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Use of Wood Characters in the Identification of Selected Timber Species in Nigeria

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Abstract

Ten popular timber species belonging to seven families in Nigeria were identified in the Herbarium. Wood samples of each species were studied anatomically in search of stable taxonomic micromorphological attributes. Characters of the treachery elements, in particular, the vessel; fibre and ray structure; intercellular canal and phloem parenchyma are diagnostic among the species. The invariable presence of non-septate fibres in *Afzelia africana* (Sm.) and *Milicia excelsa* (Welsh. and C. C. Berg.) delimits them from other woods which all posses septate fibres. Occurrence of tyloses in the metaxylem of *Cordia millenii* (Bak.), *Antiaris toxicaria* (Lesch.), *Tectona grandis* (L. F.), *Terminalia ivorensis* (A. Chev.) and *Triplochiton scleroxylon* (K. Schum.) separates them from *Anogeissus leiocarpus (*Guill. and Perr.), *Khaya ivorensis* (A. Chev.) and *Mansonia altissima* (A. Chev.). A detailed study of the wood structure of the commercial Nigerian timber species may provide an invaluable tool for determination, identification of fragments and thereby assisting in promoting quality assurance as well as detecting adulteration in wood trade and detecting camouflage and substitution of CITES-listed trees.

Keywords: timber, character, identification, fragment, CITIES-listed

Introduction

Nigerian forests shelter over 900 different species of trees (Keay *et al.,* 1964; Onochie and Stanfield, 1964). But only few of these are exploited economically on commercial scale. Most of the few that are exploited are large trees which are among the highly prized hardwood timbers of Tropical Africa and are well known all over the world. The IATA (1990) laid down the objective that tropical trees for export should come from sustainable sources.

For many purposes, the name "tree" is scientifically exact in that it serves to describe particular types of plant habit. For map-making however, it is customary to go a little further and distinguish certain types of trees; groups of trees may be differentiated into deciduous (broad leaved tree) and coniferous woods (narrow leaved trees).

The wood of some tree species, by reasons of its inherent properties, is of no value as timbers; others because of their scarcity or their inaccessibility are only of local economic importance as timber.

Jane (1967) recommended that the aspects of variation in wood structure are of practical importance in the industrial sense. He intended to draw the attention of wood anatomists engaged in wood quality study to look at the question of variability in wood structure. Wood anatomists in the field look at variation in three ways: the differences between species, genera and families; the variations observed within individuals of the same species and the variations occurring in the individual trees as they grow older, from the pith outwards and from the bottom upwards. The wood anatomists are concerned with wood quality and interested first of all in the general way in which structural features influence wood properties and processing and use characteristics. The ways in which the structural features of the particular species determine their properties and limit the uses and applications can be studied more precisely. The precise ways in which structural features and variations in those features are related to properties and end uses is an extensive and complicated knowledge that can be attained only very briefly here. Cell size and proportion and arrangement of the various types of elements and tissues, for example, tracheid, vessels, fibres, parenchyma and of early wood and late wood, vertical elements and ray tissues, determine the grain and figure. Cell diameter in relation to cell wall thickness and the proportion of thin walled to thick walled cells determine density which is closely correlated to mechanical strength, machining and working properties and yield in pulping. Usually, identification is a matter of experience and is made from the general appearance of wood, not as it is apparent to the inexperienced person, but as it is seen with the practiced eye, which always makes it possible to distinguish between superficially similar woods. Scientific diagnosis calls for a very sound knowledge of wood structure. The problem of species delimitation in processed wood samples has prompted this study, which intends to survey the anatomy of 10 popular

species distributed in seven families and representing the spectrum of timber diversity in West Africa.

Materials and methods

Wood samples of ten tree species were collected from saw-mills in the major timber-producing centres in Nigeria, namely Akure, Ibadan, Ondo and Benin/Sapele, all lying approximately within 5° 53′ and 34° 22′. Samples were first identified by saw-millers and standard reference texts (Panshin and Zeeuw, 1964; Hutchinson and Dalziel, 1958-72) and then were used to obtain corresponding botanical names in the Herbarium (IFE and FHI). A list of species used in the study is provided in Tab. 1. Herbaria abbreviations are according to Holmgren *et al.* (1990) and all scientific names are according to the FWTA (Hutchinson and Dalziel, 1958-72). While the visual sense is of greatest use, touch may sometime play a part in studying wood. The colour, texture and appearance of specimens were observed and feel to touch was used to determinate whether the wood grains are rough, smooth, dull, lustrous or glossy.

