**Thermal and Therapeutic Characteristics of *Combretodendron marcrocapum* Wood**

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**ABSTRACT**

Wood is one of the most important natural and endlessly renewable sources of energy which also provide energy-sufficient material for our buildings and many other products. The thermal and therapeutic properties of *Combretodendron marcrocapum* wood were characterized in terms of chemical, physical, phytochemical, antimicrobial and functional groups present. Some obtained results from physical and thermal analysis were as follows; oven dry density 55.2 x 10-2g.cm-3, water imbibitions (at different intervals: 30 mins 20.1%, 5 hrs 31.3% & 24 hrs 56.3%), thermal conductivity 28.85 x 102 Umoh/cm, electrical conductivity 5.2 x 10-3 Sm-1, afterglow time 591Sec, flame duration 121.66Sec, flame propagation rate 11.9 x 10-2cm.S-1, ignition time 1.67Sec, moisture content 16.68% and ash content 1.91% showed that it is a good timber that could be suitable for various construction purposes. Phytochemical screening showed the presence of all the analysed secondary metabolites: saponins, tannins, steroids, flavonoids, carbohydrates, proteins, terpenoids, glycosides and alkaloids. The AAS of the sample showed the presence of some metals such as K, Na, Ca, Zn, Pb, As, Cu and Hg in the decreasing order of their concentrations. The Thin Layer Chromatographic analysis showed one spot for chloroform-methanol extracts and two spots for chloroform extracts with Retardation factor (Rf) values of 0.6, 0.7 and 0.5 respectively. It was further characterized using Fourier Transform Infrared and Ultraviolet Spectroscopic methods which suggested a 1,2,3- trisubstituted phenylamide with NH, CO and CN groups attached as the functional groups present. The results confirmed the effectiveness of the *Combretodendron marcrocapum* wood for various construction purposes and its medicinal ability due to the presence of all the analysed secondary metabolites. It could also be administered as theraphy for the cure of related diseases of the tested organisms.

**Key words:**, *Combretodendron marcrocapum,*Thermal, Therapeutic, Antimicrobial and Functional groups.

**INTRODUCTION**

**Wood** is a porous and fibrous structural tissue found in the [stems](https://en.wikipedia.org/wiki/Plant_stem) and roots of [trees](https://en.wikipedia.org/wiki/Tree) and other [woody plants](https://en.wikipedia.org/wiki/Woody_plant). It is an [organic material](https://en.wikipedia.org/wiki/Organic_material) with a natural [composite](https://en.wikipedia.org/wiki/Composite_material) of [cellulose](https://en.wikipedia.org/wiki/Cellulose) fibers that are strong in tension and embedded in a [matrix](https://en.wiktionary.org/wiki/matrix) of [lignin](https://en.wikipedia.org/wiki/Lignin) that resists compression. Wood is sometimes defined as only the secondary [xylem](https://en.wikipedia.org/wiki/Xylem) in the stems of trees (Hickey and King, 2001). It is also defined more broadly to include the same type of tissue elsewhere such as in the roots of trees or shrubs. In a living tree it performs a support function, enabling woody plants to grow large or to stand up by themselves. It also conveys water and [nutrients](https://en.wikipedia.org/wiki/Nutrient) between the [leaves](https://en.wikipedia.org/wiki/Leaf), other growing tissues, and the roots. Wood may also refer to other plant materials with comparable properties, and to material engineered from wood, or wood chips or fiber (Desch and Dinwoodie, 1981).

*Combretodendron marcrocapum* is a plant that belongs to *Lecythidaceae* family. In Nigeria, its Igbo name is akpudele, awori in yoruba and kurya in Hausa (Arbonnier, 2004; Udeozo *et al*., 2011).It is a hardwood with its heartwood reddish to dark brown, sometimes with darker streaks; sapwood yellowish white, clearly demarcated texture fine to moderately coarse, grain varying from straight to interlocked when freshly cut, the wood has a rotten cabbage odour that disappears on drying. (Desch and Dinwoodie, 1981). *Combretodendron marcrocapum* tree is up to 120ft or more in height, bore straight and cylindrical, sometimes shallowly fluted, 60 to 80ft long unbutteressed but flared at the base, trunk diameters 2.5 to 5ft (Desch and Dinwoodie, 1981; Arbonnier, 2004).

