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Comparative Anatomy of Some Ficus Species

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Abstract The wood anatomy of seven species of *Ficus*: *F. ingens*, *F. exasperata*, *F. vallischoudae*, *F. vogelina*, *F. muccuso*, *F. elastica* and *F. indica* of Moraceae from Nigeria was investigated and described. Some interesting observations were made about the genus which distinguished the wood species under study from one another, such features include crystals and silica inclusions; sizes of rays, vessels and fibres. *F. elasitca* possessed narrowest rays and lacked any crystal inclusion. *F.ingens* had few fibres and possessed silica aggregates. Fibres were abundant in *F. vallischoudae* as observed at the transverse section. *F. exasperata* contained the smallest vessel size and its pores were more abundant than any of the other wood species under study, but fewer vessels were observed in *F. muccuso*, and *F. indica*. Septate fibres were observed in *F. vallischoudae* and *F. vogelina*. Rhomboidal crystals were observed in all the wood species except in *F. elasitca*, though they were rare in *F. vogelina* and *F.muccuso*. These anatomical features were therefore brought to the fore as possible taxonomic significance and diagnostic value. Photo micrographs prepared from three sections namely transverse section, tangential longitudinal section and radial longitudinal section were also presented in this study.

Keywords: *features, crystals, rays, fibres, species , vessels*

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1. Introduction

The features and characteristics of wood can vary between species and within the same species. Each wood species has unique cellular structure that creates differences in wood properties and ultimately determines the suitability for a particular use. Cellular characteristics provide a blueprint for accurate wood identification [1], and reliable wood identification usually requires the ability to recognize basic differences in cellular structure and wood anatomy. The structure and characteristics of wood can vary between species and within the same species. Generally Ficus species are of light to medium density, but other features such as vessels diameter, parenchyma cells, ray height, ray width, the proportion of fibres and vessels also vary among species. This is often true because the macroscopic properties of wood such as density, hardness, and bending strength, among others, are properties derived from the cells (e.g. fibre) of which wood is compose. Wood strength properties had once been linked with inherent factors such as density which is a good indicator of the various structural features as well as physical, mechanical and chemical properties of wood [2] which in turn is chiefly governed by the relationship between fibre cell wall and fibre cell cavity volume of seasoned wood [3]. This is because the macromolecular organization of the secondary wall of the cells from tree xylem is in large part responsible for the physiological properties of wood, and since woods of different species from the same genus often have different properties and perform differently under various conditions, serious problems can develop if species or a particular genus are mixed during the manufacturing process and in use. The genus under study is a huge genus of the family Moraceae in the order Urticales [4], and is readily distinguished by the highly characteristics fruits. Some Ficus grow as independent trees, but many start life as epiphytes with interlacing roots that grow into one another, eventually strangling their host and developing an irregular and contorted trunk [5]. There are over 800 species of tree in the Ficus genus of which 59 species have been reported in West Tropical Africa [6] while 41 have been identified in Nigeria [7]. While most of them are tree, others are vine or shrub. Popular as house plants, these trees can withstand a lot o pruning and can be shaped into much smaller sizes [8]. Young branches are used for making pipe stems. On the basis of anatomical features, previous studies indicated that the Ficus had a greater percentage of parenchyma cells when compared with Gmelina [9], though some species of Ficus could be fair alternative sources of wood for pulp and paper making, it suggests that some species of Ficus might pose a problem in paper pulp as excessive parenchyma cells may affect the strength of pulp sheets as well as cause 'fines' which results in slow machine drainage and effluent difficulties. The wood of Ficus species have been reportedly used for furniture, paper pulp, yokes, tent-poles, canoes, house posts, utensils, containers and drums [10]. This study

intends to look into anatomical properties of the genus in order to bring to the fore some 'intra-genus' differences in anatomical properties of some species of this genus.

