Research Article
Volume 10:04, 2024

Journal of Pharmacognosy & Natural Products

ISSN: 2472-0992 **Open Access**

GC-MS Evaluation of Stem Bark Extract of *Sterculia oblonga* for Biomedical Potentials

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Abstract

The stem-bark of *Sterculla oblonga,* which is a rich lignocellulosic material, was analysed using GC-MS chromatography in other to identify the bioactive compounds present in the plant and deduce its possible therapeutic potentials. The pulverized plant sample was extracted by maceration for 48 hours using ethanol solvent, after solvent recovery, the crude extract was used for the GC-MS analysis. Results revealed the presence of 12 bioactive compounds namely: 1-(Butylsulfanyl)-2-ethoxyethane 4-methoxyphenol (mequinol), 2,6-dimethoxy-phenol (Syringol), 3,4,5-Trimethoxyphenol, 4,4,5,6-Tetramethyltetrahydro-1,3-oxazin-2-thione, n-Hexadecanoic acid (Palmitic acid), 1-Docosene, 14-methyl-8-hexadecen-1-ol, 1,19-Eicosadiene, Z-10-Tetradecen-1-ol acetate, 1-Nonadecene and Oleic Acid. These chemicals were further grouped into 5 viz organo-sulphur (2%), phenols (24%), alkaloids (2%), fatty acids/esters (22.18%) and hydrocarbons (8.66%). Because of the high percentage of phenolic compounds present, the ethanolic extract of stem-bark of *S. oblonga* could find useful therapeutic applications as antimicrobial, anti-cancer, anti-oxidant and anti-diabetic agents.

Keywords: Bioactive compounds • *Stercula oblonga* • Organo-sulphur • Phenols • Hydrocarbons

Introduction

The biopolymers called hemicellulose, cellulose and lignin, which have demonstrated antimicrobial properties, make up most lignocellulosic materials [1]. One of the most prevalent natural materials, lignocellulosic materials has favorable qualities like low density and biodegradability. They are also readily available, cheap, and environmentally friendly. Massive amounts of lignocellulose are extracted from agricultural waste, but only a small amount of that is used since lignocellulose's biotechnological significance is not well understood [2]. The amount of lignocellulosic content available in a material varies. Considering the enormous amount of chemical compounds available in the extract from these biopolymeric materials, there are countless prospects for the development of new drugs [3]. For instance, example aqueous extracts from willow leaves (*Salix sasaf*) have been reported to be effective against Guman carcinoma cells and have been tested *in vivo* and *in vitro* [4]; antimicrobial activity of *Punica granatum* has been reported to be effective against all test microorganisms [5]. The heavy dependency of people on traditional medicine for primary health care has prompted in-depth research into plants to enhance their curative properties [6]. Some common sources of lignocellulosic materials are shown in Figure 1.

Yellow *Sterculia*, or *Sterculia oblonga* (Figure 2), is a commercial wood tree in the *Malvaceae* family that is found mostly in tropical rainforests in countries like Cameroon, Gabon, Liberia, Ghana, Nigeria, etc. It is reported that the edible seeds have a pea-like flavor. They are best eaten roasted or raw. Handbags, hats, rope, paper, and other items are made from the bark's fibers. The wood can be used to build little furniture pieces, like cupboards, or matchsticks.

