Original Research

Volume 5, Issue 2, pp 12-23, September, 2023

ACHIEVERS JOURNAL OF SCIENTIFIC RESEARCH

Opecn Access Publications of Achievers University, Owo

Available Online at www.achieversjournalofscience.org

Isolation, Purification, and Characterization of Gums from the Bark of *Terminalia mantaly* and *Khaya senegalensis*

Oyegoke, D.A.,[1] Ogundele, O.D.,[1]* Aruwaji, A.N.,[1] and Fasuyi, F.O.[2]

[1]Department of Chemical Sciences, Achievers University, Owo, Ondo State, Nigeria.
[2]Department of Applied Chemistry, Osun State College of Technology, Esa Oke, Nigeria.

Corresponding Author's E-mail: olusoladavidogundele@gmail.com

Submitted: July 12, 2023, Revised: August 25, 2023, Accepted: September 02, 2023, Published: September 28, 2023

Abstract

This study investigates the physicochemical, mineral, proximate, FTIR, and SEM analysis of the gums obtained from the bark of *Terminalia mantaly* and *Khaya senegalensis*. The physicochemical analysis for *Terminalia mantaly* gum (TMG) gave values of 30.76 %, 4.50, 0.10 g/cm^3, 0.142 mg/cm^3, 8.78 %, and 10.55 % for percentage yield, pH, bulk density, tapped density, swelling index and water absorption capacity respectively while 29.50 %, 4.80, 0.12 g/cm^3, 0.105 mg/cm^3, 8.45 %, and 10.27 % for percentage yield, pH, bulk density, tapped density, swelling index and water absorption capacity respectively were recorded for *Khaya senegalensis* gum (KSG). The results of the proximate analysis showed that TMG had a higher percentage of moisture content, crude fat and ash content than KSG, and KSG had a higher percentage of crude fibre, crude protein, and carbohydrate content than TMG. Elemental analysis for *Terminalia mantaly* gum (TMG) gave values of 58.50 mg/kg, 42.0 mg/kg, 11.30 mg/kg, 38.50 mg/kg, 2.58 mg/kg, 1.53 mg/kg, and 0.33 mg/kg for potassium, magnesium, sodium, calcium, zinc, iron, and copper respectively while 58.00 mg/kg, 41.60 mg/kg, 39.00 mg/kg, 10.50 mg/kg, 1.50 mg/kg, 2.34 mg/kg, and 0.30 mg/kg for potassium, magnesium, calcium, sodium, iron, zinc, and copper respectively were recorded for *Khaya senegalensis* gum (KSG). The results show no toxicity and high nutritional and mineral value of the gums. Thus, they are safe to be used in the pharmaceutical and food industries.

Keywords: Isolation; Purification; Proximate Analysis; Gums; *Terminalia mantaly*; *Khaya senegalensis*.

1.0 Introduction

Gums are polysaccharides in many trees' roots, tubers, seeds, or surface cells. Due to their intense sensitivity to water, gums are simple to isolate. In microorganisms and plants, polysaccharides can naturally be found in secretions, cell walls, storage materials, and extracellular compounds (Izydorczyk *et al.,* 2005). The seeds of most leguminous plants contain a sizable quantity of gums. Like other polysaccharides, gums comprise many monosaccharide units connected by O-glycosidic bonds. Differences in monosaccharides, types of linkages, levels of polymerization, and chain configurations influence the physical characteristics of polysaccharide gums, including their solubility, flow characteristics, gelling, and interfacial and surface properties (Irani and Khaled, 2020). Plant gums have recently gained popularity in the food sector as stabilizers, coating agents, encapsulants, gelling agents, emulsifiers, thickeners, bulking agents, and syneresis inhibitors, in addition to serving as nutritional fiber supplements. As a result, plant gums are highly sought-after in the textile, cosmetic, pharmaceutical, clinical, and biomedical sectors (Mohanty and Krishna, 2014).

During the early days of medicine, using gums to treat various illnesses, including coughs, fevers, colds, sexual dysfunction, diarrhea, and dysentery, was quite popular (Izydorczyk *et al.*, 2005). Presently, gums are an excellent active ingredient in controlled drug delivery systems because they can perform multiple tasks, such as maintaining physicochemical characteristics and improving the solubility of medicines that are difficult to dissolve in water (Chaudhari and Patil, 2012). Low toxicity, biodegradability, unlimited availability, low cost, and biocompatibility are the characteristics of tree exudates. Over 85% of pharmaceutical formulations are made up of excipients and any additives made to the active drug substances throughout the production process (Murtaza *et al.*, 2017). Excipients may be used as disintegrants and binders in drug products in immediate-release tablets. Binders aid in the homogeneity of powder combinations used to make the immediate-release tablet, enhancing granules' circulation and the finished tablet's hardness. Tablets are formulated with disintegrants to assist them in breaking up into tiny pieces in an aqueous phase (Sarkodie *et al.*, 2021). The sources of disintegrants and binders can be synthetic, semi-synthetic, or natural. Over the past ten years, there has been a significant surge in the search for natural excipients. Pharmaceutical excipients derived from natural sources are recognized to be reasonably abundant, affordable, and biodegradable (Odeku, 2013).