There is rarity of information on *Combretodendron marcrocapum* as a result, some thermal and variable properties, phytochemical, functional group and anti microbial assay of the wood were investigated.

**MATERIALS AND METHODS**

**Sample collection and Identification**

The analysed wood sample used for this work was collected from timber shed at Udi in Udi Local Government Area of Enugu State, the southern part of Nigeria. It was identified by timber dealer, forest officer and confirmed by literature (Keay *et al*., 1981).

**Sample preparation:** The wood was cut in a saw mill into two different shapes and sizes which includes 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°C for 24 hours before the experiments. The sample was also ground to fine powder and stored in a clean dry covered plastic container ready for the analysis.

**Methods**

**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 methods (ASTM, 1998 and ASTM, 1999). At the end of the each analysis, the average obtained values from the three samples were recorded as results.

**Micro element composition:** In determining of the trace metal elements, Atomic Absorption Spectrophotometer model PG 990 manufactured by PG instrument Ltd U.S.A. was used.

**The Phytochemical Compounds:** resins, steroids / terpenoids, tanin, alkaloids, saponin, flavonoids, carbohydrate and protein were qualitatively determined by the method outlined by Harbone (Harbon, 1998).

**The Functional Group Analysis:** The TLC, Fourier Transform Infrared and Ultraviolet Spectroscopic methods were used for the determination of functional group present in the sample using the sample chloroform and chloroform-methanol extracts.

**Test microorganisms**

Pure isolates of *Candida albicans, Staphylococcus aureus* and *Escherichia coli* were obtained from FEZ Laboratory Onitsha, Anambra State, Nigeria.

**Antimicrobial Activity**

The antimicrobial activity of different concentrations of the methanol extracts were determined by modified agar-well diffusion method (Bauer *et al*., 1996; Perez *et al*., 1990)

**RESULTS AND DISCUSSION**

The results of the physical, thermal, elemental, active constituents investigations and the analysis of the antimicrobial activity of wood methanol extract of *Combretodendron marcrocapum*  are given in tables 1- 9.

**Table 1: Results of the thermal and physical characteristics of *Combretodendron***

***marcrocapum* wood**

|  |  |  |
| --- | --- | --- |
| **Characteristics** | **Units** | **Results** |
| Afterglow time | Sec | 591 |
| Flame duration | Sec | 121.66 |
| Flame propagation rate | cm.5-1 | 11.9 x 10-2 |
| Ignition time | Sec | 1.67 |
| Over dry density | g.cm-3 | 55.2 x 10-2 |
| Moisture content | % | 16.68 |
| 30 mins Water imbibitions | % | 20.1 |
| 5 hrs Water imbibitions | % | 31.3 |
| 24 hrs Water imbibitions | % | 56.3 |
| Ash Content | % | 1.91 |
| Thermal conductivity | Umoh/cm | 28.85 x 102 |
| Electrical Conductivity | Sm-1 | 5.2 x 10-3 |
| Colour |  | reddish to dark brown |

**Table 2: *Combretodendron marcrocapum* wood micro elemental composition %**

|  |  |
| --- | --- |
| Zinc | 0.12 |
| Lead | 0.12 |
| Cadmium | Nil |
| Copper | 0.008 |
| Sodium | 0.16 |
| Calcium | 0.14 |
| Magnesium | Nil |
| Potassium | 0.25 |
| Arsenic | 0.12 |
| Mercury | 0.008 |

**Table 3: Phytochemical composition of *Combretodendron marcrocapum* wood**

|  |  |
| --- | --- |
| **Class of phytocompounds** | **Inference** |
| Saponin | ++ |
| Flavonoids | ++ |
| Steroids | + |
| Terpenoids | + |
| Tannin | +++ |
| Alkaloids | ++ |
| Carbohydrate | + |
| Protein | ++ |
| Glycosides | + |

