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Research Article

Variation in wood structure of six *Ficus species* in Sudan

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Abstract

The aim of this study was to investigate the anatomical structure wood of six species of the genus *Ficus*, which grown in Sudan, (*Ficu sycomorus, Ficus glumosa, Ficus capensis, Ficus nitida, Ficus benghalensis* and *Ficus benjamina*) and currently used for decorative purposes and shade. The stereological method was used for the quantitative description of cells wood. The study proved the great similarity in the anatomical structure of the wood among the species under study, *Ficus*. nitida has the largest diameter of the vessels, which differs significantly from the rest of the species except *Ficus sycomorus*. There are also significant differences between species on the fiber diameters, a horizontal mean free path between the vessel and the double cell walls thickness of the vessel and fiber, while there are no significant differences in the rest of the anatomical structures. From the results, the differences in wood anatomical can be used to determine the quality of wood for *Ficus* species grown in Sudan.

Keywords: *Ficus*; Anatomy; Wood Structure

Introduction

In different environmental conditions plants have developed anatomical strategies and adaptations to do certain functions. Thus, physiological processes can affect the structure of wood cells and so plant anatomy is essential to understand the processes of growth and cells structure [1].

Plant anatomy is also an important source for characters that differentiate species. Therefore, it is important to explain wood anatomy including its several ingredient cells types and their function. Moreover, comparative anatomy provides benefits to phylogenetic studies of ecological strategies, because it is possible to examine structural changes under different environmental pressures [2].

in the family Moraceae there are 850 species of genus Ficus. The Ficus trees are spread in the tropics and subtropics. Anatomical structure 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 [3].

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 fibers and vessels also vary among species [4].

Materials and Methods

An experiment was carried out in Forest products laboratory - Forest Research centre - Sudan.

Wood samples (mature wood) of 6 Ficus species trees (*Ficus sycomorus, Ficus glumosa, Ficus capensis, Ficus nitida*, *Ficus bengha-*

lensis and *Ficus benjamina*) were randomly selected from different areas. For a transverse section four specimens 1 × 1 × 2 cm were prepared from each sample. The specimens were softened and sectioned with sliding microtome. The sections were then stained with safranin and mounted in Canada balsam [5]. A microscope attached to a camera was used to examine the cross-sections of the wood samples.

Stereological counts were conducted following a procedure described elsewhere [6], using a 0.294 mm grid length under 10/0.25x magnification. The measurements of the cells structure involved random accounts on the transverse sections superimposed to nine squared on sixteen point grid. The glass slides were fixed on microscope fitted with a camera and the transveres sections were projected through the computer screen to obtain the point count (Pp), the number of points of intersection with cell boundaries per unit length of test lines (P L) and the number of cells in the count area of the microstructure (N A) for vessels, parenchyma, fibres and rays. For the general description of wood anatomy, stereological method was used to calculate average cell diameter vertical and horizontal (D v, h), average lumen diameter (LD), the mean free path between cells (MFP), vessel shape factor (VSF), fiber density index (FDI) and double cell wall thickness (DCWT) for vessel and fiber, Rankle's ratio and fiber hardness rate . The following equations were used

$D_{v,h}$ = $\underline{\text{PL v, h}}$ ……………………….1

2 NA

LD= ………………2

$MFP_{v,h}$ = $\underline{2(1\text{-Pp})}$ ……………………….3

P L v, h

$DCWT_{v,h}$ = $D_{v,h}$ - LD …………………4

VSF= $\underline{\text{D V radial}}$ ……………………….5

D V tangential

FDI= $\underline{\text{Pp w}}$ ……………………………….6

Pp l

Rankle's ratio= $\underline{\text{DCWT}}$ …………………7

LD

Fiber Hardness= $\underline{\text{DCWT}}$ ……………8

2 D

The statistical JMP program was used to analyze data.

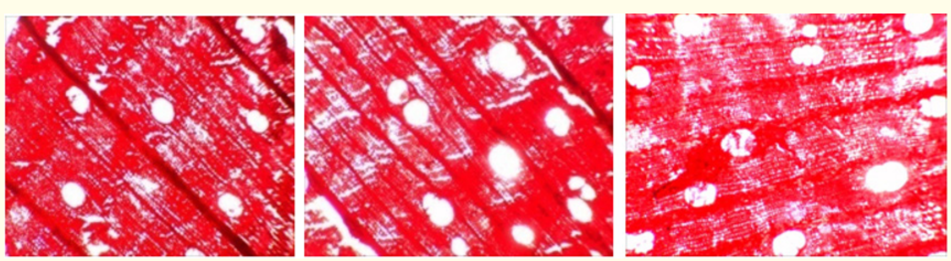

Figure 1: *Ficus capensis Ficus glumosa Ficus nitida.*

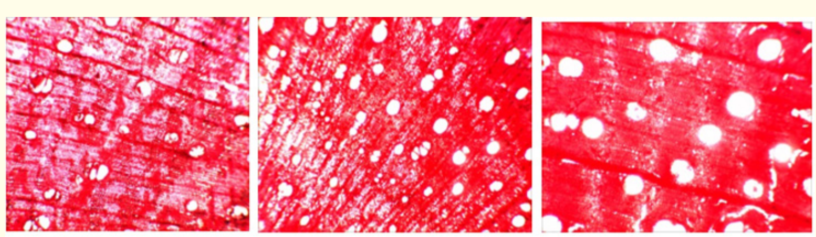

Figure 2: *Ficus benghalensis Ficus benjamina Ficus sycomorus.*

Results and Discussion

There were significant differences between all species on diameter (vertical and horizontal) of vessels, fibers, *Ficus* nitida have a biggest diameter of vessel and *Ficus glumosa* have a biggest diameter of fiber. The diameter of parenchyma was similar between all species. In addition there were no significant differences between the mean free path of vessels vertical or horizontal (Table 1).