2. Materials and Methods

Wood samples of *Ficus exasperata, F. vogeliana, F. mucuso, F. vallischoudae* and *F. indica* were collected from Forestry Research Institute of Nigeria, Ibadan. The woodsamples were later processed into 2cm x 2cm x 2cm cubes and mounted on a microtome sliding machine. Transverse, tangential and radial longitudinal sections were prepared from each wood species into 20 micrometers thick. Anatomical features were viewed using a hand lens and a light microscope at x 80 magnification Measurements of microscopic features such as the vessel mean tangential diameter (MTD) was done using a stage micrometer and an eye graticule. Anatomical descriptions are based on International Association Wood Anatomists (IAWA) codes.

Table 1. Information about the Ficus Species Collected

	Name of Species	Place of Collection	Collecto's Name and Date
1.	Ficus exasperate	FRIN Herbaratum, Ibadan Oyo state	Adeniyi Ifedayo, 13/4/2007
2.	F. vogeliana	Onigambari, Oyo state	Oluwaseyi Alao, 24/6/2010
3.	F. mucuso	FRIN	Olumide Durojaiye, 16/9/2009
4.	F. vallischoudae	FRIN	Aki Olumide , 16/11/2011
5.	F. indica	FRIN	Adeniyi Ifedayo, 11/8/2012
6.	F. elastica	FRIN	Oluwaseyi Alao 02/2/20013

FRIN = Forestry Research Institute of Nigeria

3. Results

3.1. *Ficus indica*

Ficus indica is synonymous to *Ficus benghalensis* L .The wood was light, brittle and of coarsed grain with a density of about 376.100kg/m^3 at 12% moisture content. Vessels :(5): diffuse, (9): pores were exclusively solitary, (Figure 1), 4/mm^2, oval and round, and (6): vessels were more of tangential arrangement; (79): axial parenchyma cells are vasicentric, both para tracheal and apotracheal were observed; banded (4-5 cell wide), localized aliform. grain was straight to wavy, (69): fibres were non septate and thin-walled. The wood fibre length and fibre diameter were 1.11mm and 17.08 µm respectively, while the lumen width and cell wall were 9.99 µm and 3.59 respectively. (98): rays were multiseriate of 2-5 cells wide (Figure 8) and heterogeneous type III were observed, (Figure 15) rhomboidal crystals were present in chambered cells and ordinary cells. Rays to vessel pits were minute and small. The wood is also suitable for furniture.

3.2. *Ficus vallischoudae*

The wood density was about 448.6kg/m^3. Pores were diffuse and often in pairs (Figure 2), 6/mm^2 and radial multiples; axial parenchyma cells were predominantly paratracheal, also apotracheal (banded, about 5-8 cells wide) and vasicentric; tyloses were abundant. (65): fibres were septate. The wood fibre length and fibre diameter were 0.99 mm and 21.7 µm respectively, while the lumen width and cell wall were 12.90 µm and 4.40 respectively. Grains were wavy. The rays were multi seriate of about 6-9 cells wide (Figure 9). (137): Rhomboidal crystals were observed in chambered cells. Rays were heterogeneous type III. Intervascular pitting was gash-like.

3.3. *Ficus ingens*

Pores were more of circular than oval, exclusively solitary (Figure 3), diffuse with scanty pore pairs, 4/mm^2, axial parenchyma cells were predominantly vasicentric and banded and slightly diagonal; rhomboidal crystals observed in ordinary and chambered cells; silica aggregates were observed; rays were 4-6 cells wide, and were both storied and in echelon (Figure 10), and heterogeneous types II and III. Fibres were non septate, the grains were straight to wavy, and thin-walled. The wood fibre length and fibre diameter were 1.18mm and 18.98 µm respectively, while the lumen width and cell wall were 10.57 µm and 3.39 respectively. Both intervascular and ray to vessels pits were large and round. Tyloses were observed while sheath cells were rare.

