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The Efficacy of *Protea Elliotti* Timber*:* An Important Study

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ABSTRACT

Timbers are wood prepared for use in building or for making other things. It is a combustible material. Timber obtained from *Protea elliottii* stem has paucity of information. It was analysed for physical, chemical and variable techniques using standard methods. The results of Phytochemical screening showed the presence of saponins, tannins, steroids, flavonoids, carbohydrates, proteins, resins, terpenoids, glycosides and alkaloids. The Atomic Absorption Spectrophotometer (AAS) of the sample showed the presence of some metals such as Na, Pb, K, As, Zn, Hg, Ca, Cu and Mg in the decreasing order of their concentrations. The thin layer chromatographic (TLC) analysis of the samples chloroform-methanol extract gave two spots with Retardation factor (Rf) values of 0.6 and 0.5. It was further characterized using Fourier Transform Infrared (FTIR) and Ultraviolet (UV) Spectroscopic methods. The FTIR and UV spectra results suggested a 1,2,3-trisubstituted phenylamide with OH, CO and CN groups attached as the functional groups present. The chemical components analysis indicated the presence of cellulose, hemicelluloses, lignin and other constituents in their right proportion. The results confirmed the efficaciousness of the wood for various construction purposes and its medicinal ability due to the presence of the secondary metabolites.

Key words: *Protea elliottii,* FTIR, UV, Phytochemical screening, chemical constituents and timber.

1NTRODUCTION

Wood is the fifth most important product of the world trade. The vast quantities of wood are logged by foresters to provide fuel, fibres (for pulp, paper products and boards) and sawn timbers (for house building and furniture) as commodities.

The complex chemical makeup of wood (cellulose, hemicelluloses, lignin and pectins) also makes it an ideal raw material for what could be a future "lingo-chemical" industry that could replace the petrochemical industry in providing not only plastics and all kinds of chemical products but also food and textile products[1]. 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,[2].

Protea elliottii is a species of tree in the *proteaceae* family. It is a hardwood, native to tropical Africa. Its English common names include *protea*. In Nigeria, its Igbo name is okwo, dehinbolorun in Yoruba and halshena in Hausa. It is mostly located at Nsukka.[3],[4]The genus *protea* was named in 1735 by Carl Linnaeus after the Greek God Proteus who could change his form at will because they have such a wide variety of forms Linnaeus genus was formed by merging a number of genera previously published by Herman Boerhave[5]. There is paucity of information on the wood of *Protea elliottii,* as a result, some thermal and variable properties, chemical constituents, phytochemical and functional group assay of the wood were investigated.

Sample Collection and Identification

Protea elliottii 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 [5] helped in the timber identification.

Sample Preparation

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

METHODS

Solubility analysis:

The sample solubility was determined by placing 1g of the sample powder into nine different 250cm^3 Kjeldahl flasks. 20cm^3 of different solvents which include cold water, hot water, 1.0M dilute tetraoxosulphate (IV) acid, 1.0M dilute hydrochloric acid, concentrated tetraoxosulphate (IV) acid, concentrated hydrochloric acid, 1% sodium hydroxide, ether and ethanol was added separately to each flask. The mixture was allowed to stand for two hours and later boiled gently in a fume cupboard for one hour, to determine their solubility properties.

The Thermal and physical characteristics:

Three oven dry splints of the sample were separately used for the determination of some thermal parameters which includes: afterglow time, flame duration, flame propagation rate and ignition time. Qven dry density, moisture content, water imbibitions and electrical conductivity were separately determined using three 2.5cm cubes of the sample while the sample powder was used for the determination of ash content, thermal conductivity, elemental contents, specific gravity, charring temperature and destructive distillation of the wood sample. All were variously deterrmined using American Society for testing and material (ASTM) methods [6],[7]. At the end of the each analysis, the average obtained values from the three samples were recorded as results.

The Phytochemical Compounds:

The following phytocompounds; resins, steroids, terpenoids, tanins, alkaloids, saponin, flavonoids, glycosides, phlobatannins, carbohydrate and protein were qualitatively and quantitatively determined by the methods outlined by Harbone[8].

The hydrogen ion concentration (PH) was determine by the method outlined by Amadi *et al.*[9] using electrical PH meter PHS-25 made by Life Care England.

The microelement composition: this was analysed using atomic absorption spectrophotometer (AAS) model PG 990 manufactured by PG instrument Ltd U.S.A.

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, Vansoest, Oakley and Marzieh[10],[11] and [12]

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

RESULTS AND DISCUSSION

The results of the solubility, physical, thermal investigations and the analysis of the active constituents present in the timber extract of *Protea elliottii* were represented in tables 1- 8.