An assessment of the hardness of each specimen was obtained by pressure with the finger nails, using a tree-level arbitrary scale: woods hat are easily indented by finger nail-soft; wood not easily indented by finger nail-fairly hard; wood scarcely indented by finger nail-hard. For anatomical examination, wood samples were boiled in water and then cross-cut into 1×1 mm strip. Using the Reichert OME microtome, transverse sections (T.S), radial longitudinal section (R.L.S) and tangential longitudinal section (T.L.S) were obtained from the strip of wood of each species to 20-25 μm, stained in 1% safranin, 50% alcohol and 1% alcian blue, taken through alcohol series to 100% ethanol, cleared in histoclear and mounted in euparal. To improve transparency, colouring materials were removed by soaking sections in 5% NaOH for about 20 minutes and then transferred into aqueous sodium hypochlorite (NaOCl) for 24 hours after which they were rinsed in several changes of water. Descriptive terminology and measurements followed Carlquist (1961) and the International Association of Wood Anatomists (IAWA) List of Microscopic Features for Hardwood Identification (IAWA Committee, 1989). Slides were observed by microscope, equipped with calibrated ocular eye piece to enable the measuring of cell parameters to enable record of cell dimensions. Drawings were made of transverse and longitudinal sections as shown in Fig. 1-5.

Results

A list of the timber species is provided in Tab. 1. while Tab. 2. shows the dimensions of their woods. Important qualitative characters are listed in Tab. 3. Wood texture varied from soft, fairly hard to hard.

The grains of the all the ten woods studied vary from coarse or rough to smooth with lustrous or glossy surface. Four species, *Afzelia toxicana* var *africana*, *Cordia millenii*, of the 10 species studied, three possess hard texture, five fairly hard while two are soft. *Terminalia ivorense* and *Triplochyton scleroxylon* are coarse grained while *Antiaris toxicana, Khaya ivoremse, Mansonia altissima, Milicia excelsa* and *Tectona grandis* are smooth grained and lustrous. Fig. 1-5 provide illustrations of characteristic tissues of the timber species.

Tab. 1. List of commonly used timber species of Nigeria considered in the study

Name of species	Local common names	Wood characteristics	Family
Afzelia africana	Apa (Yoruba)	Hard, tough and heavy, coarsely grained with lighter streaks, banded light and dark brown. Diffuse porous, aliform paratracheal parenchyma	*Caesalpinaceae*
Anogeissus leiocarpus	Ayin	Grayish outside, dark brown at the heart and very hard. Wood is ring porous, surface crystals and traumatic ducts	*Combretaceae*
Antiaris toxicaria	Oro	Wood is ring porous tyloses, and septate fibres rous,	*Moraceae*
Cordia millenii	Omo	Wood white, wood coarse- grained, compound tyloses, fairly light and soft.	*Boraginaceae*
Khaya ivorensis	Oganwo	Wood of two bands of axial parenchyma, first class mahogany.	*Maliaceae*
Mansonia altissima	Ofun	Semi-ring porous wood, slash soft, dull white with brown streaks.Semi-ring porous wood, solitary vessels and storied fibres	*Sterculiaceae*
Milicia excelsa	Iroko	Huge compound tyloses present in all vessels, wood peel turns dark brown	*Moraceae*
Tectona grandis	Teak	Wood d with a dark golden yellow heart-wood, solitary vessels and storied fibres	*Verbenaceae*
Terminalia ivorensis	Idigbo	Wood is fairly coarse-grained aliform confluent paratracheal parenchyma	*Combratace*

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Tab. 2. Dimensions of tissues of the wood in ten timber species of Nigeria