3.4. *Ficus vogelina*

The wood was red and of coarse texture with a density 427.2kg/m^3. The pores were diffuse and solitary (Figure 4), 5/mm^2 though some pore pairs were observed. Axial parenchyma were both paratracheal and apotracheal, vasicentric and banded of about 5-8 cells wide. The rays were predominantly multiseriate (Figure 11) of about 9-10 cells wide, heterogeneous type III. Fibres were septate and wavy. The wood fibre length and fibre diameter were 1.57 mm and 16.65µm respectively, while the lumen width and cell wall were 9.39 µm and 3.63 respectively. (110): Sheath cells were observed. Rhomboidal crystals were rare.

3.5. *Ficus muccuso*

The wood was about 348.44kg/m^3 in density. Vessels were round, solitary (Figure 5), 2/mm^2 and diffuse. Axial parenchyma were both para tracheal and apotracheal; banded, and about 5-7 cells wide, vasicentric, diffuse, and diffuse in aggregates; rays were multiseriate about 10 or more cells wide (Figure 12), and heterogeneous type III. Fibres were wavy to interlocked. The wood fibre length and fibre diameter were 1.29 mm and 18.49 µm respectively, while the lumen width and cell wall were 11.55 µm and 3.50 respectively. Intervascular pits were polygonal and slit-like. Rhomboidal crystals was rare; tyloses were present.

3.6. *Ficus exasperata*

The wood density was about 354.9kg/m^3.Vessels were predominantly solitarily and diffuse (Figure 6). 9/mm^2, pore pairs were observed; intervascular pits were minute and small. Rhomboidal crystals were found in chambered rays. Axial parenchyma cells were both Para tracheal and

apotracheal; vasicentric and banded (bands of 6-9 cells wide); rays were multiseriate, 8-10 cells wide (Figure 13), and heterogeneous type III. Fibres were non septate and wavy. The wood fibre length and fibre diameter were 1.26mm and 18.29 µm respectively, while the lumen width and cell wall were 10.37 µm and 3.96 respectively.

3.7. *Ficus elastica*

The wood density was about 311.6kg/m3. Vessels were predominantly solitarily and diffuse (Figure 7). 6/mm^2, pore pairs were observed; intervascular pits minute and small. Crystals not observed. Axial parenchyma cells were predominantly apotracheal; diffuse and diffuse in aggregates; rays were predominantly uniseriate and biseriate (Figure 14), heterogeneous type II. Fibres were non septate and wavy. The wood fibre length and fibre diameter were 1.28mm and 19.10 µm respectively, while the lumen width and cell wall were 10.04 µm and 4.53 respectively.

Figure 1. Transverse sections (TS) of Ficus species –*Ficus indica*

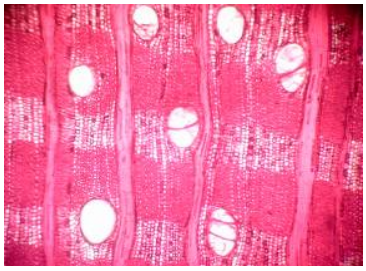

Figure 2. Transverse sections (TS) of Ficus species –*Ficus vallischoudae*

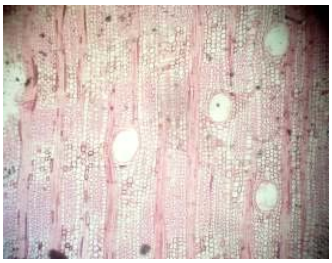

Figure 3. Transverse sections (TS) of Ficus species –*Ficus ingens*

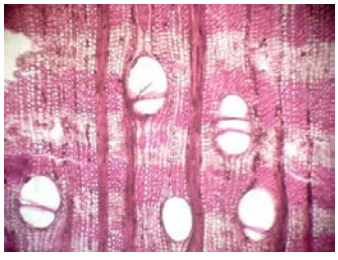

Figure 4. Transverse sections (TS) of Ficus species –*Ficus vogelina*

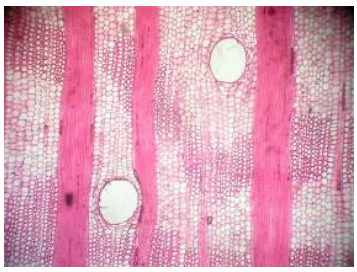

Figure 5. Transverse sections (TS) of Ficus species –*Ficus mucccuso*

Figure 6. Transverse sections (TS) of Ficus species –*Ficus exasperata*

Figure 7. Transverse sections (TS) of Ficus species –*Ficus elastica*

Figure 8. Tangential longitudinal sections (TLS) of Ficus species –*Ficus indica*

