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Research Article

Nutritional and Structural Evaluation of *Sweitenia Mycrophylla* Exudate Gum: A Potential Excipient and Food Additive

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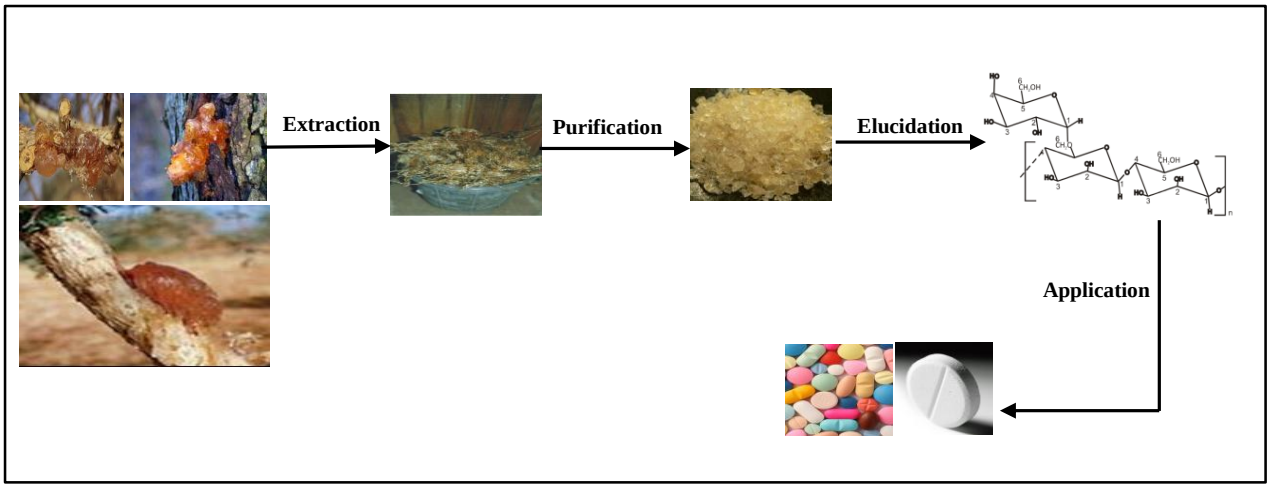
ABSTRACT

Nutritional and structural analysis of *S. mycrophylla* were investigated using standard methods. Elemental analysis of the purified *S. mycrophylla* gum sample revealed the content of potassium, sodium, calcium, manganese, magnesium, iron and zinc to be 600.0 ± 1.52 mg/g, 300.23 ± 0.2 mg/g, 0.31 ± 0.00 mg/g, 410.33 ±1.0 mg/g, 149.6 ± 4.60, 8.7±0.00 mg/g and 61.1±0.22 mg/g respectively. Gum had high content of potassium, sodium, magnesium and zinc and lower concentration of calcium, manganese and iron. Proximate analysis shows moisture content to be 5.70 ± 0.15%, Ash content 2.80±0.05%, Protein content 1.43 ± 0.01%, crude fibre 4.30 ± 0.01%, and crude fat 1.50. ± 0.03%, and carbohydrate 85.98±1.10%. These results compared favourably with acacia senegal gum (gum arabic) and makes this exudate gum highly recommendable for use in food and pharmaceutical industries. NMR spectroscopy revealed that the gum is a galactomannan type polysaccharide with mannose/ galactose ratio of 2.60. Due to its good physicochemical properties and mannose/ galactose ratio, Sweitenia mycrophylla galactomannan could be a useful polysaccharide for food and pharmaceutical industry.