Scientific name	Vessel diameter (μm)	Fibre length (μm)	Fibre diameter (μm)	Ray height (μm)	Number of cells/rays	Ray width (cell)
Afzelia africana	200-235	800-1300	100-130	250-330	25-36	2-3
Anogeissus leiocarpus	50-100	800-1650	100-150	100-150	10-16	1-3
Antiaris toxicaria	95-175	600-1300	100-120	200-280	42-49	2-4
Cordia millenii	200-230	900-1500	200-220	480-510	46-55	4-6
Khaya ivorensis	200-270	700-1200	160-200	240-550	42-80	4-5
Mansonia altissima	90-110	1000-1400	180-200	280-350	30-35	2-4
Milicia excelsa	100-190	600-1700	100-150	250-400	50-75	2-6
Tectona grandis	110-180	800-1200	180-200	350-500	30-34	2-5
Terminalia ivorensis	100-189	800-1600	100-180	350-450	26-30	2-3
Triplochiton scleroxylon	100-160	1100-1600	160-200	460-560	26-30	1-3
Test of significance of data means	Sig. diff. (P<0.05)	Ns	Sig. diff. (P< 0.05)	Ns	Sig. diff. (P<0.05)	Ns

The presence of surface crystals and traumatic ducts are characteristic of *Anogeissus leiocarpus* (Fig. 1 d-f); *Antiaris toxicana* var. *africana (*Fig. 2 d-f); is distinct from other woods in possessing tyloses, and septate fibres with simple pits; *Mansonia altissima* (Fig. 3 d-f) has characteristic sheath around the vessels and solitary crystals in the rays and *Milicia excelsea* (Fig. 4 a-c) has numerous tyloses in the vessels. Semi-ring porous wood, solitary vessels and storied fibres are characteristic of *Tectona grandis* (Fig. 4 d-f.), but in *Terminalia ivorensis* (Fig. 5 a-c); the occurrence of aliform confluent paratracheal parenchyma is a diagnostic feature. *Triplochyton scleroxylon* (Fig. 5 d-f) is known to possess porous wood and non-septate fibre. It is interesting to note that in general, there is agreement in the wood structure observed in this study with that reported by Metcalfe and Chalk (1950), especially the general family characteristics. The results of this study have shown the wealth of characters in the wood of the Nigerian timber species.

Statistical analysis has revealed significant differences among the species in vessel diameters, number of cells per