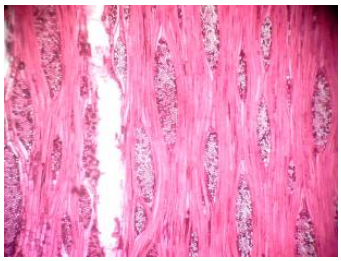

Figure 9. Tangential longitudinal sections (TLS) of Ficus species –*Ficus vallischoudae*

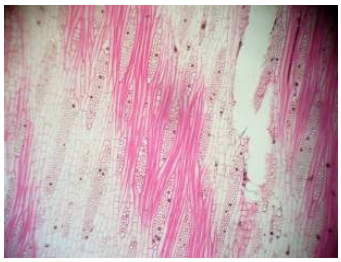

Figure 10. Tangential longitudinal sections (TLS) of Ficus species –*Ficus ingens*

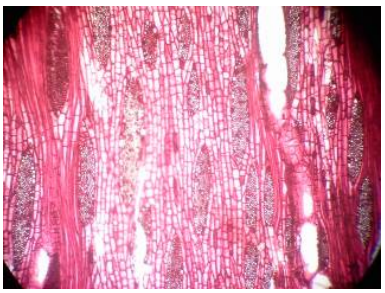

Figure 11. Tangential longitudinal sections (TLS) of Ficus species – *Ficus vogelina*

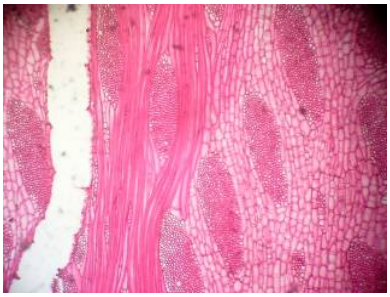

Figure 12. Tangential longitudinal sections (TLS) of Ficus species – *Ficus mucccuso*

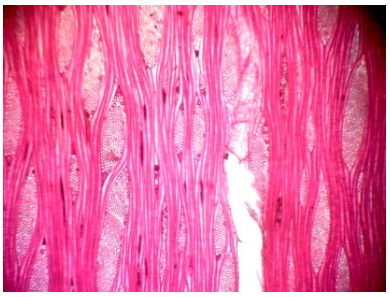

Figure 13. Tangential longitudinal sections (TLS) of Ficus species – *Ficus exasperata*

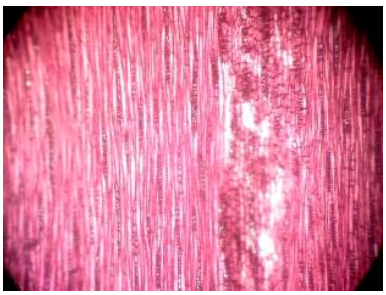

Figure 14. Tangential longitudinal sections (TLS) of Ficus species – *Ficus elastica*

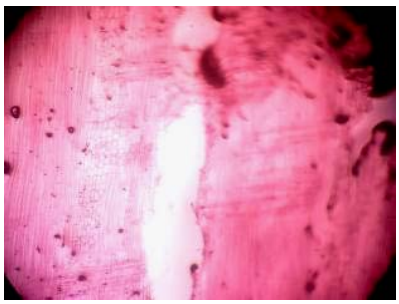

Figure 15. Radial longitudinal sections (RLS) of Ficus species –*Ficus indica*

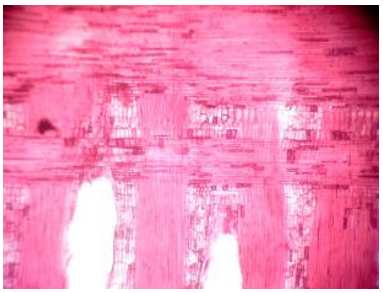

Figure 16. Radial longitudinal sections (RLS) of Ficus species –*Ficus vallischoudae*