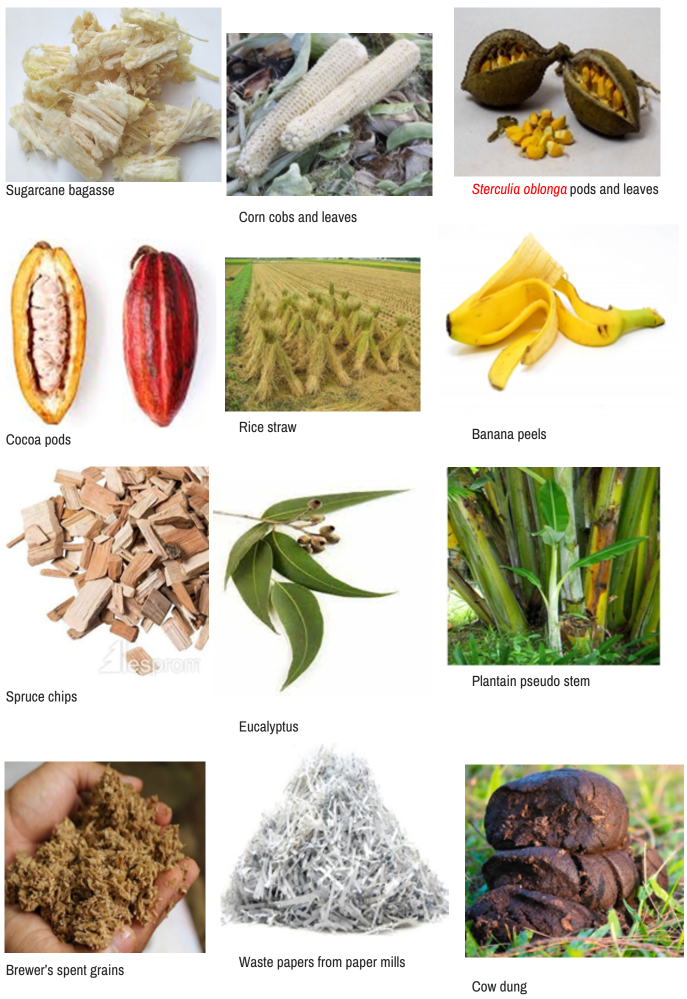

Figure 1. Common sources of lignocellulosic materials.

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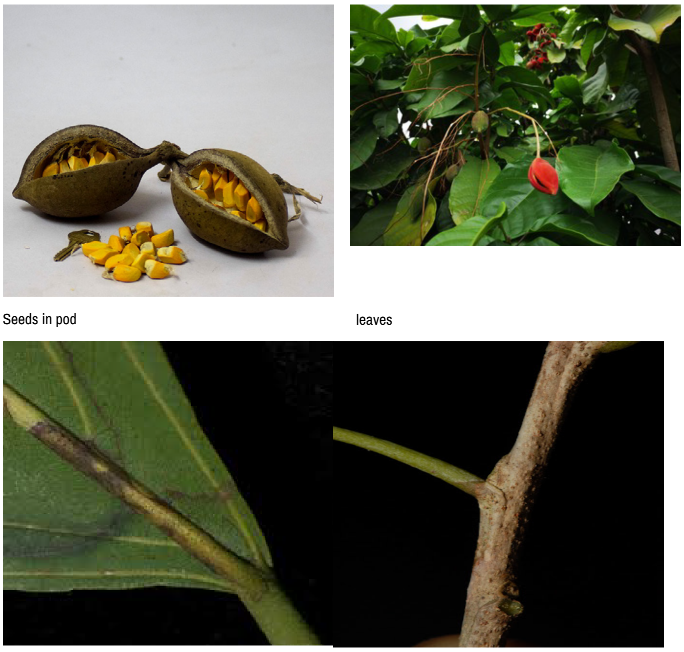
Received: 01 August, 2024, Manuscript No. jpnp-24-145188; **Editor assigned:** 03 August, 2024, PreQC No. P-145188; **Reviewed:** 15 August, 2024, QC No. Q-145188; **Revised:** 22 August, 2024, Manuscript No. R-145188; **Published:** 29 August, 2024, DOI: 10.37421/2472-0992.2024.10.312



The stem bark (the part used for present study)

Figure 2. Pictural view of *Sterculia oblonga*.

The dried wood of *Steculia oblonga* has been reported to contain 11.5 – 12.4% furfural; 36.2 – 46.32 cellulose; 19.8-21.2% pentosans; 18.2-22.7% lignin; and 1.3-3.2% ash [7]. Ezeonu CS and Ejikeme CM [8] also reported that *S. oblonga* contain tannins, 124 mg/100g; flavonoids, 3.4%; alkaloids, 10%; cyanide, 1.66 mg/100g; lipids 4.8%; phenol, 620 mg/g; and oxalate, 1.31 g/100g. The gas chromatography-mass spectroscopy analysis of essential oil from *S. oblonga* shows that the plant contains 33 compounds ranging from simple compound like p-xylene to very complex compounds like diisoctylphthalate [9]. Report on petroleum spirit extract showed that the plant contains 25 natural products which include 2-myristgnoyl pantetheine; D-limonene, limonene-b-0l, pivalate, chalestan-3-Ol, 2-methylene-, (3β, 5α), cis-13-eicosenoic acid, Hexadecane, I, l-bis(dedecyloxyl), Z-plytol, and 17-pentatriacontene [10]. This study aimed to analyze the ethanolic extract of *S. oblonga* stem bark *via* Gas Chromatography-Mass Spectrometry (GC-MS) to determine their probable usage in pharmacology and ascertain their phytochemical composition.

Methodology

Plant sample

The fresh stem bark of yellow sterculia (*Sterculia oblonga*) was collected from the rain forest of Akamkpa Local Government Area, Cross River State, Nigeria. The identification and authentication of the plant sample was done by the Herbarium Unit of Botany Department, University of Calabar. It was washed clean with distilled water, air-dried, crushed into tiny pieces, and stored at room temperature in air-tight containers for further studies.

Extraction

The maceration method of extraction was used in this study because of its easy method, no heat involved, suitable for thermally sensitive materials, inexpensive installation and maintenance costs. A total of 850 g of the dried plant was extracted sequentially using ethanol by cold maceration for 48 hours. The resulting solution was filtered and concentrated to dryness using rotary evaporator.

