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An Assay of Characteristics, Chemical Constituents and Functional Group Analysis of *Cordia Milleni:* A Tropical Timber

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Abstract: **The evaluation of the wood of *Cordia milleni* was carried out in terms of chemical, physical and variable techniques; oven dry density, water imbibitions (at different intervals: 30 mins, 5 hrs & 24 hrs), thermal conductivity, electrical conductivity, afterglow time, flame duration, flame propagation rate, ignition time, moisture content and ash content showed that it is a good timber suitable for various construction purposes. Phytochemical screening showed the presence of saponins, tannins, steroids, flavonoids, carbohydrates, proteins, resins, terpenoids, glycosides and alkaloids. The AAS of the sample showed the presence of some metals such as Na, K, Pb, As, Ca, Zn, Mg, and Cu in the decreasing order of their concentrations. The TLC analysis showed one spot for chloroform-methanol extracts and two spots for chloroform extracts. It was further characterized using Fourier Transform Infrared and Ultraviolet Spectroscopic methods which suggested a 1,2,3- trisubstituted phenylamide with OH,CO and CN groups attached as the functional groups present. The chemical components analysis showed the presence of cellulose, hemicelluloses, lignin and other constituents in their right proportion. The results confirmed the efficiency of the wood for various construction purposes and its medicinal ability due to the presence of the secondary metabolites.**

Keywords: Cordia milleni, **Chloroform-methanol, Functional group, chemical constituents and Tropical timber.**

1. INTRODUCTION

Wood is the hard, fibrous substance found beneath bark in the stems and branches of trees and shrubs. Timbers are known as wood prepared for use in building or for making other things. Practically all commercial wood comes from trees. It is plentiful and replaceable. Since a new tree can be grown where one has been cut, wood has been called the world's only renewable natural resource (Bashiru *et al.*, 1990). It is also an organic material, a natural composite of cellulose fibres (which are strong in tension) embedded in a matrix of lignin which resists compression. In the strict sense, wood is produced as secondary xylem in the stems of trees (and other woody plants). In a living tree it transfers water and nutrients to the leaves and other growing tissues, and has a support function, enabling woody plants to reach large sizes or to stand up for themselves (Feirer John, 2000).

Wood (secondary xylem) is manufactured by a succession of five major steps, which includes cell division, cell expansion (elongation and radial enlargement), cell wall thickening (involving cellulose, hemicellulose, cell wall proteins, and lignin biosynthesis and deposition), programmed cell death, and heartwood formation.(Larson, 1994 and Higuchi 1997). The quality of timber depends on its heat resistance, moisture content, susceptibility to insect attacks, workability, grains, colour, porosity and capacity to take polish and vanish (Desch, and Dinwoodie, 1981).

Cordia milleni is a plant that belongs to the *Boraginaceae* Family. It is a hardwood with *Cordia* as its common name. In Nigeria, its Igbo name is okwe, omo in Yoruba and waawankurmii in Hausa (Keay *et al.*,1964)

Its origin and geographic distribution occurs from Sierra Leone, East to Western Kenya and Tanzania, south to DR Congo and Northern Angola. The tree is commonly planted in West Africa.

In Nigeria, *Cordia milleni* seed powder mixed with palm oil is applied externally to ringworm and itching skin and is located mostly in the south eastern part of Nigeria especially Nsukka (Udeozo *et al.*, 2011). In Cameroon and other West Africa Countries, large pieces of bark are stripped from the bole to make nutwalls and partition. Also, leaf decoction is taken to dispel worms, treat asthma, cough and cold. The flowers provide nectar and pollen for honey bees (Eboatu and Altine, 1991). There is dearth of information on the wood of *Cordia milleni* as a result; some thermal and variable properties, chemical constituents, phytochemical and functional group assay of the wood were investigated.

2. EXPERIMENTAL

Sample collection and Identification:

Cordia milleni timber was collected from timber shed at Nsukka in Igboeze North Local Government Area of Enugu State. Timber dealer, forest officer (Mr. Vin Okakpu of Nnewi Forestry) as well as literature (Keay *et al.*, 1964) helped in the timber identification.

Sample preparation:

The timber was cut in a saw mill into two different shapes and sizes; dust from the timber was also collected. The timber was cut into splints of dimensions 30 x 1.5 x 0.5cm and cubes of dimensions 2.5 x 2.5 x 2.5cm. The samples were dried in an oven at 105^{o}C for 24 hours before the experiments.

3. METHOD

The Thermal characteristics: Afterglow time, flame duration, flame propagation, ignition time, oven dry density, moisture content, water imbibitions, ash percentage, thermal conductivity and electrical conductivity were variously determined using American Society for testing and material (ASTM) methods (1998b and 1999a) The microelement composition was analysed using atomic absorption spectrophotometer model PG 990 manufactured by PG instrument Ltd U.S.A.