GRAPHICAL ABSTRACT



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Introduction

The polysaccharide gums represent one of the most abundant industrial raw materials for food and pharmaceuticals and have been the subject of intensive research over synthetic materials due to their sustainability, biodegradability and biosafety [1]. Natural polysaccharide gums represent a group of polymer which swell to form highly viscous solutions or dispersions in aqueous medium. They have found wide application in pharmaceutical formulation such as polymer matrix in sustained release solid dosage form [2-6], binders in tablet formulation [7], stabilizers or suspending agents in liquid dosage forms [8], bioadhesive in drug delivery systems and food additive in food processing [9]. Polysaccharide gums used in the pharmaceutical and food industries include guar gum, gum tragacanth, acacia gum and xanthan gum among others. They have the advantage of biocompatibility, low cost and relatively wide spread availability compared to their synthetic counterparts [9]. The nutritional evaluation and characterization of polysaccharide gums is an essential step in establishing their suitability as food additive and pharmaceutical excipients. *Sweitenia mycrophylla* is a large tree, reaching a height of 30-40 m and a girth of 3-4 m, in favourite condition it can reach 60 m high and 9 m girth. It is popularly known as Mahogany [10, 11]. Gum is produced from bark of the tree for sales in markets in Bombay, India. It is marketed in pure form or mixed with other gums. An oil that might be of commercial value can be extracted from the seed kernels and various medicinal uses of the parts of the tree has been reported [11]. Physicochemical properties, toxicological properties, chemical modifications and application of unmodified and modified *Sweitenia mycrophylla* gum as excipient in drug formulations had been investigated in previous studies [12-15]. Our focus now is in application of the polysaccharide in food processing. There are no sufficient studies that confirm the nutritional and structural characterization of this gum. Hence this research aims at investigating the nutritional composition of the gum and relate this to its structural composition in order to utilize it in food processing as an additive.

Experimental

Materials and methods

Collection and preparation of gum

Gum was collected from the bark of *S. mycrophylla* tree in Owena Forestry, Ondo State, Nigeria between November 2009 and February 2010. The plant was identified and authenticated at the herbarium of the Department of Plant and wood Technology, Federal University of Technology, Akure, Nigeria. Gum was tapped from the bark of the tree. The crude samples of gum consist of a mixture of large and small nodules mixed with bark and organic debris. These were hand sorted to remove fragments of bark and other visible impurities and then were spread out in the sun to dry for one week. The dried cleaned gum samples were milled with a kenwood blender (UK) and later sieved using a bin (mesh size-250 microns) so as to obtain a fine and uniform sample, kept in labeled plastic container for subsequent analysis.

Purification of gum sample

Dried crude gum (l0 g) was stirred in cold distilled water (250 mL) for 2 hours at room temperature. The supernatant was obtained by centrifugation and made up to 500 mL and ethanol solution was added (l:4 v/v) to precipitate all the carbohydrate. The precipitated material was washed again with ethanol, followed by distilled water and dried at room temperature milled with kenwood blender (UK) and later sieved using a bin (mesh size-250 microns) kept in labeled plastic container for subsequent analysis.

Nutritional analysis of gum

The moisture content was determined by drying to constant weight at 105 °C (in a muffle furnace) [7]. Nitrogen content of the gum was determined by kjeldah method [7] using Gerhad kjeldotherm and vapodest system (Germany). Crude protein was calculated from the nitrogen content using the conversion factor of 6.25. Carbohydrate, crude fat, crude fibre and ash content were measured accordingly to [7].

Elemental contents of the crude gum was analyzed using atomic absorption spectrophotometer (AAS), A- analyst model 400 (England) for the presence and concentration calcium, magnesium, manganese, zinc and iron and flame photometer Hitachi 482 (Germany) for the presence and the concentration of potassium and sodium.

NMR spectroscopy

^{13}C-NMR and ^{13}C-DEPT NMR of *Sweitenia mycrophylla* gum were recorded in an NMR (600 MHz) spectrometer (Agilent technologies, America). The sample (10 mg) was dissolved in 700 μL at 70 °C with continous stirring for 6 hours followed by sonication for 10 minutes. The sample was centrifuged and transferred to a 5 mm NMR tube. Chemical shifts were reported in ppm relative to an internal standard TMSP (Tetramethylsilane propoinic acid). Peak integra were performed using Agilent software, America.

