

ARTICLE

Physicochemical Properties of Gum Arabic

F. Inegbedion^{1*} V. U. Okojie² F. Egharevba²

1. Department of Polymer Technology, Auchi Polytechnic Auchi, Nigeria

2. Department of Chemistry, Ambrose Alli University Ekpoma, Nigeria

ARTICLE INFO

Article history

Received: 19 November 2020

Accepted: 18 December 2020

Published Online: 30 December 2020

Keywords:

Gum Arabic

Physicochemical

Hydrocolloid

ABSTRACT

Gum Arabic is harvested commercially from wild trees throughout the Sahel from Senegal and Sudan to Somalia and in the northern part of Nigeria. Clumps of gum Arabic were collected and dirt particles were removed, the samples were dried and grounded to fine powder. The Physicochemical properties of gum Arabic was determined using standard methods and the values obtained showed; Moisture content $6.9\% \pm 5$, Soluble content 90.6%, Viscosity $5.45 \pm 3\text{Ns/m}^2$, Ash content $3.2 \pm 4\%$, Zinc 3mg/kg, Iron 41mg/kg ± 5 , Manganese 48.2mg/kg ± 5 and Copper 33.3mg/kg ± 2 . The gum also contains carbohydrate 0.3ppm ± 2 , protein 0.75ppm ± 2 , starch 0.0076 ± 10 and nitrogen 0.12ppm ± 5 . It was observed that the gum does not contain cadmium and nickel.

1. Introduction

Acaria Senegal, popularly known as gum Arabic is a leguminous tree crop which belongs to the family Mimosaceae. This family contains over 300 known species including Acacia Senegal and Acacia Seyal and are the most commercially exploited species. Both species are considered as the important economic Acacia plant in the Sudan-Ssahelian ecological zones covering not less than eleven states in the northern part of Nigeria. The species produces the best grade of gum in commercial quantity in Nigeria and it is an important source of foreign exchange earnings ^[1].

Acacia gum is the dried exudates obtained by tapping the stems and branches of acacia Senegal or other related species. The gum has various uses in the food, textiles, prints and pharmaceutical industries in the world. The trees are planted in shelterbelt to check wind and soil ero-

sion, hence it is used to fight against desert encroachment ^[2,3]. The plant adds nitrogen to the soil through its nitrogen fixing ability and leaf litter fall thereby improving soil fertility ^[4]. Its pods, seeds and leaves are excellent browse and fodder for livestock ^[5].

Gum Arabic is harvested commercially from wild trees throughout the Sahel from Senegal and Sudan to Somalia, although it has been historically cultivated in Arabia and West Asia. Gum Arabic is a complex mixture of polysaccharides and glycoproteins that is used primarily in the food industry as a stabilizer. It is edible and is a key ingredient in traditional lithography and used in printing, paint production, glue, cosmetics and various industrial applications, including viscosity control in inks and in textile industries, although less expensive materials compete with it for many of these roles ^[6,7].

Gum Arabic is unique among the natural hydrocolloid because of its extremely high solubility in water. Most

*Corresponding Author:

F. Inegbedion,

Department of Polymer Technology, Auchi Polytechnic Auchi, Nigeria;

Email: festusinegbedion1@gmail.com

common gums cannot be dissolved in water at concentration higher than about 5% because of their very high viscosities. Gum Arabic is insoluble in oils and in most organic solvents. Whereas most gums form highly viscous solution at low concentration of about 1-5%, high viscosities are not obtained with gum Arabic until concentration of about 40-50% is obtained.

Technically, gum Arabic is classed in a group of substances called arabinogalactan protein. Eighteen different amino acids have been identified in acacia Senegal, although only four comprises more than 10% of the protein. The gum also comprises essentially a complex polysaccharide, consisting mostly of galactose, arabinose, rhamnose and glucuronic acid [8,9]. Gum Arabic is useful as hydrocolloid, emulsifier, texturizer and film-former [10].

Substances frequently called gums are hydrocarbons of high molecular mass; others are petroleum products, rubber latex, synthetic polymeric gums, balms and resins. Recently, the term “gum” as technically employed in the industry, refers to plant or microbial polysaccharides and their derivatives that are capable of forming dispersions in cold or hot water, producing viscous mixtures or solutions [11].

2. Materials and Methods

2.1 Sampling

The sample was harvested from Acacia Senegal. The stem of the specie was cut and the gum oozed out and dried at room temperature of $30^{\circ}\text{C}\pm 5$ to form clumps. The clumps were collected and particles such as sand, sticks and dirt were removed from the clumps and preserved with formaldehyde to avoid micro organism infestation which may cause biodegradation of the gum. The samples were dried for easy grounding. The dried samples were grounded to fine power and kept in an air-tight container.

Materials used include; Ethanol, tetraoxosulphate (VI) acid, toluene, anthrone reagent, hydrochloric acid, sodium carbonate, alkaline sodium phenate, sodium hypochlorite, sodium potassium tartrate, dry ammonium sulphate and sodium sulphate. They were supplied and used as standard analytical reagents.

2.2 Methods

Metal contents was determined using the Atomic Absorption Spectrophotometer (AAS), Sugar contents and Carbohydrate contents were determined using Anthrone method, Viscosity was determined using Oswald Viscometer, pH was determined using the Jenway 3510 pH meter. Other properties such as Ash content, Moisture content,

Insoluble matter, Soluble matter, Nitrogen and Protein were determined using standard methods.