The Phytochemical Compounds: resins, steroids, terpenoids, tanins, alkaloids, saponin, flavonoids, glycosides, phlobatannins, carbohydrate and protein were qualitatively and quantitatively determined by the methods outlined by Harbone, (1998)

The hydrogen ion concentration (PH) was determined by the method outlined by Amadi *et al.* (2004) using electrical PH meter PHS-25 made by Life Care England.

The Chemical Constituents: lignins, hemicellulose, cellulose, crude fibre, crude protein, carbohydrate, phenol and destructive distillation of the wood products were quantitatively determined by the methods outlined by Goering and Vansoest (1975), Oakley (1984) and Marzieh & Marjan (2010)

The Functional Group Analysis: The samples chloroform-methanol and chloroform extracts were monitored using TLC, Fourier Transform Infrared and Ultraviolet Spectroscopic methods.

4. RESULT AND DISCUSSION

RESULT:

The results of the thermal investigation and the analysis of the active constituents present in the timber extract of *Cordia milleni* are given in tables 1- 8.

Table 1: Results of the Solubility Property of *Cordial millenii*

Solvents	Results
Hot and cold water	Insoluble
1.0M Dilute HCl	Insoluble
Concentrated HCl	Insoluble
Concentrated HCl + heat	Slightly Soluble
1.0M Dilute H_2SO_4	Slightly Soluble
Concentrated H_2SO_4	Slightly Soluble
Concentrated H_2SO_4 + heat	Soluble

1% NaOH	Insoluble
Ethanol	Insoluble
Diethyl ether	Insoluble

Table 2: Results of thermal characteristics of *Cordial millenii*

Characteristics	Units	Results
Afterglow time	Sec	215
Flame duration	Sec	138.67
Flame propagation rate	$cm.5^{-1}$	10.6×10^{-2}
Ignition time	Sec	2.33
Over dry density	$g.cm^{-3}$	22.8×10^{-2}
Moisture content	%	33.3
30 mins Water imbibitions	%	22.4
5 hrs Water imbibitions	%	46.3
24 hrs Water imbibitions	%	77.1
Ash Content	%	1.75
Thermal conductivity	Umoh/cm	26.47×10^{2}
Electrical Conductivity	Sm^{-1}	2.8×10^{-3}
Specific Gravity		0.36
Porosity Index	%	1.38
PH		6.65
Charring Temperature	^{o}C	91 – 103
Colour		Cornsilk

Table 3: Micro elemental composition %

Zinc	0.16
Lead	0.30
Cadmium	Nil
Copper	0.0001
Sodium	0.34
Calcium	0,28
Magnesium	0.01
Potassium	0.03
Arsenic	0.06
Mercury	Nil

Table 4: Phytochemical composition of *Cordial millenii*

Class of phytocompounds	Inference
Saponin	++
Flavonoids	+
Resins	+
Steroids	++
Terpenoids	+
Tannin	++
Alkaloids	+
Carbohydrate	+
Protein	++
Glycoside	+++

Key +++ - highly present
++ - moderately present
+ - slightly present
- - absent

Table 5: Results of Quantitative Chemical Constituents of *Cordial millenii*

Chemical Constituents	Units	Results
Lignins	%	20.0
Hemicellulose	%	30.0
Cellulose	%	46.0
Crude Fibre	%	2.4
Crude Protein	%	1.55
Carbohydrate	Mg/g	1.44
Phenol	Mg/g	1.70
Tannin	Mg/100g	840
Alkaloids	%	11.2
Flavonoids	%	8.2
Saponins	%	33.2
Oxalate	g/100g	3.05
Total Acidity	$g/100cm^3$	0.27
Cyanogenic Glycoside	Mg/100g	518
Lipid	%	2.4
Wood Charcoal	(g)	2.0
Pyroligneous acid	cm^3	2.25
Wood tar	cm^3	0.2
Wood gas	cm^3	902

Table 6: Results of Thin layer chromatographic characteristics of chloroform-methanol and chloroform extracts of *Cordial millenii*

Sample	Number of spot	Rf value
Chloroform-methanol extract.	1	0.7
Chloroform extract	2	0.6 & 0.5

Tables 7: Results of Fourier Transformed Infrared and Ultraviolet spectra of Chloroform - methanol extract.

Wave number (cm^{-1})	Suspected chromophores
3432	O-H stretch for alcohols, phenols & carboxylic acids
2088	N=C=S stretch for isothiocyanate
1647	C = O stretch for ketones, acid amides & esters
1459	C=C stretch for alkene and aromatics
1022	C – H deformation bond for alkyl groups
UVλ_{max} 304, 404 and 671	Indicating highly conjugated trisubstituted aromatic compound.

