eggenberger (1954) reported a Mw =1.0×106;

Mukherjee and Deb (1962) reported Mw up to 5.8 × 105 and Fenyo (1988) reported a range of 4.0 ×106 to 2.2 × 106.Recently GPC coupled on line to multi angle laser light scattering (MALLS) has been demonstrated to be a very powerful method for characterizing highly poly disperse polymer systems and the molecular weight of *A. Senegal* gum was found to be equivalent to 5.4 × 105(Picton,2000).

1.2.9.8. Acidity and pH measurements:

The hydrogen ion concentration is very important in chemistry and industry of gums, therefore functional properties of gum are affected by changes in pH e.g. viscosity, emulsifying power. Arabic acid substance is the major component of commercial gum Arabic and when decomposed, it gives arabinose.

Karamalla (1965) reported pH values of 4.42 for *Acacia Senegal* gum while he recorded value of 4.74 for*Acacia seyal* var. *fistula* gum. Anderson (1967) reported value of 4.3 for pH of Acacia *Senegal* gum. Karamalla (1998) reported 4.66 pH values for *Acacia Senegal* and 4.2 for *Acacia seyal* gum.

1.2.10.Food Industry Applications:

Gums, for their high viscosity in solutions and inability to crystallize are, particularly, suited to serve in food stuff such as: thickeners for beverages, stabilizers for oil and water emulsions and as wider application where function is to prevent agglomeration and setting of minute particles. They are also used to incorporate flavors in confectionery such as pastilles and gum drops, and the preparation of lozenges. The role of gum Arabic in confectionary products is, usually, either to prevent crystallization of sugar or to act as an emulsifier (Glicksman *et al.*, 1973).

1.2.10.1. Pharmaceutical and cosmetic applications:

Gums are used as a suspending and emulsifying or binding agents in pharmaceutical industries, it has been used in tablet manufacturing, where it functions as a binding agent or as a coating prior to sugar coating, sometimes in combination with other gums (Voget, 1995).

1.2.10.2. Paints and coating composition application:

The hydrophilic colloids and modified cellulose find application in paint industry because of their stabilizing effect on paint emulsions, waxes and numerous others products. Gamble and Grady (1938) treated pigments with water soluble hydrocolloids such as gum Arabic to add controllable coating composition. Horne *et al*., (1953) developed non8 glare coating chemotropic properties to paints. The gum also finds application in based on a water-soluble dye dissolved in gum Arabic solutions.

1.2.10.3. Other industrial uses:

Due to their adhesive properties gums have been used in the manufacturing of adhesives for postages tamps and also in the formulations of paints and inks. Gums may serve as a source of monosaccharide, as e.g. mesquite gum (family *prosopis*) serves as a source of L-arabinose (51%) because of its easier hydrolysis, and availability of the gum in large quantities.

Chapter two

Materials and Method

2.1.Material

Samples of *Acacia* A. *seyal* (Talha), were obtained from different locations in Sudan . The samples represents four different productive areas as the following: Buram, Hejleij, Blue Nile and Deain. The samples were for season 2019/2020.Each sample was coded and labeled to distinguish the production area from where it has been obtained.

Apparatus and Instruments:

-Colorimeter (LOVIBOND TYPE F).
-Viscometer type (Brookefield DV).
-Thermocel type (TC-650).
-Moisture Analyzer type(TOLEDO).
-Polarimeter typ (BELLINGHAM+STANLEY).
-PH Meter type (JENWEY).

2.2. Method:

2.2.1. Determination intensity of color:

The sample was crushed and milled by a mortar and a pestle.12.5 grams were weighed and dissolved in 87.5 ml of water to obtain concentration 12.5%(on dry weight base), The sample was placed in a stirrer for an hour. The concentration was checked using refractometer. The solution was left for three hours. Then the sample was filtered and left for another half hour.

(Lovibond type F) colorimeter was switch on and the solution was taken in a sample tube then the cell was inserted and the color of the sample was matched using the standards colors-red, blue and yellow.