Determination of the secondary metabolites of the crude extract using Gas Chromatography-Mass Spectrometry (GC-MS)

The identification of the individual compounds of the ethanol crude extract was done by standard method using a GC-MS analyzer. The components were identified by correlating the masses of the generated spectra to those of the library's reference mass spectra.

Results and Discussion

Results in Table 1 show the yield of the three extracts and the calculated percentage yield for the three extracts. Gas chromatogram of ethanol extract of *S. oblonga* stem bark is presented in Figure 3. The GC-MS analysis of bioactive compounds in ethanol extract of *sterculia oblonga* stem bark and pharmacological potentials of the phyto-compounds in the ethanolic extract of *S. oblonga* stem bark are presented in Table 2 and Table 3 respectively.

The GC-MS analysis of the stem-bark of *S. oblonga* showed the presence of twelve (12) different phytochemicals including organo-sulphur compounds (2%), phenols (24%), alkaloids (2%), fatty acids/esters (52%) and hydrocarbons (20%) (Figure 4) From the results, it is safe to say that the stem-bark of *Sterculia oblonga* contains very high amount of fatty acids/esters, followed by phonols, and hydrocarbons. The presence of these compounds sums up the effective use of the plant in many pharmacological applications such as wound healing, anti-cancer, anti-microbial, anti-oxidant and sex stimulant activities.

Table 1. Percentage yields of extract.

Solvent	Weight of Plants (g)	Weight of Extract (g)	Colour of Extract	Texture of Extract	Percentage Yield (%)
Ethanol	1200	13.21	Green	Sticky	11

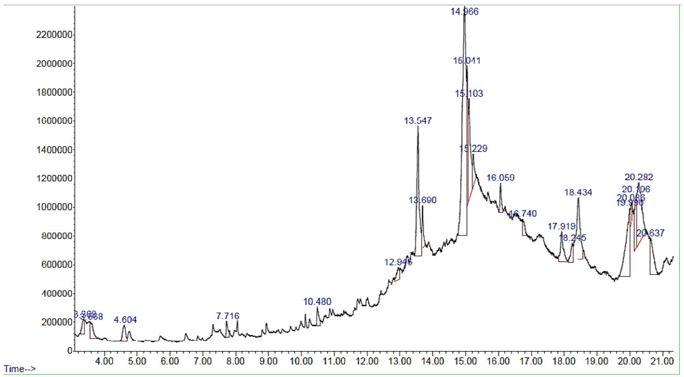


Figure 3. Gas chromatogram of ethanol extract of *Sterculia oblonga* stem bark.

Table 2. GC-MS results of secondary metabolites in ethanol extract of *Sterculia oblonga* stem bark.

S/N	Retention Time	Peak Area (%)	Molecular Formula	MW	Name of Compound
1.	3.37	1	$C_8H_{18}OS$	162	1-(Butylsulfanyl)-2-ethoxyethane
2.	4.6	1.56	$CH_3OC_6H_4OH$	124	4-methoxyphenol (mequinol)
3.	7.72	0.9	$HO(CH_3O)_2C_6H_3$	154	2,6-dimethoxy-phenol (Syringol)
4.	10.48	1.12	$C_9H_{12}O_4$	184	3,4,5-Trimethoxyphenol
5.	12.95	0.93	$C_8H_{15}NOS$	173	4,4,5,6-Tetramethyltetrahydro-1,3-oxazin-2-thione
6.	13.55	9.98	$C_{16}H_{32}O_2$	256	n-Hexadecanoic acid (Palmitic acid)
7.	16.74	1.14	$C_4H_8O_2$	308	1-Docosene
8.	17.92	2.75	$C_{17}H_{34}O$	254	14-methyl-8-hexadecen-1-ol
9.	18.25	1.53	$C_{20}H_{38}$	278	1,19-Eicosadiene
10.	19.99	8.8	$C_{16}H_{30}O_2$	254	Z-10-Tetradecen-1-ol acetate
11.	20.19	3.24	$C_{19}H_{38}$	266	1-Nonadecene
12.	20.64	3.4	$C_{18}H_{34}O_2$	282	Oleic Acid

Table 3. Pharmacological potentials of the phyto-compounds in the ethanolic extract of *Sterculia oblonga* stem bark.