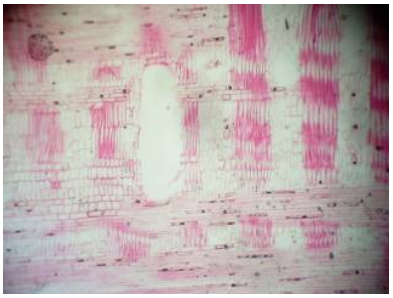

Figure 17. Radial longitudinal sections (RLS) of Ficus species –*Ficus ingens*

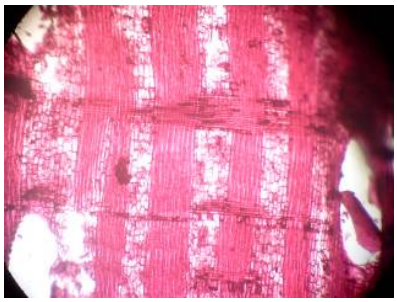

Figure 18. Radial longitudinal sections (RLS) of Ficus species –*Ficus vogelina*

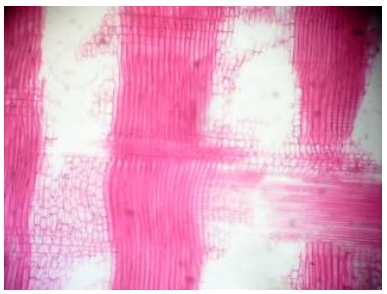

Figure 19. Radial longitudinal sections (RLS) of Ficus species –*Ficus mucccuso*

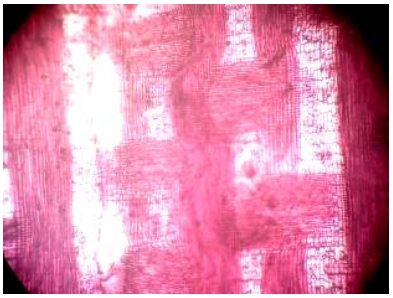

Figure 20. Radial longitudinal sections (RLS) of Ficus species –*Ficus exasperata*

Figure 21. Radial longitudinal sections (RLS) of Ficus species –*Ficus elastica*

4. Dicussion

On the basis of microscopic anatomy, this study shows that it is possible to select wood anatomical characters by which the species can be separated quite well. Ray size was widest in *F.muccuso* as observed at the transverse section, this also reflects at the tangential section; the rays in all specimens studied showed echelon arrangement. The narrowest rays were found in *F. elasitca.* Fibres seemed to be few in *F.ingens* but were abundant in *F. vallischoudae* as observed at the transverse section. This might explain the reason why the wood species (*F. vallischoudae*) was denser than most of the wood species under study. Pore pairs were more frequent in *F. vogelina* and *F. vallischoudae*. The vessels in *F. exasperata* were the smallest in size and were more abundant than any of the other species under study, while fewer vessels were observed in *F. muccuso*, and *F. indica*. Rhomboidal crystals were observed in all the wood species except in *F. elasitca*, though they were rare in *F. vogelina* and *F.muccuso.* Silica aggregates were observed only in *F.ingens*. Septate fibres were observed only in *F. vogelina* and *F. vallischoudae*.

5. Conclusion

The present study has brought to light some differential characters which can be profitably used for identification purposes. Within *Ficus* species under study, *F.muccuso* can be recognized on account of its wide rays; *F. elastica* on account of its narrow rays; *F. vallischoudae* on the basis of its fibres which were numerous; *F.ingens* on account of its aggregate silica; *F. elasitca* on the basis of its lack of crystal inclusions (perhaps rare) and *F. exasperata* on account of its numerous and small-sized vessels. However, an ultra structural study would be necessary to confirm the presence of other features which can be further used for identification of the wood species as the absence or presence, sizes and distribution of any identified features will go a long way to affect how each wood species behaves in service.

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