The slides were adjusted until a visual color match had been gained.

2.2.2. Determination of viscosity:

A solution at a concentration of 25% was prepared by dissolving 50 grams of the sample in 150 ml of water, then the concentration was checked using the refractometer. The Brokfield viscometer DV device was switched on. The thermocel unit was swished on to maintain 25C temperature. Then the viscosity was measured using spindle (18) and speed (12 RPM).

2.2.3. Determination of the optical rotation:

The specific rotation was determined 1% w/v according to FAO (1990) using (Bellingham+Stainly) Polarimeter.

The solution was prepared by dissolving 1 gram of the sample in 99 ml of water (on dry base). The device was reset with water, and the solution was placed inside the sample chamber (20cm), and the reading was recorded .The optical rotation was calculated by multiplying the reading by 50.

2.2.4. Determination of moisture content:

10 grams were weighed from finely milled sample placed in the Moisture analyzer. Reading was recorded.

2.2.5. Determination of pH value:

The pH value was determined for 25 % aqueous solution at room temperature. The concentration was checked using refractometer . The device was calibrated using buffer solutions 4 and 7 . Then the PH for the sample was recorded .

Chapter three

Results and Discussion

3.1.Results:

Table 3.1. Physical properities of A.*seyal* in Buram area 2020

Beginning of season **End of season**

Lovibond	Moisture	pH	O.R	Viscosity	lovibond	Ph	O.R	Viscoisity
56	12	4.12	56	123	95	4.2	51	76
51	14	4.08	54	145	80	4.12	48	66
47	14.8	4.12	51	153	90	4.15	51	58
49	14.5	4.17	57	167	78	4.23	52	61
50	14.1	4.09	53	150	75	4.21	51	65
51	14.3	4.1	51	133	83	4.16	54	70
57	12	4.14	50	124	79	4.2	53	68
53	14.3	4.17	54	113	77	4.11	56	69
60	12.5	4.22	55	123	80	4.24	57	73
58	13.6	4.21	56	120	81	4.25	54	68

Table3.2.Physical prosperities of A.*seyal* in Aldian 2020

Lovibond	MOISTURE	PH	O.R	Viscosity	Lovibond	Moisture	PH	O.R	Viscosity
20	16,3	4.12	53	68	32	10.6	4.09	56	75
22	15.8	4.22	58	62	33	9.1	4.12	51	79
24	15.2	4.24	56	64	33	9.4	4.21	50	81
21	15.9	4.09	50	71	34	9.5	4.19	49	83
23	15,6	4.11	49	74	35	9	4.2	56	78
25	15	4.18	54	69	31	11	4.17	52	77
23	15.7	4.18	52	60	34	9	4.22	58	78
24	15.2	4.19	59	64	35	9.1	4.21	53	73
26	14.7	4.17	56	64	34	9.7	4.19	55	71
24	14.4	4.21	58	63	35	8.6	4.21	51	70

Beginning of season **End of season**

Table3.3. Physical prosperities of A.*seyal* in Blue Nile season 2020

Beginning of season					**End of season**				
Lovibond	moisture	Ph	O.R	Viscosity	Lovibond	moisture	ph	O.R	Viscosity
23	14.7	4.2	47	178	30	9.4	4.09	46	61
24	13.3	4.09	48	150	37	9.7	4.11	49	60
25	13	4.1	50	134	32	10.9	4.21	49	57
24	13.9	4.12	51	160	33	10.7	4.22	50	58
24	13.8	4.16	50	155	34	11.8	4.15	51	59
23	14.5	4.19	50	132	30	9.4	4.18	52	60
24	14	4.12	52	114	32	10.8	4.2	49	61
23	14.8	4.21	51	135	31	11.5	4.21	48	60
20	16.7	4.2	55	145	33	10.8	4.16	50	58
21	15.3	4.19	52	113	35	10.4	4.17	49	59