Key +++ ------- highly present

++ ------- moderately present

+ -------- slightly present

* ------- absent

**Table 4: Results of Thin layer chromatographic characteristics extracts of *Combretodendron marcrocapum* wood**

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

**Tables 5: Results of Fourier Transformed Infrared and Ultraviolet spectra for**

***Combretodendron marcrocapum* wood Chloroform 1st spot extract.**

|  |  |
| --- | --- |
| **Wave number (cm-1)** | **Suspected chromophores** |
| 3802.14 | N-H stretch of Aliphatic primary amine |
| 3367.53 | O-H stretch for alcohols, phenols and carboxylic acid |
| 2929.47 | C-H stretch for alkanes and aromatics |
| 2209.57 | C=N stretch for nitriles |
| 1721.42 | C = O stretch for ketones, carboxylic acid, amides & esters |
| 1458.26 | C=C stretch for alkene and aromatic rings |
| 1123.21  837.48 | C–O stretch for alcohols, esters and carboxylic acids  C–H deformation bonds for alkyl groups |
| UV max 217.50 and 275.50 | Indicating highly conjugated aromatic amide.. |

**Table 6: Result of Fourier Transformed Infrared and Ultraviolet Spectra of**

**Chloroform 2nd sport extract.**

|  |  |
| --- | --- |
| **Wave number (cm-1)** | **Suspected chromophores** |
| 3422.74 | O–H stretch for phenols and alcohols |
| 2852.23 | C–H stretch for alkanes |
| 2146.26 | C=N stretch for nitriles |
| 1658.05  1432.95 | C = O stretch for ketones, carboxylic acid, amides & esters  C=C stretch for alkene and aromatics |
| 1122.26 | C–O stretch for alcohols, esters and carboxylic acids |
| 789.24 | C–H deformation bonds for alkyl groups |
| UV max 329.00 and 405.00 | Indicating highly conjugated aromatic amide |

**Table 7: Result of Fourier Transformed Infrared and Ultraviolet Spectra for**

***Combretodendron marcrocapum* wood Chloroform–methanol extract.**

|  |  |
| --- | --- |
| **Wave number (cm-1)** | **Suspected chromophores** |
| 3862.18 | N-H stretch for primary amine |
| 3409.35 | O–H stretch for phenols and alcohols |
| 2983.95 | C – H stretch for alkanes and aromatics |
| 2158.87 | C = N stretch for nitriles |
| 1644.26 | C = O stretch for Carboxylic acid, amides & esters |
| 1426.76 | C = C stretch for alkenes and aromatics |
| 1104.28 | C – O stretch for esters |
| 940.64 | C – H deformation bond for alkyl and methyl groups |
| UV max 249.50 and 558.50 | Indicating highly conjugated trisubstituted aromatic compound. |

**Table 8: Results of Anti-microbial Screening of Methanol extracts of *Combretodendron***

***marcrocapum* wood**

|  |  |
| --- | --- |
| **Test organism** | **Zone of Inhibition (mm)** |

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*Candida albicans*  18

*Staphylococcus aureus*  13

*Escherichia coli*, **15**

Thermal characteristics analysis carried out on the wood of *Combretodendron marcrocapum* Table 1) showed that it had low flame duration value of 121.66 seconds which indicated that it is highly flammable. Afterglow time value of 591.33seconds is above 300 seconds as a result, the wood can glow for a long time which might cause rekindle to take place as a result would be hazardous in fire situations. Water imbibitions at 30 mins, 5 hrs and 24 hrs intervals with respective values of 20.1%, 31.3% and 56.3% showed the capacity of *Combretodendron marcrocapum* wood to absorb water over a period of time (Udeozo *et al*., 2014). Its flame propagation rate and ignition time values indicated that it can be highly flammable. The result also showed a low moisture content value of 16.68% which is in-line with Arntzen 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 (Arntzen, 1994). The oven dry density and ash content values are in line with the ascertain of Desch and Dinwoodie which stated that dense and small ash content timbers are suitable in their use as a source of carbondioxide for internal combustion engine (Desch and Dinwoodie, 1981). The result indicated that *Combretodendron marcrocapum* is a hardwood that will be very good for construction and other purposes, though highly flammable and hazardous in fire situation.