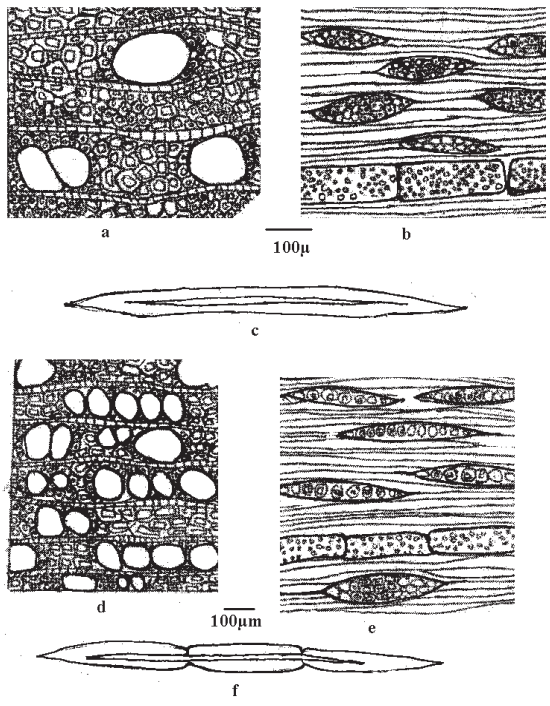

Fig. 1. a-f; a-c wood of *Afzelia africana*; d-f wood of *Anogeisus leiocarpus*

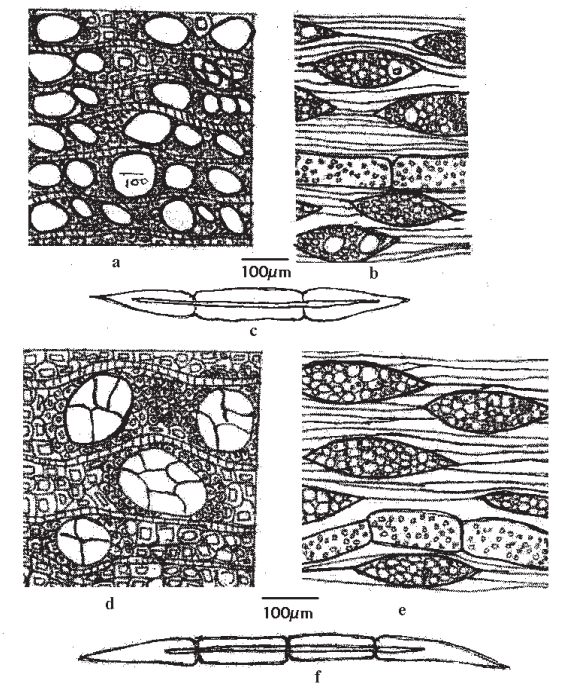

Fig. 2. a-f; a-c wood of *Anitiaris toxicana*; d-f wood of *Cordia millenii*

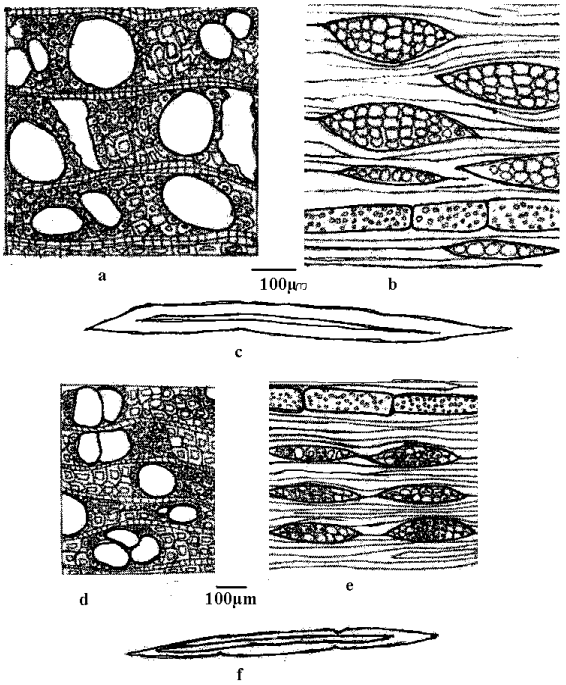

Fig. 3. a-f; a-c wood of *Khaya ivorensis*; d-f wood of *Mansonia altissima*

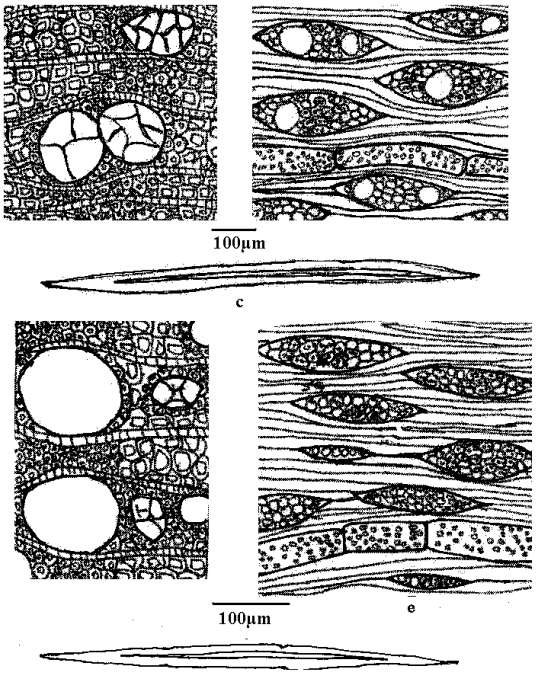

Fig. 4. a-f; a-c wood of *Milicia excelsa*; d-f wood of *Tectona grandis*

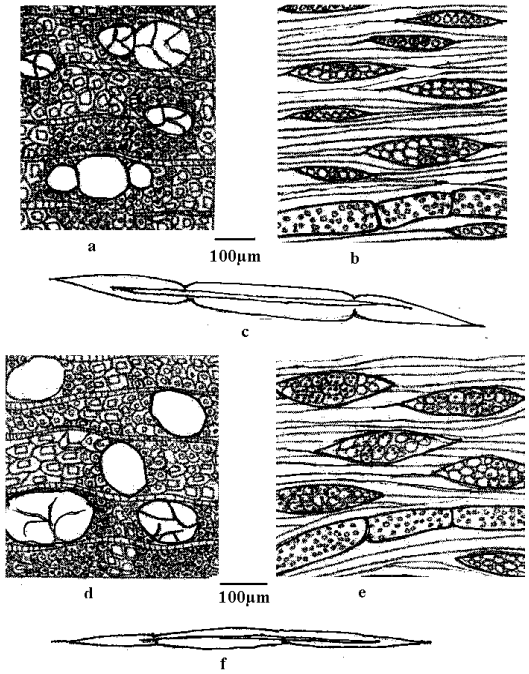

Fig. 5. a-f; a-c wood of *Terminalia ivorensis*; d-f wood of *Triplochyton scleroxylon*

ray bundle and diameter of fibres whereas ray heights, fibre lengths and ray widths are all not significantly different.

Khaya ivorensis had the largest vessel elements; *Milicia excelsa* had the longest fibres; *Cordia millenii*, *Khaya ivorensis*, *Mansonia altissima* and *Tectona grandis* havd fibre lengths ranging between 160 and 220 µm while for the other species the variation was between 100 and 180 µm. Ther were 10-36 ray cells bundle in *Annogeissus leiocarpus, Mansonia altissima, Tectona grandis, Terminalia ivorensis* and *Triplochyton scleroxylon*. The results of quantitative

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Tab. 3. Characters of the tissues of the woods of ten timber species of Nigeria

Botanical names	Character codes							
	1	2	3	4	5	6	7	8
Afzelia africana	+	-	-	+	-	-		-
Anogeissus lelocarpus	-	+	-	+	-	-	+	+
Antiaris toxicaria	-	+	-	-	-	-	+	-
Cordia millenii	+	+	+	-		+	-	-
Khaya ivorensis		+		-		+	-	-
Mansonia altissima	-	-	-	+	+	-	-	-
Milicia excelsa	+	-	+	-	-		-	-
Tectona grandis	-	+	+	+	-	+	-	-
Terminalia ivorensis	-	-	+	+	-	-	-	-
Triplochiton scletoxylon	+	-	+	+	-	-	-	-

Legend to character codes: 1 = vessels solitary, 2 = fibres septate, 3 = tyloses present, 4 = ray 10-36 cells, 5 = rays storied, 6 = axial parenchyma paratracheal, 7 = vessels dense, numerous, 8 = rays heterogenous.

analysis in Tab. 2. show that the species are distinct from each other and no two species share the same set of anatomical characters.