Table 3.4. Physical proprieties of A.*seyal* in Hejleej season 2020

Beginning of season					End of season				
Lovibond	**Moisture**	**PH**	**O.R**	**Viscosity**	**Lovibond**	**moisture**	**PH**	**O.R**	**Viscosity**
30	15	4.2	55	210	34	12.5	4.2	53	89
29	15.6	4.09	56	178	36	12.1	4.12	55	76
29	15.5	4.12	56	176	38	11.1	4.18	56	71
27	16.8	4.16	51	154	39	10.3	4.19	55	83
29	15.7	4.22	53	136	39	10.4	4.22	51	86
30	14	4.21	52	167	39	10.5	4.23	56	76
31	14.3	4.22	53	154	38	11	4.21	57	79
31	14.6	4.09	50	123	37	11.5	4.09	53	73
30	14.9	4.19	49	143	38	10.8	4.18	59	80
30	14.8	4.19	49	132	40	9.1	4.19	56	78

3.2. Discussion:

Result obtained from the color readings (Lovibond) for Buram samples showed the limit of variations among the samples range between (47-60) whereas testing these sample at the end of the season the reading obtained was shifted to the range between (67-95) (table3:1).

While the readings for 60 samples from the last three previos seasons for the same area(Buram) that reported by NAFOP for the beginning of the season were (46-62) ,whereas testing these samples at the end of the season gave readings range between (77-97) App(II) and App(V).

Comparing lovibond (color) readings of these samples with moisture obtained from the same samples ,the relationship was reversible (ie..high reading of color low reading of moisture).That means at the beginning of the season the moisture is high while the lovibond is low, at the end of the season moisture become low while lovibond give high reading .

The viscosity reading showed high reading at the beginning of the season ,the reading go down at the end of the season,That means for the all tested samples(80samples) high viscosity have low lovibond.

Studying the results of lovibond (color) with pH and optical rotation showed no regular relationship among these factors table (3:1) and App(II) ,App(V).

The results of color readings (lovibond) obtained from Aldain samples at the beginning of the season and at the end of the season were in compliance with the results reported by NAFOP for both periods.

i.e At the beginning of the season the color readings range between (20-26) table(3:2) while NAFOP reported (19-29) App(III),App(VI),And at the end of the season the color readings range between (31-35) table(3:2),while NAFOP reported (30-35) app (III)and(V).

Comparing the obtained results with the reported ones by NAFOP showed the high degree of similarity among samples readings.

At the same time moisture and viscosity showed a revisable relationship with color ie. High moisture ,high viscosity, give low lovibond (color) at the beginning of the season. At the same time low viscosity low moisture give high readings of color.

Results of samples for color readings obtained from Hejleej at the beginning of the season were (27-31),While for the same samples at the end of the season ranged between(34-40) (table 3:4).

Comparing these results with the results reported by NAFOP for 60 samples from the three previous seasons showed that the range of Hejleej at the beginning of the season is (27-31),While at the end of season the range is (35-40) app(I) and app(VIII).

Studying these results with viscosity and moisture it is obviously shown that there is a reversible relationship between moisture and viscosity with lovibond readings .

pH and optical rotation showed no clear relationship with lovibond.

Color of readings for Blue Nile samples range (20-25) at the beginning of the season, while for the same samples at the end of the season showed a range between(31-37)(table3:4).

Comparing these results with the reported data by NAFOP showed the obvious similarity in readings between the obtained results and the reported ones by NAFOP which were (19-26)for the beginning of the season and(30-36)for the end of the season app(IV) and app(VIII).

Studying the results of color of these samples with the viscosity and the moisture readings it is obvious that lovibond reading have a reversible relationship with the two parameters .However, no clear relationship has been noticed among pH,optical rotation and lovibond.

Conclusion:

From the above discussion and based on the obtained results for twenty samples from each area and compared this resuls with the readings of colour ,moisture ,viscosity optical rotation and pH of the four areas(Buram ,Aldain,Hejleej and Blue Nile) that reported by NAFOP for the three previous seasons. The conclusion is that the color of samples varies among the four areas significantly from the beginning to the end of the season. And that Buram have the highest color intensity among all other areas. And that Blue Nile Talha has the lowest intensity of color among all other areas in Sudan. And that Hejleej samples have the lowest changes among other productive area during one season in Sudan from the beginning of the season to the end of the season.