Natural polysaccharides, including starches, mucilages, and gums, are applied as disintegrants, binders, and fillers in the pharmaceutical industry. Gums are pathological byproducts of plants produced when plant damage or unfavorable environmental circumstances cause the cell membranes to disintegrate. They have sugar and uronic subunits and are naturally sticky, colloidal, and amorphous. They could have a natural, artificial, or semi-artificial makeup (Patel *et al.*, 2011). Naturally occurring gums from plants like khaya, okra, gellen, and acacia have been utilized as binders in drug manufacturing. Gums are a developing field of scientific study because of the variety in their functional properties, structural makeup, and simplicity of modification. In addition, gums are one of the components that contribute to the appropriate appearance, stability, and texture of food products. As a result, researchers are looking into novel plant-based gums with desirable functionality to suit business demand, particularly in the pharmaceutical and food industry. (Mirhosseini *et al.*, 2012).

2.0 Materials and Methods

2.1 Study Area and Collection of Sample

This research was conducted at Achievers University, Owo, Ondo state, Nigeria. The gums were collected from the bark of *Terminalia mantaly* and *khaya senegalensis* trees in Owo, Ondo state, Nigeria. The *Terminalia mantaly* and *khaya senegalensis* trees were identified at the Department of Plant Science Biotechnology, Achievers University, Owo, Nigeria.

2.2 Extraction and Purification of the Gum

The gum exudates were purified according to Odeniyi *et al*. (2017) method. The *Terminalia mantaly* and *Khaya senegalensis* gums were collected from the tree's bark and allowed to dry for five days. The desiccated gum samples were accurately weighed (100 g), and its outer surface were cleaned with de-ionized water to get rid of any dirt or other foreign objects. For 50 hours, the cleaned gum samples were maintained in the oven at 50 °C. To soften and isolate the mucilage, the samples were soaked in a 0.5%:95.5% chloroform and water mixture for five days. The residual sticky mucilage from the samples were removed using a squeezing technique with the use of a white muslin napkin. Ethanol of 99 % percentage purity was then used to precipitate the gum serving as additional purification step. The precipitated gum was washed with 100 mL of dimethyl ether and then heated to 50 °C in the oven for 10 hours. The precipitated gum was ground into a fine powder using a mixer and kept in airtight container for further analysis (Okalebo *et al.*, 1993).

2.3 Proximate Composition Analysis

Proximate analysis was used to determine moisture, crude fiber, protein, fat, ash, and carbohydrate of the gums using the AOAC (1999) and Seal *et al.* (2017) method.

2.3.1 Determination of Moisture Content

The samples were weighed at 3 g each, dried in an oven for four hours at a temperature of 105 °C, and then weighed again. The percentage weight loss was used to express the moisture content.

$$\text{Moisture content}=\frac{Wb-Wc}{Wb-Wa}\text{ x }100$$

2.3.2 Determination of Ash Content

Heating 5 g of the gum sample to a constant weight at around 550 °C in a muffle furnace, the ash content was determined. Then, it was weighed after cooling in a desiccator. As a proportion of the dry mass, the percentage ash was given.

$$\text{Percentage Ash}=\frac{\text{Weight loss }(\text{W}_\text{b}-\text{W}_\text{c})}{\text{Weight of sample }(\text{W}_\text{a})}\text{ x }100$$

2.3.3 Determination of Crude Protein

The gum sample weighing exactly 5 g was digested in a macro-Kjeldahl apparatus using conc H_2SO_4. After adding sodium hydroxide, the resultant ammonium sulfate released ammonia, which was then distilled into 1 M boric acid and titrated with 0.1 M HCl. To calculate the amount of crude protein as a percentage of sample mass, the estimated nitrogen value was multiplied by 6.25 (protein factor).

$$\%\text{Nitrogen}=\frac{\text{Vol. of acid used}\times\text{Molarity}\times 0.014\times\text{Dilution factor}}{\text{Weight of sample}}\text{ x }100$$

$$\%\text{ Protein}=\%\text{ N}\times 6.25$$

2.3.4 Determination of Fat

Using a solvent extraction system (Soxhlet apparatus) and low boiling point petroleum ether as the solvent, the crude fat was recovered from 5 g of each gum. The amount of lipid contained in the sample was determined by weighing the lipid left after the solvent from the extract was evaporated.

$$\text{Percentage of Crude fat}=\frac{\text{Weight loss }(\text{W}_2-\text{W}_3)}{\text{Weight of sample }(\text{W}_1)}\text{ x }100$$

2.3.5 Determination of Crude Fibre

Extensive extraction of components soluble in 1.25% boiling sodium hydroxide and sulphuric acid was used on a sample of exactly 5 g. In addition, crude fiber was produced as a percentage weight loss in ash residue from the recovered leftover matter of crude fiber and inorganic material.

$$\text{Percentage of Crude fibre}=\frac{\text{Weight loss }(\text{W}_2-\text{W}_3)}{\text{Weight of sample }(\text{W}_1)}\text{ x }100$$

2.3.6 Carbohydrate Content Determination

Different factors were used to estimate carbohydrate content. First, the proportion of all carbohydrates is calculated by subtracting 100 from the sum of the percentages of moisture, protein, ash, and fiber.

$$\%\text{ Carbohydrate}=100-(\%\text{ protein}+\%\text{fat}+\%\text{fibre}+\%\text{ash}+\%\text{ moisture})$$

2.4 Physicochemical Analysis of the Purified Gums

Physicochemical Analysis (pH, percentage yield, bulk density, tapped density, water absorption capacity, and swelling index) of *Terminalia mantaly* and *Khaya senegalensis* purified gums were carried out using the AOAC (1999) and Auwal *et al.* (2014) methods.