3. Results and Discussion

3.1 Results

Table 1. Results of physio-chemical properties

PROPERTIES	VALUES
Ash Content	3.23%
Moisture Content	6.9%
Insoluble Matter	9.4%
Soluble Matter	90.6%
Viscosity	5.45Ns/m ²
pH	8.16

Table 2. Results of Organic Parameters

PARAMETERS	VALUES
Carbohydrate	0.275ppm
Sugar	0.0081ppm
Nitrogen	0.1200ppm
Protein	0.7500ppm

Table 3. Results of Metal Contents Analysis

METALS	VALUES (mg/kg)
Iron	41.0
Manganese	48.2
Copper	31.3
Zinc	3.0
Cadmium	ND
Nickel	ND

Note: ND means “Not Detected”.

3.2 Discussion

The results of the physio-chemical properties of gum Arabic (from acacia Senegal) are displayed in Table I. It shows ash content, 3.23%, moisture content, 6.9%, insoluble matter, 9.4% soluble matter, 90.6%, viscosity, 5.45Ns/m² and pH, 8.16. Gum Arabic tends to be more viscous than that of cashew tree exudates. The viscosity of cashew tree exudate is 3.64Ns/m². The reason is that gum Arabic has less moisture contents of 6.9%, compared to that of cashew gum which has a moisture content of 9%. This suggests that acacia tree tends to store much moisture on its body for survival, unlike cashew tree.

From the standard in literature review by Willy Be-

necke, the ash content in gum Arabic is 4%. This has a close value with the result from this research, with a difference of 0.8% approximately. The standard insoluble matter is 1% which is not too close to the result of insoluble matter, 9.4%. The reason could be that the actual specie of gum Arabic used for the standard was not specified because physicochemical properties vary from specie to specie.

Table II displays the content of the organic nutrient in the sample; gum Arabic. It reveals that carbohydrate 0.275ppm, sugar content 0:00816ppm, Nitrogen 0.1200ppm and protein content is 0.7500ppm. Organic parameters seems to be more in cashew tree exudates which has carbohydrate content as 0.5674ppm, protein 1.0200ppm, nitrogen content 0.1640 and sugar content 0.6280ppm. The reason is traced to the different regional areas of their habitation. Nutrients are easily lost to the environment especially in savanna region where acacia trees inhabits. These values give the gum a perfect option to emulsify.

The results from the metal content analysis is given in Table III, which shows iron content; 40mg/kg, manganese; 48.2mg/kg, copper; 31.3mg/kg and Zinc; 3.0mg/kg. Cadmium and nickel was found to be absent. The absence of these two poisonous metals makes the gum applicable in the food industry.

4. Conclusion

Gum Arabic is unique among the natural hydrocolloids. Gum Arabic's mixture of saccharides and glycoproteins gives it the properties of a glue and binder which is edible by humans. For artists, it is the traditional binder used in water colour paint, in photography for gum printing and as a binder in pyrotechnic compositions. It has been investigated for use in intestinal dialysis. Pharmaceuticals and cosmetics also use the gum as a binder, emulsifying agent and suspending or viscosity increasing agent^[6]. These applications are successfully achieved on the basis of the physicochemical properties which have been established by this research work. The gum is highly viscous and slightly basic and contains little carbohydrate and sugar

compared to protein and nitrogen content, suggesting it to be a leguminous plant. Manganese, zinc, iron and copper are the analyzed trace metal content. These trace metals are vital to the proper growth and development of the acacia plant^[7].

References

- [1] Aghughu, O. Nursery Practices of Acacia Senegal (Gum Arabic). Workshop Proceedings on Gum Arabic Production and Marketing at APCU, Kano, 1998.
- [2] Aghughu, O., Ojiekpon, I. F., Wuranti, V. Agronomic practices for gum Arabic (Acacia Senegal) production. *Journal of Agriculture, Forestry and Fisheries*, 2005.
- [3] Bhatia S. C. *Environmental Chemistry*. CNS Publishers and Distributors, 1st Edition, 2006: 46+496.
- [4] Cossalter, C. *Acacia Senegal: Gum tree with promise for Agro - Forestry*. Nitrogen fixing Tree Association, Hawaii, *FAO Conservation Guide*, 1991, 27: 91-102.
- [5] Scholte, P. T. Leaf litter and Acacia pods as feed for livestock during the dry sea season in Acacia Camiphora Bush. *Journal of Arid Environments*, 1992, 22: 271-276.
- [6] Smolinske, S. C. *Handbook of Food, Drug and Cosmetic Excipients*, 1st ed. London: Heineman Publishers, 1992: 7.
- [7] Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education. 7th edition. 2007: 95-100+121+143-147+151.
- [8] Williams, P. A., Idris, O. H. M. *Structural Analysis of Gum from Acacia Senegal*, 1st ed. New York: Kluwer Academics, 2008: 154.
- [9] William, P. A., Phillips G. O. Gum Arabic. In *Handbook of Hydrocolloids*, Cambridge, New York Woodhead publishing, 2000.
- [10] Phillip, G. O., Ogasawara, T. The regulatory and Scientific Approach to Defining Gum Arabic as a Dietary fiber. *Food Hydrocolloids*, 2007, 22: 24-30.
- [11] De Pinto, G., Martinez, M., Mendoza J. A. Cashew tree exudate gum: a novel bioligand tool. *Biochem Systems Ecol.*, 1995, 23: 151-156.