Also from the reading of the moistur for all samples we can notice that the moisture has a reversible relation with the reading of color among all the 80 samples from different areas.

Aslo there is a reversible relationship between the viscosity and the colour reading i.e high viscosity result in low reading of color and low viscosity result in high degree of color. That means the reading of color can be affected by the long and short of the storaging period.

Also the relation between the optical rotation and pH with the lovibond haven’t been noticed obviously.

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Appendix:

Results obtained from Kerry lab in Khartoum

App (I) Physical prosperities of A.*seyal* in Hejleej 2018

Beginning of season **End of season**

Lovibond	Moisture	PH	0.R	viscosity	Lovibond	moisture	Ph	O.R	Viscosity
30	15.1	4.18	47	122	37	10.2	4.21	53	87
29	15	4.28	50	123	35	10.9	4.2	48	98
28	14.8	4.23	49	146	37	10.4	4.25	49	87
29	14.7	4.31	54	134	38	10	4.23	53	84
30	15.3	4.3	53	95	39	9.9	4.32	50	78
28	14.5	4.26	50	110	40	8.7	4.27	53	83
27	14.2	4.32	51	113	39	10.1	4.33	49	77
28	14.6	4.25	50	98	38	10.4	4.27	53	83
28	14.7	4.32	49	101	38	10.3	4.34	50	80
27	14	4.28	44	110	39	10	4.28	47	79

App(II) Physical prosperities of A.*seyal* in Buram 2018

Beginning of season **End of season**

56	12.1	PH	O.R	VISCOSITY	lovibond	moisture	PH	O.R	VISCOSITY
51	12.7	4.16	49	105	88	9.9	4.19	55	89
48	13.3	4.19	50	123	97	6.8	4.2	53	92
62	11.6	4.2	53	122	81	10.7	4.25	50	81
57	13	421	54	112	84	10.1	4.23	52	76
53	15.2	4.23	57	191	83	9.8	4.22	49	87
49	15.7	4.26	52	123	84	10	4.17	59	68
51	15	4.32	55	120	83	9.8	4.21	55	74
54	14.8	4.25	53	112	77	11.4	4.27	56	71
49	15.6	4.21	51	109	79	11	4.18	53	75
54	15	4.28	50	110	84	10.2	4.22	52	78

App(III) Physical prosperities of A.*seyal* in aldian 2018

Beginning of season **End of season**

Lovibond	Moisture	pH	O.R	Viscosity	Lovibond	moisture	PH	O.R	Viscosity
24	16.1	4.29	53	132	33	10	4.25	51	78
26	14.2	412	56	122	34	9.5	4.22	52	72
27	13.8	4.21	49	113	33	10	4.21	49	75
27	13.9	4.23	53	145	32	10.7	423	53	78
25	15.4	4.31	53	156	33	10.1	4.27	53	69
24	16	4.22	56	134	32	10.8	4.19	51	72
27	14	4.18	55	124	34	9.3	4.2	55	75
25	15.1	4.21	57	123	34	9.5	4.25	59	78
23	16.4	4.23	58	127	34	9.3	4.23	57	77
26	14.6	4.18	56	110	35	8.6	4.23	56	80

App(IV) Physical prosperities of A.*seyal* in Blue Nile 2018

Beginning of season **End of season**

Lovibond	Moisture	Ph	O.R	Viscosity	Lovibond	Moisture	PH	O.R	Viscosity
22	14.4	4.23	55	123	33	10,8	4.2	53	57
25	13	4.12	49	112	35	9.9	4.23	55	54
25	12.8	4.11	54	132	33	10.7	4.17	50	61
23	14	4.21	57	135	31	11	4.21	55	58
20	15.2	4.18	48	133	34	10.3	4.21	58	57
24	13.6	4.18	50	135	32	10.8	4.11	47	56
25	13.1	4.22	51	109	31	11.2	4.12	49	55
25	13	4.23	58	114	31	11.4	4.19	54	67
21	14.9	4.26	55	120	35	9.5	4.3	48	53
19	15.9	4.14	57	117	36	8.8	4.27	53	59