2.5 Elemental Analysis (Mineral Analysis)

The gums were digested using aqua regia solution according to Okunade *et al.* (2022) method, and elemental analysis was carried out with Atomic Absorption Spectrometer (iCE 3000, Thermo Fisher).

2.6 Fourier Transform Infrared (FTIR) Spectrophotometry

TMG and KSG samples were prepared in potassium bromide disks. The FTIR spectra were recorded at up to 4000 cm^{-1} using a Fourier Transform Infrared (FTIR) spectrophotometer (model 7600S, Shimadzu Corporation, Japan).

2.7 Scanning Electron Microscopy (SEM)

The morphology of the TMG and dKSG powder were observed through SEM (Quanta 200, FEI, Hillsboro, USA).

3.0 Results and Discussions

3.1 Physicochemical Analysis of *Terminalia mantaly* gum (TMG) and *Khaya senegalensis* gum (KSG)

The percentage yield obtained in this study shows that TMG had a higher yield of 30.76% while KSG had a lower yield of 29.50%. The percentage yield obtained here is slightly higher than the 28.50% obtained by Ozoude *et al.* (2020) for *Khaya senegalensis* gum and 25.00% obtained by Olorunsola *et al.* (2016) for *Acacia nilotica* gum. The differences could be attributed to environmental conditions, processing methods, and plant source differences. The higher yield could also be attributed to the purification method used in this study.

Both pH obtained for TMG (4.50) and KSG (4.80) are in the acidic range, indicating their suitability in pharmaceutical applications. Furthermore, neutral and acidic gums are more efficient in pharmaceutical and drug formulations because using basic gums in drug formation stimulates the oxidation of susceptible drugs (Gyedu-Akoto *et al.*, 2008).

Bulk density is an essential factor in pharmaceuticals. For example, it estimates how much powder can fit in a capsule filler or tablet press or how much powder can fit within a capsule. TMG had a bulk density of 0.10 g/cm^{3,} while KSG had a value of 0.12 g/cm^3. These values are lower than the 0.177 g/cm^3 and 0.182 g/cm^3 obtained by Odeniyi *et al.* (2017) for native and microwave-modified *Terminalia mantaly* gums.

TMG had a tapped density of 0.142 g/cm^{3,} while KSG had a value of 0.105 g/cm^3. These values are lower than the 0.20 g/cm^3 and 0.193 g/cm^3 obtained by Odeniyi *et al.* (2017) for native and microwave-modified *Terminalia mantaly* gums. The differences could be attributed to the purification method used in this study. Tapped density is a widely used metric for powder characterization due to its ease and speed of measuring, a measure of the homogeneity of powder samples, and its capacity to pack under pressure, which is related to its flowability (Mahmud *et al.*, 2008).

The water absorption capacity and swelling index of gums enhance the cohesion in the formulation of tablets, which determines the rate and ease of drug dissolution. TMG had 8.78 and 10.55 % for swelling index and water absorption capacity, respectively, while KSG had 8.45 and 10.27 % for swelling index and water absorption capacity, respectively. Due to the presence of hydrophilic functional groups, the extracted gum displayed good swelling and water-retaining properties (Bhatta *et al.*, 2018). The isolated gum's water-holding and swelling properties may be related to shorter chain molecules. The production of ready-to-eat foods depends on water-holding capacity, and a strong adsorption capacity guarantees the finished product's cohesiveness (Mahmud *et al.*, 2008; Olayemi *et al.*, 2010). As a result, tablets made with TMG and KSG have good drug release and disintegration patterns.

3.2 Proximate Analysis of *Terminalia mantaly* gum (TMG) and *Khaya senegalensis* gum (KSG)

The physical qualities of food, such as its form, texture, color, flavor, and weight, as well as aspects that affect the food's quality, freshness, shelf life, and resistance to bacterial growth, are all greatly influenced by its moisture content (Ogundeleolusola *et al.*, 2019).

Table 1. Physicochemical Analysis of *Terminalia mantaly* gum (TMG) and *Khaya senegalensis* gum (KSG)

Physicochemical Analysis	KSG	TMG
Percentage Yield (%)	29.50 ± 3.15	30.76 ± 4.54
pH	4.80 ± 0.70	4.50 ± 0.40
Bulk density (g/cm^3)	0.12 ± 0.02	0.10 ± 0.01
Tapped density (g/cm^3)	0.105 ± 0.02	0.142 ± 0.01
Swelling index (%)	8.45 ± 1.51	8.78 ± 1.73
Water absorption capacity (%)	10.27 ± 1.85	10.55 ± 2.05

Number of replicates = 3; Mean ± Standard Deviation; *Khaya senegalensis* gum (KSG), *Terminalia mantaly* gum (TMG).

Therefore, the gum's moisture content is crucial to its flow characteristics and microbiological resistance. The purified gum's moisture content, which was 1.02% for TMG and 1.71% for KSG, met the required level (15%) (Builders *et al.*, 2008). Gums that contain more moisture exceeding 15% of their weight in water are more prone to clump up, facilitate microbial activity, and degrade with time. As a result, quality and shelf life are decreased. Therefore, TMG and KSG are more suitable as prospective pharmaceutical excipients due to their low moisture content, which was observed to be 1.02% and 1.71%, respectively.