Table 1: The Solubility Characteristics of *Protea elliotti*

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

The solubility determination result (Table 1) indicated that *Protea elliottii* powder completely dissolved only in the presence of concentrated tetraoxosulphate (vi) acid at high temperature. Therefore, the sample is resistant to polar, organic and corrosive substances except highly corrosive hot acid. This is in line with [13] who stated that chemicals are able to extract some extraneous materials in wood, yet woods are highly resistant to them and as such cannot be degraded by the chemicals.

Table 2: Results of the thermal and physical characteristics of *Protea elliotti*

Parameters	Units	Results
Afterglow time	Sec	290.67
Flame duration	Sec	14.67
Flame propagation rate	$cm.s^{-1}$	29×10^{-2}
Ignition time	Sec	3
Over dry density	$g.cm^{-3}$	19.9×10^{-2}
Moisture content	%	16.21
30 mins Water imbibitions	%	136.6
5 hrs Water imbibitions	%	198.4
24 hrs Water imbibitions	%	253.3
Ash Content	%	3.22
Thermal conductivity	Umoh/cm	48.65×10^{2}
Electrical Conductivity	Sm^{-1}	6.5×10^{-3}
Specific Gravity		0.29
Porosity Index	%	1.26
PH		6.5
Charring Temperature	°C	65 – 90
Colour		Cornsilk

Thermal and physical characteristics analysis carried out on the wood of *Protea elliottii* with its result stated in Table 2, showed that it had low flame duration value of 14.67seconds which indicated that it could not sustain combustion. Afterglow time value (290.67seconds) of more than four minutes showed that it would glow long enough for rekindle to take place as a result could be hazardous in fire situations. Water imbibitions at 30 mins, 5 hrs and 24 hrs intervals with respective values of 136.6%, 198.4% and 253.3% showed the capacity of *Protea elliottii* wood to absorb water over a period of time [13]. The oven dry density and ash content values are in line with the ascertain of [13],which stated that denser and small ash content timbers are suitable in their use as a source of carbondioxide for internal combustion engine. One can deduce from the results that *Protea elliottii* is a hardwood that will be suitable for various constructions and other purposes.

Table 3: Results of Phytochemical Analysis

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

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

Table 3 showed the result of the phytochemical analysis which ascertained the presence of all the tested secondary metabolites; flavonoids, alkaloids, saponin, protein, resins, tannin, steroids, terpenoids, glycosides and carbohydrate. The medicinal values of medicinal plants lie on these phytocompounds which produce definite physicological actions in human body. Tanins are anti-inflammatory, control gastritics and irritating bowel disorders, they also contribute to antimicrobial power which heals wounds and stop bleeding[14]. Flavonoids exhibit an anti-inflammatory, anti-allergic effects, analgesic and anti-oxidant properties[15]. Steroids are used in medicine for treatment of diseases. Terpenoids are associated with anti-cancer and also play a role in traditional and alternative medicine such as aromatherapy, antibacterial and other pharmaceutical functions. 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 [15]. Saponin has been found to be anti carcinogenic, cholesterol reducer and anti-inflammatory substance. The presence of alkaloids showed that it can be used as antimycotics and also in the treatment of stomach pains,[16].

Table 4: Trace element composition %

Trace element	Result (%)
Sodium	2.29
Lead	0.14
Potassium	0.13
Arsenic	0.12
Zinc	0.06
Mercury	0.02
Calcium	0.01
Magnesium	0.005
Copper	0.006
Cadmium	Nil

From the Atomic Absorption Spectrophometric analysis results (Table 4) it indicated the presence of sodium, potassium, calcium, magnesium, copper and zinc which are beneficial to healthy adults at normal intake levels. Sodium and potassium play important role in maintenance of osmotic, electrolytic balance and proper rhythm of clothing.[17] calcium which is important constituent of skeleton and bones, Magnesium is for signaling the nervous system and also participates in osmotic and electrolyte balance but can cause genetic disorder.[18] Copper is also involved in body enzymatic activities while zinc is required for growth, sexual development, wound healing infection, sense of taste and night vision in human.[14],[19] Lead, mercury and arsenic were also present while cadmium was absent.