S/N	Name of Compound	Class of Phytochemical	Major Function	Pharmacological Activity
1.	1-(Butylsulfanyl)-2-ethoxyethane	Organo-sulfur	Antibiotic and antidiabetic agent	Anti-cancer agent [11], fertility activity
2.	4-methoxyphenol (mequinol)	Phenol	Antimicrobial	Diabetic Wound dressing [12], cosmetic preservative [13]
3.	2,6-dimethoxy-phenol (Syringol)	Phenol	Antimicrobial	Antitermitic activity [14]
4.	3,4,5-Trimethoxyphenol	Phenol	Antimicrobial	Anti-invasive cancer agents [15], Antiplasmodial activity [16]
5.	4,4,5,6-Tetramethyltetrahydro-1,3-oxazin-2-thione	Alkaloid	Antioxidant, Antimicrobial	Cosmetics, anti-cancer and anti-cholesterol activity [17]
6.	n-Hexadecanoic acid (Palmitic acid)	Fatty acids/ Ester	Anti-inflammation	Anti-inflammation [18], Cytotoxic activity [19]
7.	1-Docosene	Hydrocarbon	Antimicrobial	Antibacterial [20], antioxidant [21] and antifungal activity [22]
8.	14-methyl-8-hexadecen-1-ol	Hydrocarbon	-	No therapeutic report
9.	1,19-Eicosadiene	Hydrocarbon	Antimicrobial	Antidiabetic activity
10.	Z-10-Tetradecen-1-ol acetate	Ester	sex pheromone	Sex attractant [23]
11.	1-Nonadecene	Hydrocarbon	Anti-inflammator y	Antimicrobial, antioxidant, anticancer [24]
12.	Oleic Acid	Fatty acid	Antimicrobial; Anti-inflammatory	Anti-inflammation, modulation of leukocytes activity [25,26]

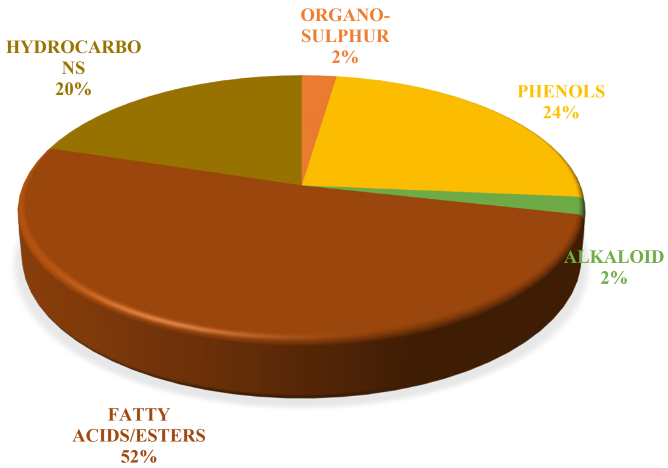


Figure 4. Percentage composition of phytochemicals identified in the crude ethanolic extract of *Sterculia oblonga* stem bark.

Organo-sulfur compounds have shown antimicrobial activity against various pathogens, including bacteria, viruses, fungi, and parasites. These compounds can help inhibit the growth of harmful microorganisms and may be beneficial in fighting infections [27,28]. A study by Kamenetsky R, et al. revealed that organosulfur compounds could have fertility potential [27]. Other therapeutic applications of Organosulfur compounds include: Anti-cancer [11], antioxidant activity [29]. However, the GC-MS chromatogram of the stem-bark of *S. oblonga* revealed only 2% of organo-sulfur content.

The presence of phenolic compounds in medicinal plants contributes significantly to their therapeutic potential. These compounds exhibit antioxidant, anti-inflammatory, antimicrobial, and other bioactive properties that can help prevent or alleviate various health conditions. By consuming plant-based foods rich in phenolic compounds or using herbal remedies derived from these plants, individuals may benefit from the protective effects against oxidative stress-related diseases [30].

Plants rich in alkaloids continue to be valuable sources of bioactive compounds with diverse medicinal properties that contribute to human health and well-being. Many medicinal potentials of alkaloid compounds including antioxidant activity [31], and antidiabetic activities have been reported [32].

The most significant amount of phytochemicals present in the bark of *S. oblonga* stem is fatty acid/esters. This suggests that the plant could be a great source of health essential oil if properly extracted. The oils may help lower the adverse effects of diabetes and blood pressure [33].

Plants containing hydrocarbons have shown potential therapeutic implications in various fields, primarily because of the existence of secondary metabolites that can exhibit medicinal properties. Some plants produce hydrocarbons that possess antimicrobial/anti-inflammatory properties [34] and anti-cancer potentials [35].

Conclusion

The bark on the stem of *Sterculia oblonga* revealed the existence of twelve (12) different phytochemicals including organo-Sulphur compounds (2%), phenols (24%), alkaloids (2%), fatty acids/esters (52%) and hydrocarbons (20%). The presence of these compounds makes the plant a suitable choice for variety of therapeutic applications as far as herbal medicine is concerned.

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How to cite this article: Nkom, Patience Yake, Esther Offiong Asuquo, Lynius Ashipu Bebiaundeye and Endurance Egwu Ukam. "GC-MS Evaluation of Stem Bark Extract of *Sterculia oblonga* for Biomedical Potentials." *J Pharmacogn Nat Prod* 10 (2024): 312.