The ash content obtained in this study shows that TMG had a higher value of 2.12%, while KSG had a value of 2.75%. The values obtained in this study are in accordance with the 2.30 % reported by Mahfoudhi *et al.* (2012) for the gum obtained from the bark of *Prunus dulcis*. The findings suggest that both TMG and KSG contain inorganic nutrients, indicating that they may be a source of minerals with nutritional value (Emmanuel *et al.*, 2020). The mineral components present determine the ash content. Ash content has been found to be effective in creating and regulating the blood's chemical balance as well as in regulating hyperglycemia.

The fat content shows that TMG had a higher value of 1.94%, while KSG had a value of 1.41%. The fat content in this study is higher than the 0.85% % reported by Mahfoudhi *et al.* (2012) for the gum obtained from the bark of *Prunus dulcis*. The results' differences can be attributed to the purification method and different species of plant samples used. The low-fat content in this study would improve the shelf life of both TMG and KSG due to a lowered chance of rancid growth. Hence, TMG and KSG would have a longer shelf life.

The protein content shows that KSG had a higher value of 4.51% and TMG with a value of 4.17%. The protein contents obtained in this research are higher than the 0.50% obtained by Irani *et al.* (2020) in the gum exudates of *Acacia nilotica.* Proteins are essential in the body to produce blood plasma, enzymes, and hormones. In addition, they also boost the immune system, enhance cell growth and division.

The carbohydrate value in this study is predominant, as a high value was recorded. TMG had a value of 89.93%, and KSG had a value of 88.07The body system hydrolyzes carbohydrates to produce glucose, which are either used instantly or stored in the muscle as glycogen for later. When carbohydrates are consumed more than human body's requirement, the leftover is transformed into fat and kept in the fat deposits underneath the skin. Due to the important contribution of polysaccharides as macronutrients, main dietary fiber constituents, components of food structure that affect sensory qualities, and additives, carbohydrate analysis is of utmost relevance in pharmaceutical industries.

The crude fibre values obtained in this study show that KSG had a higher value of 1.55% compared to 0.82% for TMG. These values are higher than the

0.15% obtained by Irani *et al.* (2020) in the gum exudates of *Acacia nilotica.* The results' differences can be attributed to the purification method and different species of plant samples used. Fibers cannot be absorbed nor digested by the human body system. Overall, dietary fibers work in human body to reduce the rate of plasma glucose absorption and hence lower the risk of hyperglycemia. Additionally, they lower plasma cholesterol levels and guard against cardiovascular disease and colon cancer.

Table 2. Proximate Analysis of *Terminalia mantaly* gum (TMG) and *Khaya senegalensis* gum (KSG)

Proximate	KSG	TMG
Moisture content (%)	1.71 ± 0.15	1.02 ± 0.24
Ash content (%)	2.75 ± 0.47	2.12 ± 0.40
Fat (%)	1.41 ± 0.25	1.94 ± 0.31
Protein (%)	4.51 ± 0.58	4.17 ± 0.82
Carbohydrate (%)	88.07 ± 4.15	89.93 ± 3.74
Crude fibre (%)	1.55 ± 0.72	0.82 ± 0.45

Number of replicates = 3; Mean ± Standard Deviation; *Khaya senegalensis* gum (KSG), *Terminalia mantaly* gum (TMG),

3.3 Mineral Analysis of *Terminalia mantaly* gum (TMG) and *Khaya senegalensis* gum (KSG)

The potassium ion concentration was found to be higher in TMG (58.50 mg/kg) than in KSG (58.00 mg/kg). The potassium ion concentration recorded in this research is lower than 120 mg/kg stated by Olorunsola *et al.* (2016) for *Acacia nilotica* gum. The results' differences can be attributed to the different species of plant samples. Potassium was observed to be the predominant ion in both TMG and KSG. Potassium is a vital nutrient and mineral crucial in muscle contraction, heart health, and fluid balance. High consumption may lower the risk of partial stroke, sodium tolerance, and blood pressure issues. It may also prevent kidney diseases (Stone and Weaver, 2021).

The magnesium ion concentration was found to be higher in TMG (42.00 mg/kg) than in KSG (41.60 mg/kg). Magnesium is the second predominant mineral in TMG and KSG, hence its suitability for pharmaceutical application. Over 250 metabolic processes in the human body require magnesium. It enhances healthy immunological function, regulates pulse, keeps bones strong, and maintains appropriate muscle and nerve function. Additionally, it aids in blood glucose regulation (Schachter, 1996).

The calcium ion concentration is the third predominant ion in TMG and KSG. Calcium ion concentration was higher in KSG (39 mg/kg) compare to TMG (38.50 mg/kg). The calcium ion concentration obtained in this study is higher than 18 mg/kg reported by Olorunsola et al. (2016) for *Khaya senegalensis* gum and lower than 366 mg/kg obtained by Irani *et al.* (2020) in the gum exudates of *Acacia nilotica*. Calcium is a mostly connected with strong teeth and bones; however, it also assists with muscular contraction, blood clotting, and maintaining consistent heartbeats and neurological activity. The body stores about 98.5% of its calcium in the bones, with the other 1.5% in muscles, blood, cartilage, and other tissues (Dickinson *et al.*, 2006; Kahwati *et al.*, 2018).