Table 5: Quantitative Chemical Constituents of *Protea elliotti*

Chemical Constituents	Units	Results
Lignins	%	22.0
Hemicellulose	%	28.0
Cellulose	%	40.0
Crude Fibre	%	5.0
Crude Protein	%	4.66
Carbohydrate	Mg/g	1.59
Phenol	Mg/g	3.14
Tannin	Mg/100g	1030
Alkaloids	%	7.6
Flavonoids	%	5.4
Saponins	%	1.6
Oxalate	g/100g	1.31
Total Acidity	g/100cm^3	0.44
Cyanogenic Glycoside	Mg/100g	810
Lipid	%	0.4
Wood Charcoal	(g)	4.0
Pyroligneous acid	cm^3	1.75
Wood tar	cm^3	0.1
Wood gas	cm^3	810

Quantitative Chemical Constituents examination of *Protea elliottii* showed that the sample contained 22% of lignin, 40% of cellulose, 28% 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. It contributes 25-35% of hardwood dry weight [20][,21][,22],[23] The destructive distillation of *Protea elliottii* gave rise to four products in the following compositions; wood charcoal (4.0g), pyroligneous acid (1.75cm^3), wood tar (0.1cm^3) and wood gas (810 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°C, the chemical bonds begin to break and are manifested as carbohydrate. Hemicellulose and lignin components are pyrolyzed in the temperature ranges of 200°C - 300°C and 225°C - 450°C 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°C - 450°C, significant depolymerization of cellulose begins from 300°C - 350°C. Also around 300°C aliphatic side chains starts splitting off from aromatic rings in the lignin. The carbon-carbon linkage between lignin structural units is cleaved from 370°C - 400°C [24],[25]

Table 6: Thin layer chromatographic characteristics of *Protea elliotti* chloroform-methanol extracts.

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

Tables 7: Results of Fourier Transformed Infrared and Ultraviolet spectra of Chloroform –methanol 1st spot extract.

Wave number (cm^{-1})	Suspected chromophores
3410.26	O-H stretch for alcohols, phenols and carboxylic acid
2972.40	C-H stretch for alkanes and aromatics
2848.96	C-H stretch for alkanes
2509.47	C=N stretch for nitriles
2117.91	C=N stretch for nitriles
1647.26	C = O stretch for ketones, carboxylic acid, amides & esters
1448.59	C=C stretch for alkene and aromatic rings
1104.28	C–O stretch for alcohols, esters and carboxylic acids
1021.34	C–H deformation bonds for alkyl groups
UV λ_{max} 205, 213 and 275	Indicating highly conjugated trisubstituted aromatic compounds.

Table 8: Result of Fourier Transformed Infrared and Ultraviolet Spectra of Chloroform – methanol 2nd sport extract.

Wave number (cm^{-1})	Suspected chromophores
3414.08	O–H stretch for alcohols
2853.78	C–H stretch for alkanes
2514.30	C=N stretch for nitriles
2127.55	C=N stretch for nitriles
1644.37	C=O stretch for ketones, acid amides and esters
1406.15	C=C stretch for alkene and aromatics
1101.39	C–O stretch for alcohols, carboxylic acids and esters
1020.38	C–H deformation bonds for alkyl groups
UV λ_{max} 204, 214 and 276	Indicating highly conjugated 1,2,3 trisubstituted aromatic compounds. .

The thin layer chromatography of the chloroform-methanol extract (Table 6) discovered two components with R_f values of 0.6 and 0.5. The TLC results confirmed the presence of some components and its high purity.

The FTIR and UV spectra of the isolated compounds showed the observed bands as summarized in Tables 7 and 8. The O-H stretching band at 3431.48cm^{-1} is of alcohols, carboxylic acid and phenols. The C-H stretching at 2959.87cm^{-1}, 2951.19cm^{-1}, 2847.99cm^{-1} and 2840cm^{-1} corresponds to that of an aliphatic C-H. The C=N absorption peak for nitriles appeared at 2517.19cm^{-1} and 2166.13cm^{-1}. The C=O stretching bands at 1652.09cm^{-1} and 1653.05cm^{-1} are that of ketones, acid amides, esters and carboxylic acids. The C-O absorption peak for alcohols, esters and carboxylic acids appeared at 1105.56cm^{-1} and 1113.93cm^{-1} while the C-H deformation bonds for alkyl groups occurred at 1022.31cm^{-1} and 1023.27cm^{-1}. 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.

CONCLUSION

The study had shown that *Protea elliottii* contained some components that could made it useful in animal feed formulation and as well a good material for various construction works though could be hazardous in fire situations. The UV and FTIR spectra showed that it contains some bioactive compounds. The presence of all the analysed secondary metabolites showed that *Protea elliottii* could be used in the cure and management of various diseases. Also, the complex chemical makeup of the timber showed the presence of cellulose, hemicelluloses, lignin and other components in the right proportion which confirmed that *Protea elliottii* is a hardwood and also very efficacious.

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