Results

Table 1. ^{13}C and ^{13}C-DEPT 135° NMR assignment of *Sweitenia mycrophylla* gum (10 mg in 700 μL D_20, 60 °C) Referenced to TMS

	Chemical shift (ppm)					
Residue	C-1	C-2	C-3	C-4	C-5	C-6
α-D-Galactopyranosyl	98.87	71.90	73.00	74.80	76.00	63.50
B-D-Mannopyranosyl	102.1	77.20	73.50	77.10	75.20	62.50

Table 2. Nutritional composition of *S. mycrophylla* gum

Parameters	
Calcium [mg/g]	0.31 ± 0.00
Sodium [mg/g]	600.00 ± 1.52
Potassium [mg/g]	300.23 ± 0.20
Manganese [mg/g]	410.33 ± 1.0
Magnesium [mg/g]	149.6 ± 4.60
Iron [mg/g]	8.7 ± 0.00
Zinc [mg/g]	61.1 ± 0 .22
Carbohydrate [%]	85.98±1.10
Protein [%]	1.43 ± 0.01
Fat [%]	0.50 ± 0.01
Fibre [%]	4.30 ± 0.04
Moisture content [%]	5.70 ± 0.15
Ash [%]	2.80 ± 0.05

Mean ± S.D, n=3

Figure 1. Crude *S. mycrophylla* exudate gum

Figure 2. ^{13}C NMR Spectrum (600 MH_Z) of *Sweitenia mycrophylla* gum (10 mg in 700 μL D_20, 60 °C). Referenced to TMSP

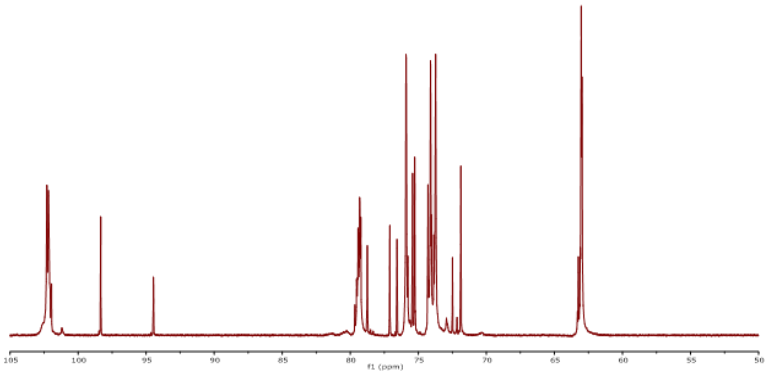
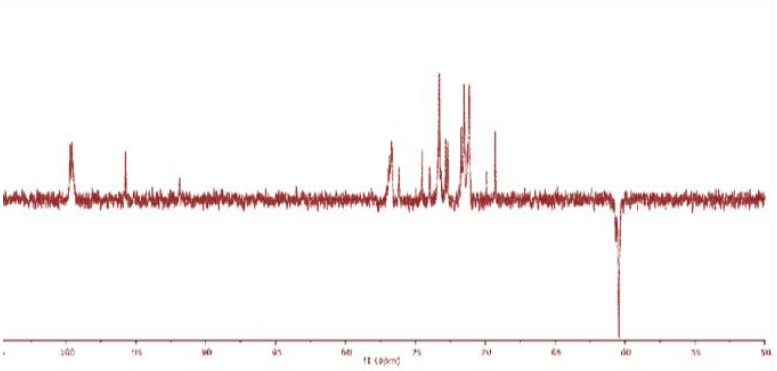


Figure 3. ^{13}C DEPT-135 Spectrum (600MH_Z) of *Sweitenia mycrophylla* gum S (10 mg in 700 μL D_20, 60 °C). Referenced to TMSP