The elemental analysis showed that TMG had a higher sodium ion concentration (11.30 mg/kg) than KSG (10.50 mg/kg). The result gotten in this research is slightly lower than the 11.91 mg/kg obtained by Irani *et al.* (2020) in the gum exudates of *Acacia nilotica*. The body needs a certain quantity of sodium to conduct activities such as relaxing and contracting muscles, maintaining nutrients and water balance, and nerve impulses. The human body requires 500 grams of sodium daily to perform these essential processes (Gharibzahedi and Jafari, 2017).

The concentration of copper in this study is higher in TMG (0.33 mg/kg) than KSG (0.30 mg/kg). The result gotten in this research is slightly low compare to the 3.31 mg/kg obtained by Mahfoudhi *et al.* (2012) for the gum obtained from the bark of *Prunus dulcis*. The result showed that the values obtained were lower than the acceptable limit of 1.3 mg/kg by the world health organization WHO specification for food and herbal medicines. Hence, this indicates that KSG and TMG can be considered good candidates for pharmaceutical excipient use (FAO/WHO, 2016).

The zinc ions' concentration was higher in TMG (2.58 mg/kg) than in KSG (2.34 mg/kg). Although the body system needs little zinc's concentration, over 90 enzymes requires zinc to execute important biochemical processes. It is essential for protein synthesis, creation of DNA, repair of damaged cells, cell division, and maintaining a healthy immune system (Brown *et al.,* 2001; Deshpande *et al.,* 2013). Hence, TMG and KSG are suitable for pharmaceutical applications.

The iron concentration was higher in TMG (1.53 mg/kg) than KSG (1.50 mg/kg). The concentration of iron obtained in this study is lower than 10.75 mg/kg reported by Mahfoudhi *et al.* (2012) for the gum obtained from the bark of *Prunus dulcis*. The results' differences can be attributed to the purification method and different species of plant samples used. The body needs iron for growth. Hemoglobin, which is present in red blood cells and carries oxygen from the lungs to the part of the body, and myoglobin which oxygenates muscles are two proteins that the body needs iron to produce. The body needs iron to manufacture a number of hormones (Abbaspour *et al.,* 2014; Briguglio *et al.,* 2020).

Cadmium has been identified to be very toxic to the human body, such as the liver, kidneys, lungs, brain, and bones (Sobha *et al.*, 2007) at any concentration above the permissible limit of 0.20 mg/kg set by FAO/WHO, (2016), and 0.30 mg/kg WHO limit of heavy metals in herbal medicines (WHO, 2007). However, the result of this study shows that cadmium (Cd) was not detected; thus, KSG and TMG don't pose any potential risk in pharmaceutical and food applications.

Lead was not detected in both KSG and TMG. Lead is a cumulative toxic chemical, which can cause behavioral, hematological, neurological, renal, reproductive, and cardiovascular disease at levels above the tolerable limit of 0.3mg/kg (FAO/WHO, 2016). Hence, the present study's findings showed that both KSG and TMG would not translate into potential health risks in pharmaceutical and food applications.

3.4. Fourier Transform Infrared (FTIR) Spectra.

The spectra of TMG and KSG are presented in Figures 1 and 2 respectively. The FTIR spectra of TMG and KSG are slightly similar. The first peak was at 1401.51 cm^{-1} in TMG, and 1607.12 cm^{-1} in KSG correspond to C-O stretching and O-H bending of alcohol and ether (Rahman, 2012).

The two spectra have similar peak patterns around 1954.14 cm^{-1} and 2163.32 cm^{-1}, indicating similar functional groups (Kalinkova, 1999). The peaks at 2622.12 and 2631.71 cm^{-1} in TMG may correspond to stretching vibration of the hydroxyl (OH) group, while 3272.34 cm^{-1} may correspond to stretching vibration of the free hydroxyl group. The noticeable peak of KSG at 3503.61 cm^{-1} and TMG at 3537.12 cm^{-1} could correspond to aromatic C-H stretching vibration (Duerst, 2007).

Table 3. Mineral Analysis of *Terminalia mantaly* gum (TMG) and *Khaya senegalensis* gum (KSG)

Metals (Mg/Kg)	KSG	TMG
K	58.00 ± 2.16	58.50 ± 2.15
Mg	41.60 ± 1.62	42.0 ± 1.70
Ca	39.00 ± 1.56	38.50 ± 1.49
Na	10.50 ± 0.85	11.30 ± 0.92
Zn	2.34 ± 0.60	2.58 ± 0.72
Fe	1.50 ± 0.03	1.53 ± 0.02
Cu	0.30 ± 0.01	0.33 ± 0.02
Cd	ND	ND
Pb	ND	ND

Number of replicates = 3; Mean ± Standard Deviation; *Khaya senegalensis* gum (KSG), *Terminalia mantaly* gum (TMG)