Discussion

At the moment, there is no method of identifying wood fragments apart from smell which is viable for fresh samples alone. The gross structure of the woods can provide potentially useful characters that could be employed to identify the Nigerian timber trees in both fresh and dry states, and even preserved and enquiry samples. While a lot of information is available on most families of trees in this area, information at both the generic and specific levels remains scanty. The woods may have a general pattern of tissue organization, arising from a common phylogeny, but in details of size, arrangement, content and number, they show clear differences.

Kerr and Bailey (1934) were the first who reported on the general anatomy of the genus *Afzelia* and our observations in this work are in agreement with previous studies. However, our study of *Afzelia africana* revealed the presence of dominant aliform paratracheal parenchyma forming a diamond shape. The light-brown colour of the wood and the coarse-grained, rough, hard wood texture (due to the non-storied fibre arrangement in the wood) are unique attributes (Armstrong, 1948). There is a lot of promise in the use of wood for timber identification in Nigeria, but for now, this cannot be achieved as the level of information remains scanty. No doubt, the information obtained from the wood structures could provide a credible alternative for identification of timber species, even after processing, in order to enhance the identification of commercial samples of timber and detect the wide spread practice of adulteration and substitution. By describing the stem wood anatomy of these 10 species, a path has been set in the Nigerian forestry knowledge towards filling the gap left by Metcalfe and Chalk (1950) as to the wood structure of the tree species. Valuable information may be also provided for archaeological samples by studying wood remains of the past historical settlements.

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