Table 2 show that there were significant differences between double cell wall thickness (vertical and horizontal) of vessels and fibers, *Ficus nitida* have biggest value of double cell wall thickness vertical of vessels and *Ficus sycomorus* have a lowest value (0.51 and 0.11 respectively). *Ficus benghalensis* have a biggest value of double cell wall thickness horizontal of vessels and *Ficus sycomorus* have a lowest value (0.72 and 0.18 respectively). *Ficus glumosa* have a biggest value of double cell wall thickness (vertical and horizontal) of fibers. Furthermore there were no significant differences between the lumen diameter of vessels and fibers.

Species	DVv	DVh	DPv	DPh	DFv	DFh	MFPVv	MFPVh
F. glomosa	0.86 b	0.69 b	0.07 a	0.13 a	0.15 a	0.15 a	0.82 a	0.98 a
F. bengamina	0.71 b	0.78 b	0.09 a	0.11 a	0.07 b	0.09 b	0.22 a	0.24 b
F. bengalensis	0.72 b	1.39 a	0.11 a	0.12 a	0.06 b	0.08 b	0.63 a	0.36 b
F. capensis	0.73 b	0.92 ab	0.11 a	0.16 a	0.09 b	0.12 ab	0.58 a	0.47 ab
F. sycomorus	1.18 a	1.01 ab	0.11 a	0.14 a	0.05 b	0.12 ab	0.6 a	0.71 ab
F. netida,	1.44 a	1.12 ab	0.1 a	0.01 b	0.06 b	0.09 b	0.51 a	0.5 ab
P	0.03	0.21	0.58	0.51	0.01	0.09	0.57	0.17
SE±	0.17	0.2	0.02	0.02	0.02	0.02	0.22	0.2

Table 1: Diameter of different cells and mean free path of vessels (in micron) of *Ficus spp.*

Means fallowed by the same letter in columns are not significantly different using DMRT at P = 0.05.

Species	DCWTVv	DCWTVh	DCWTFv	DCWTFh	LDV	LDF
F. glomosa	0.3 ab	0.27 bc	0.1 a	0.09 a	0.9 a	0.06 a
F. bengamina	0.45 ab	0.53 ab	0.03 b	0.05 bc	0.25 b	0.04 a
F. bengalensis	0.27 ab	0.72 a	0.02 b	0.03 c	0.82 a	0.06 a
F. capensis	0.18 ab	0.22 bc	0.02 b	0.05bc	0.82 a	0.07 a
F. sycomorus	0.11 b	0.18 c	0.04 b	0.08 ab	1.13 a	0.08 a
F. netida,	0.51 a	0.25 bc	0.02 b	0.04 bc	0.92a	0.06 a
P	0.2	0.03	0.008	0.03	0.01	0.72
SE±	0.12	0.13	0.01	0.01	0.15	0.02

Table 2: Lumen diameter and double wall thickness of different cells (in micron) of *Ficus spp*.

Means fallowed by the same letter in columns are not significantly different using DMRT at P = 0.05.

Table 3 show that there were no significant differences between S F v and F D I with the exception of rankle's ratio and fiber hardness which were significantly different between them. [7] reported that there is a light differential characteristic of Ficus cells which can be profitably used for identification purpose. On the basis of anatomical features, previous studies indicated that the Ficus has a greater percentage of parenchyma cells when compared with Gmelina [8,9] reported that the quantitative anatomical characteristics of *Ficus spp* namely fiber length, fiber diameter, fiber cell wall thickness, vessel length, vessel diameter, ray height, ray width and wood density exhibited statistically significant differences among species. [10] reported that there were differences between quantitative anatomical the stem and branch wood of *Ficus carica L. sub sp. Carica,* these results are less similar with results of this study. In general, species native to colder habitats had narrower xylem conduits than those from warmer habitats. In parallel to these physiological and experimental findings, comparative wood anatomists found that some variable anatomical characters can be correlated to the local environment of the species (e.g., temperature, soil moisture) or its biogeographic range (e.g., latitude, elevation) as reviewed by [11,12], and more recently [13]. Because the earlier broad surveys used wood collections (xylaria), they could only relate wood anatomy to the limited habitat and location information recorded for each specimen (these limitations were stressed by [14].

Species	V S F	FDI	F Hardness	Rankle's ratio
F. glomosa	2.13 a	5.79 a	0.3 a	3.09 a
F. bengamina	1.09 a	7.08 a	0.27 ab	2.36 ab
F. bengalensis	2.6 a	3.22 a	0.17 ab	1.1 b
F. capensis	0.88 a	2.76 a	0.13 b	0.83 b
F. sycomorus	1.19 a	5.43 a	0.29 a	1.68 ab
F. netida,	1.34 a	5.35 a	0.19 ab	1.66 ab
P	0.75	0.52	0.12	0.06
SE±	0.92	1.76	0.05	0.52

Table 3: Vessel shape factor, fiber (density index, hardness) rankle's ratio (in micron) of *Ficus spp*.

Means fallowed by the same letter in columns are not significantly different using DMRT at P = 0.05.

Conclusion

From this study on wood anatomy of 6 Ficus species in Sudan indicates that their differences in wood anatomical structures which can be related in the species identification and quality of wood. Therefore, there is a great necessity to study the wood anatomical of trees and classify them for their suitability uses on the basis of wood anatomical structure.

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