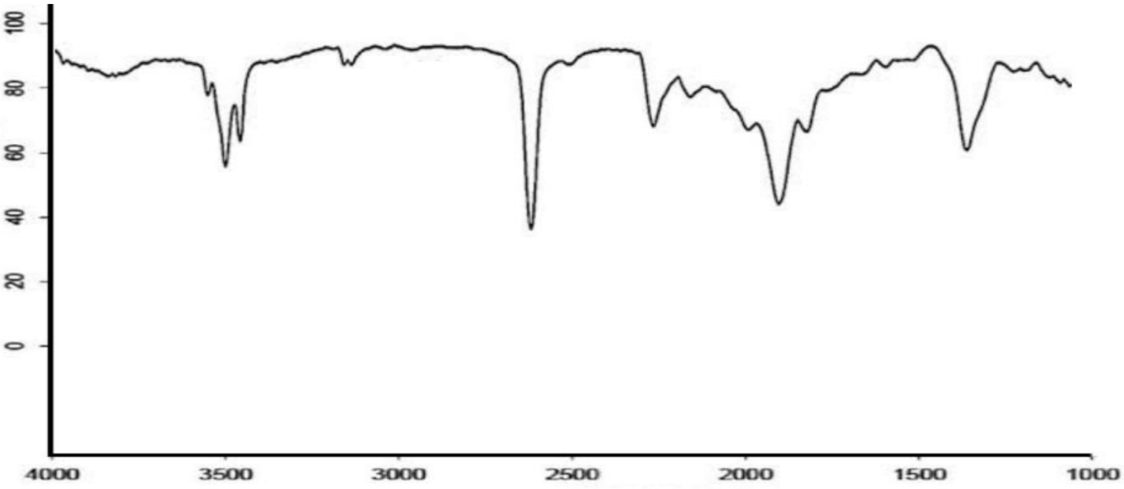

Figure 1. TMG Fourier Transform Infrared (FTIR) Spectrum.

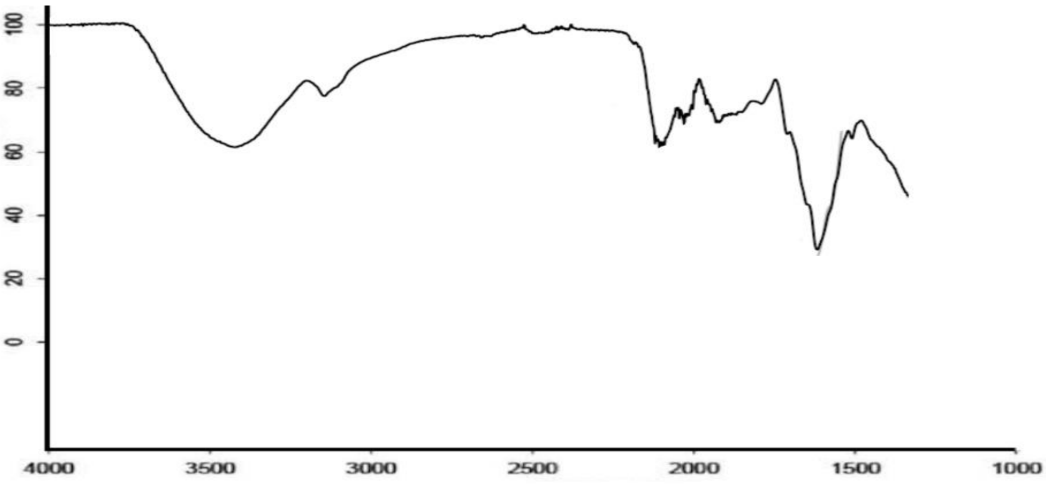

Figure 2. KSG Fourier Transform Infrared (FTIR) Spectrum.

3.5. Scanning electron micrograph (SEM) Analysis

The scanning electron micrograph of TMG and KSG powder shows the surface and shape characteristics of the particles, which were observed to be granular, smooth surfaces with particle size evenly spread. Both showed regular shaped patterns, which revealed the definite nature of TMG and KSG.

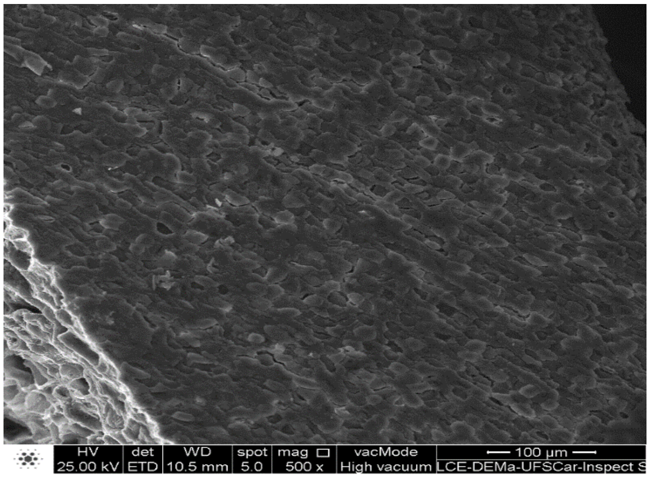

Figure 3. SEM micrograph of TMG.

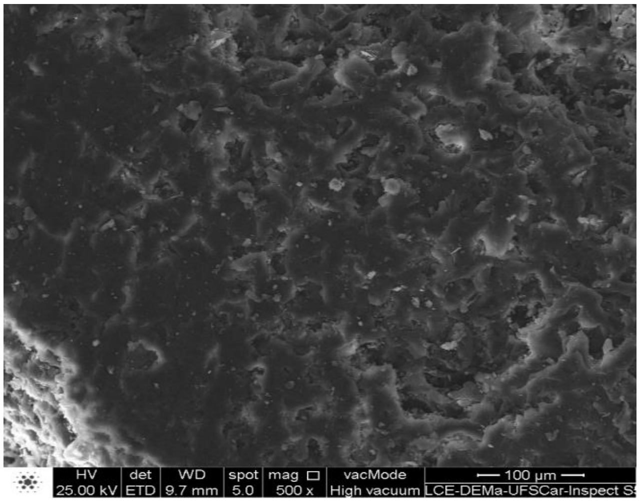

Figure 4. SEM micrograph of KSG.