Discussion

Moisture content of the gum was 5.70% (Table 2) and compares favourably with the minimum standards (<15%) for good quality gum according to European specification [16]. This suggests its suitability in formulations containing moisture sensitive drugs. Given suitable temperature moisture will lead to activation of enzymes and the proliferation of microorganisms, thereby affecting its shelf life. It is important to investigate the moisture content of an exudate gum, for industrial application lies not only on the cheap and easy availability of the material but the optimization of production processes such as drying, packaging and storing [15]. The total ashes value of the gum was found to be 2.80% (w/w) (Table 2). This falls within the acceptable level of less than 4% for gum arabic reported by [12] for food and pharmaceuticals. Ash content is an important property considered as a purity parameter in gums. The very low values of ash show that the exudate gum has a good quality of

mineral content with low level of contamination [15]. The value for protein content obtained 1.43% (Table 2) fairly agrees with that of acacia gum (0.5–2.7%).Also the gum has considerable percentage of crude fibre (4.3%) and fat (1.5%). The result of the elemental analysis of gum showed that the gum is rich in sodium, calcium, magnesium, iron, potassium, manganese and zinc. Elemental analysis of the purified *S. mycrophylla* gum sample revealed the content of potassium, sodium, calcium, manganese, magnesium, iron and zinc to be 600.0±1.52 mg/g, 300.23±0.2 mg/g, 0.31±0.00 mg/g, 410.33 ± 1.0 mg/g, 149.6 ± 4.60, 8.7 ± 0.00 mg/g and 61.1±0.22 mg/g respectively. Gum had high content of potassium, sodium, magnesium and zinc and lower concentration of calcium, manganese and iron. In the ^{13}C spectrum of *Sweitenia mycrophylla* gum (Figure 2), signals from anomeric carbons appear in the 90 to 105ppm regions while the nonanomeric carbons are between 60 and 85 ppm. The anomeric C-1 carbons are the most diagnostic; thus from C-1 alone one can often determine the different types of sequences present and their relative proportions [17]. The resonances of C-2 to C-5 can be found at 65-78 ppm. The primary hydroxyl group (-OH) (C-6) resonate at 60-70 ppm [17, 18]. The carbon anomeric region of ^{13}C NMR of *Sweitenia mycrophylla* gum showed two major signals which were assigned as C-1 of $\alpha - D - sugar$ residue A at 98.87 ppm and C-1 of $\beta - D - sugar$ residue B at 102.1 ppm. The spectrum region of anomeric carbons (102.1 and 98.87 ppm) and the methylene carbons (62.50 and 63.50) are well depicted (Figures 2 and 3). The resonances of the carbon atoms were well resolved (Figure 2) and identified as the resonances of C-2, C-3, C-4 and C-5 of sugar residue B and C-2, C-3, C-4 and C-5 of residue A (Table 1). The facts are almost identical with gums of other origin [19]. The ^{13}C-DEPT NMR 135° spectrum (Figure 3) showed at a high field two inverted signals (62.45 and 63.65 ppm) assigned to methylene carbon (C-6) of the sugar residues. The ^{13}C-DEPT NMR experiment was used to identify the methylene (CH_2) group signals of the carbon atoms bearing two protons which have opposite amplitude to the CH and CH_3. Resonances were assigned with the aid of literature data [20, 21]. Based on the monosaccharide composition and NMR spectroscopy, residue A was assigned $\alpha - D - galactose$ and B was assigned $\beta - D - mannose$.

Conclusion

The results of this study clearly show that *S. mycrophylla* gum have considerable proximate content and good concentration of essential elements which compared favourably with standard gum Arabic and WHO/FAO requirement. Thus *S. mycrophylla* gum may be utilized in gum based industries, most importantly in food and pharmaceuticals as emulsifier and additive in food processing and effective binder in drug formulations.

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