The results of the Atomic Absorption Spectrophometric analysis of the *Combretodendron marcrocapum* wood sample presented in Table 2 showed that it contained some essential minerals; potassium, sodium, calcium, copper and zinc which are of great importance because they are beneficial to healthy adults at normal intake levels and in the formulation of animal feeds. Sodium and potassium play important role in maintenance of osmotic, electrolytic balance and proper rhythm of clothing. Calcium is an important constituent of skeleton and bones (Tahir *et al*., 1999). 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 (Maret and Sandstead, 2006). Lead, arsenic and mercury were also present while magnesium and cadmium were absent.

The result of the phytochemical analysis depicted in Table 3 revealed the presence of all the tested secondary metabolites which includes; saponin, flavonoids, steroids, terpenoids, tannin, alkaloids, protein, glycosides and carbohydrate. 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. Flavonoids exhibit an anti-inflammatory, anti-allergic effects, analgesic and anti-oxidant properties (Dunguid *et al*., 1999). 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. Tanins are anti-inflammatory, control gastritics and irritating bowel disorders, they also contribute to antimicrobial power which heals wounds and stop bleeding (Gills, 1992). The presence of alkaloids showed that it can be used as antimycotics and also in the treatment of stomach pains (Akpuaka, 2009). The carbohydrate content of the sample extract showed that it is a good source of energy. Protein indicated high nutritional value of the extract, therefore can help in physical and mental growth and development (Dunguid *et al*., 1999).

The thin layer chromatography of the chloroform and chloroform-methanol extracts pointed out in Table 4 showed three components with Rf values of 0.7, 0.5 and 0.6. The TLC results confirmed the presence of some components and its high purity.

Considering the FTIR and UV spectra of the isolated compounds, the bands observed are summarized in Tables 5-7. The O-H stretching bands at 3367.53cm-1, 3422.74cm-1and 3409.35cm-1 are of alcohols, carboxylic acid and phenols. The O-H can be said to be associated. The C-H stretching at 2929.47cm-1, 2852.23cm-1, and 2983.95cm-1 corresponds to that of an aliphatic C-H. The C=N absorption peak for nitriles appeared at 2209.57cm-1, 2146.26cm-1  and 2158.87cm-1. The C=O stretching bands at 1721.42cm-1, 1658.05cm-1  and 1644.26cm-1 are that of ketones, acid amides, esters and carboxylic acids. The C-O absorption peak for alcohols, esters and carboxylic acids appeared at 1123.21cm-1, 1112.26cm-1 and 1104.28cm-1 while the C-H deformation bonds for alkyl groups occurred at 837.48cm-1,789.48cm-1 and 940.64cm-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.

The results of the antimicrobial studies (Table 8) revealed that the methanol extracts of *Combretodendron marcrocapum* wood exhibited potent activities against all the tested pathogenic bacteria and fungi. The zones of inhibitions of the extracts are 13mm, 15mm and 18mm for *Staphylococcus aureus, Escherichia* *coli* and *Candida albicans* respectively.

**CONCLUSION**

From the findings of this study, the results of thermal and variable characteristics, phytochemical and AAS analysis of *Combretodendron marcrocapum* woodhad shown that it contained some components that could made it useful in animal feed formulation, good material for various construction works and as well as some components of medicinal value. The UV and FTIR spectra showed that it contains some bioactive compounds. The wood methanol extract exhibited antibacterial effects on *Staphylococcus aureus, Escherichia coli* and anti fungal effect on *Candida albicans*. The results showed that *Combretodendron marcrocapum* woodhas a very high medicinal value that could be administered as theraphy for the cure of diseases of the tested organisms.

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