4.0 Conclusion

Terminalia mantaly and *Khaya senegalensis* gums were characterized, and both possess nutritional values, making them suitable in food and pharmaceutical industries. These gums are ideal for use in drugs, food, paints, etc. The benefits are broad, pose no potential risk (toxicity), and are free from objectionable microorganisms. The majority of plant products are essentially unexplored, thus fresh knowledge must be discovered on how they may be used as medicinal agents. Due to its high mineral content, it can be used as a supplement and a significant source of daily minerals in foods consumed by humans to prevent and treat various ailments. Several synthetic medications can be produced using this natural gum with less negative effects. Its nutrient profile demonstrates that it can provide a number of nutritional and physiological benefit

References

Abbaspour, N., Hurrell, R., and Kelishadi, R. (2014). Review on iron and its importance for human health. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, *19*(2), 164.

Auwal, M.S., Saka, S., Mairiga, I.A., Sanda, K.A., Shuaibu, A., and Ibrahim, A. (2014). Preliminary phytochemical and elemental analysis of aqueous and fractionated pod extracts of Acacia nilotica (Thorn mimosa). In *Veterinary research forum: an international quarterly journal* (Vol. 5, No. 2, p. 95). Faculty of Veterinary Medicine, Urmia University, Urmia, Iran. https://doi.org/10.3923/jms.2013.111.117

Bhatta, R., Hossain, M.S., Banik, S., Moghal, M.M.R., Rashid, M.M.O., and Akter, M. (2018). Swelling and mucoadhesive behavior with drug release characteristics of gastoretentive drug delivery system based on a combination of natural gum and semi-synthetic polymers. *Marmara Pharmaceutical Journal*, *22*(2), 286-298. https://doi.org/10.12991/mpj.2018.66

Briguglio, M., Hrelia, S., Malaguti, M., Lombardi, G., Riso, P., Porrini, M. and Banfi, G. (2020). The central role of iron in human nutrition: from folk to contemporary medicine. *Nutrients*, *12*(6), 1761. https://doi.org/10.3390/nu12061761

Brown, K.H., Wuehler, S.E., and Peerson, J.M. (2001). The importance of zinc in human nutrition and estimation of the global prevalence of zinc deficiency. *Food and Nutrition Bulletin*, *22*(2), 113-125. https://doi.org/10.1177/156482650102200201

Builders, P.F., Kunle, O.O., and Adikwu, M.U. (2008). Preparation and characterization of mucinated agarose: a mucin–agarose physical crosslink. *International journal of pharmaceutics*, *356*(1-2), 174-180. https://doi.org/10.1016/j.ijpharm.2008.01.006

Chaudhari, S. P., and Patil, P. S. (2012). Pharmaceutical excipients: a review. *Int J Adv Pharm Biol Chem*, *1*(1), 21-34.

Deshpande, J.D., Joshi, M.M., and Giri, P.A. (2013). Zinc: The trace element of major importance in human nutrition and health. *Int J Med Sci Public Health*, *2*(1), 1-6. https://doi.org/10.5455/ijmsph.2013.2.1-6

Dickinson, H.O., Nicolson, D., Cook, J.V., Campbell, F., Beyer, F.R., Ford, G.A., and Mason, J. (2006). Calcium supplementation for the management of primary hypertension in adults. *Cochrane Database of Systematic Reviews*, (2). https://doi.org/10.1002/14651858.cd004805.pub2

Duerst, M. (2007). Spectroscopic methods of analysis: infrared spectroscopy. *Swarbrick J., Boylon JC, Encyclopedia of Pharmaceutical Technology*, *3*, 3405-3418.

Emmanuel, A.T., David, O.O., and Oyeniyi, A.T. (2020). Effects of Processing Temperature on the Proximate and Mineral Composition of Oreochromis niloticus. *International Journal of Recent Innovation in Food Science and Nutrition*, *3*(1).

Gharibzahedi, S.M.T., and Jafari, S.M. (2017). The importance of minerals in human nutrition: Bioavailability, food fortification, processing effects and nanoencapsulation. *Trends in Food Science and Technology*, *62*, 119-132. https://doi.org/10.1016/j.tifs.2017.02.017

Gyedu-Akoto, E., Oduro, I., Amoah, F. M., Oldham, J.H., Ellis, W.O., Opoku-Ameyaw, K., and Hakeem, R.B. (2008). Physico-chemical properties of cashew tree gum. *African Journal of Food Science*, *2*, 060-064.

Irani, R., and Khaled, K.L. (2020). Quantitative Analysis of Nutrients in the Gum Exudates ofAcacia nilotica. *Int J Cur Res Rev| Vol*, *12*(08), 11. https://doi.org/10.31782/ijcrr.2020.12083

Izydorczyk, M., Cui, S.W., and Wang, Q. (2005). Polysaccharide gums: structures, functional properties, and applications. *Food carbohydrates: Chemistry, physical properties, and applications*, *293*, 299. https://doi.org/10.1201/9780203485286.ch6

Joint, F.A.O., World Health Organization, and WHO Expert Committee on Food Additives. (2016). *Evaluation of certain food additives and contaminants: eightieth report of the Joint FAO/WHO Expert Committee on Food Additives*. World Health Organization.