Table 8: Result of Fourier Transformed Infrared and Ultraviolet Spectra of Chloroform extract.

Wave number (cm^{-1})	Suspected chromophores
3426	O - H stretch for alcohols, phenols & carboxylic acids
3415	O – H stretch for alcohols
2853	C - H stretch for alkanes
2505	C = N stretch for nitrile
2093	N=C=S stretch for isothiocyanate
1646	C = O stretch for ketones, acid amides & esters
1450	C=C stretch for alkene and aromatics
1105	C – O stretch for alcohols, carboxylic acids & esters
1018	C – H deformation bond for alkyl groups
UVλ_{max} 205, 213 and 275	Indicating highly conjugated isoquinoline amide.

5. DISCUSSION

Table 1, indicated that *Cordia milleni* wood powder was insoluble in hot and cold water, ethanol, sodium hydroxide, diethyl ether, dilute HCl and concentrated HCl. Slight solubility was detected with heated concentrated HCl, diluted H_2SO_4 and concentrated H_2SO_4. The sample only dissolved in a high temperatured concentrated H_2SO_4. This is in-line with Petterson (2007) who stated that woods are highly resistance and non degradedable by chemicals, though the chemicals can extract some extraneous materials from the wood. One can deduce from the result that *Cordia milleni* wood could only dissolve in hot concentrated H_2SO_4 acids.

The thermal characteristics analysis carried out on the wood of *Cordia milleni* (Table 2) showed that it had low afterglow time (less than five minutes) which made it less hazardous in fire situations because it wouldn't glow long enough for rekindle to take place. Its flame duration value indicated that it can moderately sustain combustion. Water imbibitions at 30 mins, 5 hrs and 24 hrs intervals showed the capacity of *Cordia milleni* timber to absorb water over a period of time (Udeozo *et al*., 2014). The oven dry density and ash content values are in line with the ascertain of Desch and Dinwoodie (1981) which stated that denser and small ash content timbers are suitable in their use as a source of carbondioxide for internal combustion engine. The result also showed a high moisture content value of 33.3% which is in-line with Arntzen (1994) who stated that, the fiber saturation point usually varies between 21 and 28%. Wood gains and losses moisture as change occurs in the temperature and humidity of the surrounding air. Decrease in moisture content of a wood affects the weight dimensions and strength of the wood and as well affects both the physical and mechanical properties of wood, depending on whether the moisture content is above or below the fiber saturation point. The sample also showed good specific gravity which is a measure of their density and strength. According to Panshin and Dezeeuw (1964), increase in specific gravity increases strength properties because internal stresses are distributed among more molecular material. As a result, wood with high specific gravity has high wood strength and high physical and mechanical properties. While those with low specific gravity will have low wood strength and their physical and mechanical properties will be affected too. David *et al* (1999) explained that specific gravity of wood is based on oven dry weight of the wood and also reflect the presence of gums, resins and extravites which contribute little to mechanical properties.

Wood, a thermally degradable and combustible material has its charring as a primary factor that determines the load-carrying capacity of wood in high temperature environment. *Cordia milleni* with high charring temperature of 91-103^{o}C has high ability of load-carrying capacity in high temperatured environment. The porosity index result indicated the presence of pore spaces in the wood. Pore spaces are filled with either water or air. Smaller pores tend to be filled with water are referred to as capillary porosity while large pores are typically filled with air and are referred to as non-capillary porosity. The porosity index and water imbibition at different intervals results give good estimate of the sample particle compactness and absorptivity. One can deduce from the results that *Cordia milleni* is a hardwood that will be very good for construction and other purposes.

The results of the Atomic Absorption Spectrophometric analysis of the sample (Table 3) showed that copper, magnesium and potassium were present and are involved in body enzymatic activities, Sodium which help in P^{H} balance of body fluids, zinc which is essential for the activity of DNA polymerases, calcium which is important constituent of skeleton and bones, lead and arsenic were also present while mercury and cadmium were absent.