App(V) Physical prosperities of A.*seyal* in Buram 2019

Beginning of season **End of season**

Area	Lovibond	moisture	Ph	O.R	Viscosity	Lovibond	PH	O.R	Viscoisity
62	14.7	4.2	51	61	88	7.4	4.17	53	83
57	13	4.21	50	56	86	8.1	4.21	55	78
67	14.9	4.18	49	58	83	9.3	4.24	56	81
59	14.5	4.24	44	61	84	9	4.23	58	76
51	13.7	4.19	56	63	78	10.2	4.24	57	78
60	12.4	4.21	53	62	82	10.9	4.15	50	71
58	12	4.22	54	54	80	10.4	4.21	51	68
57	12	4.2	50	66	77	11	4.25	49	71
59	12.4	4.23	53	69	79	10.8	4.19	53	74
60	12.5	4.21	55	74	81	10..6	4.3	52	78

App(VI) Physical prosperities of A.*seyal* in aldian 2019

Beginning of season **End of season**

Lovibond	MOISTURE	PH	O.R	Viscosity	Lovibond	moisture	PH	O.R	Viscosity
23	15.7	4.21	55	132	32	11.2	4.24	52	76
25	14.2	4.2	55	122	34	10.3	4.24	54	75
26	14	4.21	57	113	30	12.1	4.09	49	70
27	13.8	4.23	52	145	33	10.7	4.23	56	68
23	15.8	4.31	51	156	34	10.4	4.26	54	69
21	16.1	4.26	56	134	33	10.8	4.19	55	68
19	16.5	4.18	55	124	32	11.1	4.21	49	61
20	16	4.23	58	123	34	10.3	4.25	51	65
24	14.9	4.09	50	127	35	9.8	4.23	57	67
25	15.2	4.11	56	110	31	11.6	4.2	56	75

App(VIII) Physical prosperities of A.*seyal* in Blue Nile 2019

Beginning of season					End of season				
Lovibond	**Moisture**	**PH**	**O.R**	**Viscosity**	**Lovibond**	**moisture**	**PH**	**O.R**	**Viscosity**
22	15	4.22	55	112	33	10.2	4.23	54	60
25	13.3	4.21	49	110	34	10.8	4.23	56	61
25	13.6	42	54	105	32	11	4.19	51	57
23	14.7	409	57	96	30	10.3	4.2	53	55
20	16.1	4.31	48	87	36	9.7	4.19	57	58
24	14.1	4.31	50	98	30	12	4.09	55	56
25	13.5	4.29	51	90	35	10.7	4.11	56	58
25	13.2	4.26	58	103	34	11.5	4.23	53	59
21	15.7	4.26	55	110	30	9.3	4.12	50	61
19	16.4	4.19	57	98	30	9	4.23	55	59

App (VIII) Physical prosperities of A.*seyal* in Hejleej 2019

Beginning of season **End of season**

Lovibond	Moisture	PH	0.R	Viscosity	Lovibond	moisture	pH	O.R	Viscosity
31	13.1	4.22	50	134	36	12.3	4.31	55	80
30	14	4.28	52	150	36	12.6	4.11	56	98
29	14.7	4.19	57	154	35	13.2	4.28	57	86
30	14.2	4.24	58	134	37	11.8	4.19	54	83
29	14.6	4.09	59	156	38	11.1	4.23	52	78
28	15.6	4.25	58	126	40	9.1	4.18	54	80
27	16.2	4.3	57	131	39	10.5	4.31	55	75
28	15.4	4.21	56	123	38	10,1	4.23	58	83
29	14.6	4.32	54	101	38	10	4.21	58	81
27	16.4	4.23	56	100	38	10.1	4.28	56	80