Kahwati, L.C., Weber, R.P., Pan, H., Gourlay, M., LeBlanc, E., Coker-Schwimmer, M., and Viswanathan, M. (2018). Vitamin D, calcium, or combined supplementation for the primary prevention of fractures in community-dwelling adults: evidence report and systematic review for the US Preventive Services Task

Force. *Jama*, *319*(15), 1600-1612. https://doi.org/10.1001/jama.2017.21640

Kalinkova, G.N. (1999). Infrared spectroscopy in pharmacy. *Vibrational spectroscopy*, *19*(2), 307-320. https://doi.org/10.1016/s0924-2031(99)00017-x

Mahfoudhi, N., Chouaibi, M., Donsi, F., Ferrari, G., and Hamdi, S. (2012). Chemical composition and functional properties of gum exudates from the trunk of the almond tree (Prunus dulcis). *Food Science and Technology International*, *18*(3), 241-250. https://doi.org/10.1177/1082013211415173

Mahmud, H.S., Oyi, A.R., and Allagh, T.S. (2008). Studies on some physicochemical properties of Khaya senegalensis gum. *Nigerian Journal of Pharmaceutical Sciences*, *7*(1), 146-152.

Mohanty, S., and Krishna, M.G. (2014). Proximate analysis and standardization of plant exudates: gum olibanum and gum dikamali. *International Journal of Pharmaceutical Sciences Review and Research*, *24*(1), 172-176.

Murtaza, M.S., Sameen, A., Huma, N., and Hussain, F. (2017). Influence of hydrocolloid gums on textural, functional and sensory properties of low fat cheddar cheese from buffalo milk. *Pakistan Journal of Zoology*, *49*(1), 27-34. https://doi.org/10.17582/journal.pjz/2017.49.1.27.34

Odeku, O.A. (2013). Potentials of tropical starches as pharmaceutical excipients: A review. *Starch‐Stärke*, *65*(1-2): 89-106. https://doi.org/10.1002/star.201200076

Odeniyi, M.A., Oyedokun, B.M., and Bamiro, O.A. (2017). Native and microwave-modified Terminalia mantaly gums as sustained-release and bioadhesive excipients in naproxen matrix tablet formulations. *Polim Med*, *47*(1), 35-42. https://doi.org/10.17219/pim/76058

Ogundele, O.D., Thompson, S.O., Lawal, S.K., and Demehin, B.F. (2019). Effects of drying temperature on proximate composition and functional properties of (*Colocasia esculenta*) cocoyam flour. *International Journal of Recent Innovation in Food Science and Nutrition*, *2*(1): 25-33.

Okalebo, J.R., Gathua, K.W., and Woomer, P.L. (2002). Laboratory methods of soil and plant analysis: a working manual second edition. *Sacred Africa, Nairobi*, *21*, 25-26.

Okunade, M. B., Ogundele, O. D., Anaun, T. E., and Afolabi, A. B. (2022). Heavy Metals Assessment of Fish Samples Obtained from Selected Cold-Rooms in Ondo State of Nigeria. *Achievers Journal of Scientific Research*, *4*(1), 1-10.

Olayemi, O.J., Mahmud, H.S., and Apeji, Y.O.N. N.I. (2010). Effect of concentration on the release property of Khaya senegalensis gum in chloroquine phosphate tablet formulation. *Int J Appl Pharm*, *2*(3), 22-26.

Olorunsola, E.O., Bhatia, P.G., Tytler, B.A., and Adikwu, M.U. (2016). Thermochemical properties of hydrophilic polymers from cashew and khaya exudates and their implications on drug delivery. *Journal of Drug Delivery*, *2016*. https://doi.org/10.1155/2016/7496585

Ozoude, C.H., Azubuike, C.P., Ologunagba, M.O., Tonuewa, S.S., and Igwilo, C.I. (2020). Formulation and development of metformin-loaded microspheres using Khaya senegalensis (Meliaceae) gum as co-polymer. *Future Journal of Pharmaceutical Sciences*, *6*(1), 1-11. https://doi.org/10.1186/s43094-020-00139-6

Patel, H., Shah, V., and Upadhyay, U. (2011). New pharmaceutical excipients in solid dosage forms-A review. *International Journal of Pharmacy and Life Sciences*, *2*(8).

Rahman, A. (2012). Application of fourier transform infrared spectroscopy for quality control of pharmaceutical products: a review. *Indonesian Journal of Pharmacy*, *23*(1), 1-8.

Sarkodie, L.C., Entsie, P., Boakye-Gyasi, M.E., Owusu, F.W., Bayor, M.T., and Ofori-Kwakye, K. (2021). Evaluation of the binding and disintegrating properties of gum obtained from the stem bark of Cinnamomum zeylanicum. *South African Journal of Science*, *117*(11-12): 1-7. https://doi.org/10.17159/sajs.2021/11550

Schachter, M. (1996). The importance of magnesium to human nutrition. *Schachter center for Complementary Medicine*.

Stone, M., and Weaver, C. (2021). Improving human nutrition: A critical objective for potassium recommendations for agricultural crops. In *Improving Potassium Recommendations for Agricultural Crops* (pp. 417-445). Springer, Cham. https://doi.org/10.1007/978-3-030-59197-7_15

World Health Organization. (2016). Evaluation of certain food additives and contaminants. Eightieth report of the Joint FAO/WHO Expert Committee on Food Additives. *World Health Organization technical report series*, (995), 1.