The result of the phytochemical analysis (Table 4) showed the presence of all the analysed secondary metabolites which ranges from glycosides, steroids, saponin, tannin, protein, flavonoids, alkaloids, resins, terpenoids and carbohydrate in their increasing order of magnitude. The medicinal values of medicinal plants lie on these phytocompounds which produce definite physicological actions in human body. Saponin has been found to be anti carcinogenic, cholesterol reducer and anti-inflammatory substance. Tanins are anti-inflammatory, control gastritics and irritating bowel disorders, they also contribute to antimicrobial power which heals wounds and stop bleeding (Gills,1992). Flavonoids exhibit an anti-inflammatory, anti-allergic effects, analgesic and anti-oxidant properties (Dunguid *et al.*,1989). The presence of alkaloids showed that it can be used as antimycotics and also in the treatment of stomach pains (Akpuaka, 2009). Terpenoids are associated with anti-cancer and also play a role in traditional and alternative medicine such as aromatherapy, antibacterial and other pharmaceutical functions. The high carbohydrate content of the sample extract showed that it is a good source of energy. Resins are valued for their chemical properties and associated uses as the product of varnishes, adhesives and food glazing agents. Protein indicated high nutritional value of the extract, therefore can help in physical and mental growth and development (Udeozo *et al*., 2014)

Results of Quantitative Chemical Constituents of *Cordia milleni* (Table 5) indicated that the sample contained 20% of lignin, 46% of cellulose, 30% of hemicelluloses, etc which help to confirm that the sample is a hard wood. Lignin is largely responsible for the strength, rigidity of plant and shields carbohydrate polymers from microbial and enzymatic attack. It contributes 20-25% of hardwood. Cellulose, a major chemical component of wood fibre wall, contributes 40-50% of hardwoods dry weight. Hemicellulose is a group of carbohydrate biopolymers that exist in close association with cellulose in the plant cell wall but it is less complex and easily hydrolysable (Arntzen, 1994 and Desch & Dinwoodie, 1996). The destructive distillation of *Cordia milleni* gave rise to four products in the following compositions; wood charcoal (2.0g), pyroligneous acid ($2.25cm^3$), wood tar ($0.2cm^3$) and wood gas ($902\ cm^3$). As wood reaches elevated temperatures, the different chemical components undergo the thermal degradation that affects the performance of wood. The extent of the changes depends on the temperature level and length of time exposed. At 100^oC, the chemical bonds begin to break and are manifested as carbohydrate. Hemicellulose and lignin components are pyrolyzed in the temperature ranges of 200^oC - 300^oC and 225^oC - 450^oC respectively. Much of the acetic acid liberated from wood pyrolysis is attributed to deactylation of hemicelluloses. As a result of the vigorous production of flammable volaties from 300^oC - 450^oC, significant depolymerization of cellulose begins from 300^oC - 350^oC. Also around 300^oC aliphatic side chains starts splitting off from aromatic rings in the lignin. The carbon-carbon linkage between lignin structural units is cleaved from 370^oC - well in animal feed formulation. Crude fiber indicates the level of indigestible component of food. Low crude fiber content shows that the sample has high nutritional value (A.O.A.C.,1990). There depicts low oxalate content (3.05g/1009) in the analyzed sample. Foods high in oxalate causes inflammation, pain and burning, irritation of tissue and mucous membranes and contribute to the formation of calcium oxalate kidney stones (Fatoki and Ekwenchi, 1998). The lipid content of 2.40% in *Cordia milleni* wood proves energy storage capacity in the structural component of the sample's cell membrane (Fahy *et* al., 2009).

The thin layer chromatography of the extract (Table 6) showed two components with R_f values of 0.6 and 0.5 when chloroform extract was spotted and one spot with R_f value of 0.7 with chloroform-methanol extract. The TLC results confirmed the presence of some components and its high purity.

The results of the FTIR and UV (Table 7) showed strong absorption at 3432 cm^{-1} and 2088 cm^{-1} which indicated the presence of alcohols, phenols, carboxylic acids and isothiocyanate. The absorption at 1647 cm^{-1} and 1459 cm^{-1} showed the presence of ketones, acid amides, esters and alkenes. The presence of O-H, C-H and C=N (Table 8) for hydrogen bond in phenols, carboxylic acids and alcohols, alkanes and nitriles were shown by absorption at 3426 cm^{-1}, 2853 cm^{-1} and 2505 cm^{-1} respectively. The absorption in the ultraviolet visible spectra and FTIR spectra suggested that the active compound might be 1,2,3-trisubstituted aromatic compound with O-H, C=O and C=N groups attached.

6. CONCLUSION

The results of thermal and variable characteristics, phytochemical and AAS analysis of the wood, *Cordia milleni* had shown that it contained some components that could made it useful in animal feed formulation and as well a good material for various construction works. The UV and FTIR spectra showed that it contains some bioactive compounds. The presence of all the analysed secondary metabolites showed that *Cordia milleni* could be used in the cure and management of various diseases. Moreover, the complex chemical makeup of the timber showed the presence of cellulose, hemicelluloses, lignin and other components in the right proportion which confirmed that *Cordia milleni* is a hardwood that could be very efficacious in various construction works and as an ideal raw material for "ligno-chemical" industry that could replace the petrochemical industry in providing not only plastic and all kinds of chemical products but also food and textile products..

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