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Research Article

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Morphological and anatomical studies of *Cordia abyssinica* R.Br. and *Cordia sinensis* Lam. (Boraginaceae) in Sudan.

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ABASTRACT

This study deals with the morphological and the anatomical features of the Cordia abyssinica R.Br. and Cordia sinensis Lam. (Boraginaceae) in Sudan. The morphology and leaf anatomy of these two species show considerable differences in their morphological characters and similarities on their transverse leaves sections. The diagnostic characters were; the alternate leaves, stems squared, presence of hairs, Inflorescence usually a panicle or raceme. C. abyssinica was small to medium-sized evergreen tree, where the C.sinensis was Small tree. The leaves of C.abyssinica were dark green color with large size, while C. sinensis have a light green with small size. The two species have sweetly flowers scented, sessile, hairy, compacted conspicuous panicles of scorpioid cymes; calyx tubular, wide at the throat; corolla white, funnel shaped; The C. sinensis had Flowers sweet scented, calyx glabrous. Fruit yellow; orange or bright red, mucilaginous and edible.

Key word: Morphological, Anatomical, Diagnostic characters.

INTRODUCTION

In this work, a morphological and anatomical study of *Cordia abyssinica* and *Cordia sinensis* (Boraginaceae) were studied. The study was aimed to provide valuable and reliable illustrated morphological and anatomical descriptions of these two species from the genus *Cordia* in Sudan. The investigated plants were selected for their great economically importance in Sudan as (Fuel, Medicine, Food and Fodder) [10]. The literature survey revealed that no anatomical studies were carried on this genus in Sudan or abroad. On other hand there are many taxonomical, phytochemical, studies on these plants. Enumeration of diagnostic features followed in this investigation will definitely lead to correctly identified species and adulterants can, therefore, be detected. In addition these anatomical characters will contribute positively to establish a Sudanese Herbal Pharmacopoeia.

Plant anatomy deals with the structure, contents and development of cells and tissues. It is of primary importance for all aspects of research in plant science such as morphogenesis, physiology, ecology, taxonomy, evolution, genetics, reproduction, ect. [2]. The systematic anatomy is mainly aimed towards relating structure particularly of vegetative organs to taxonomic classification of the plants in which the characters are exemplified. Application of systematic anatomy can also be extended to detection of adulterants and substitutes [3]. Taxonomically Boraginaceae is composed of about (21genera and 110 species) in the flora of Southern Africa, divided among six tribes [7]. The genus *Cordia* an estimated 350 species in pan tropical with about eight species occurring in Southern Africa [5].

In Sudan there are five species of this genus [6]. All members of *Cordia* have Flowers bisexual or unisexual, actinomorphic or sometimes zygomorphic. Calyx usually 5 lobed. Corolla 5-lobed. Stamens (or staminodes) as many as corolla lobes. Ovary superior, Entire or 4-lobed. Style 1, terminal or gynobasic. Fruit mostly consisting of 4 nutlets, less often 1 nutlet or a drupe [5].

Anatomical evidence can be employed in the identification of fragmentary material, which may often be economic importance, in the preliminary identification on the herbarium specimens. Also as an aid towards establishing the interrelationships of taxa at and above the species level. Below the species level other methods of attack are generally more rewarding [7]. Leaf epidermis and leaf cross-sectional anatomy provide extensive taxonomic data and the literature on this subject is now vast. Characters such as the differentiation of epidermal long-cells and short-cells and the form and distribution of silica bodies and various types of trichomes and papillae have played a big part in the modern re-classification of the family at all levels [1].

EXPERIMENTAL SECTION

Fresh specimens of the two species were collected from Khartoum River Nile bank and Shambat; Faculty of Forestry, University of Khartoum.

I. Morphological Study:

Each species is taxonomically described; their distributions, syno names and vernacular names were included. Photographs for species included using digital camera.

2. Anatomical Study:

Specimens were prepared by cutting the stem in 2 cm length and leaf in cm length, and fixed in formalin: glacial acetic acid: 70% (5:5:90%) for 6 days because F.A.A. is a killing solution of the protoplasm in addition it must retain or fix the undistorted structure and render the mass of material firm enough .Then the fixed parts of the plants were washed with distilled water and dehydrated by serial of ethyl alcohol (50% ,70%,90%and 100% respectively).The plant organs were transferred to mixture of 1:1 Cedar wood oil absolute ethyl alcohol and then in to pure cedar wood oil ,followed by a mixture of cedar wood oil and xylene ,and finally left over night in pure xylene.wax embed in was carried out in an oven adjusted at 60c where the plant organs were transferred from mixture of wax and xylene into pure wax, each change took about 20 minutes and finally into another container of pure wax. The melted wax containing the plant organs were poured into a mold cooled in water and trimmed.

The wax were stuck to the wooden blocks before sectioning with a rotary microtome (Lei12 1512-west Germany), adjusted at 10-20 microns for transverse sections of stems and leaves using a brush. The ribbons of sections were collected on glass slides and cover with egg albumin to keep attached to the slides.were left 15 minutes on a hot plate at temperature below 60 C^{o}, which is the milting point of embedding wax; to give maximum expansion of the tissue on to slides. Then the slides were left for an overnight to ensure complete dryness before staining, the staining required successive process of dewaxing, rehydration then staining and dehydration.

The processes were carried out by passing the slides through a series of coupling jars containing xylene, absolute ethanol 95%,90%,70%,50% ethanol, safranine stain, 50%, 70%, 50%,95%, absolute ethanol, fast green stain, xylene at them, a drop of D.P.X (mountant) was added to the slide before placing the cover slips [8].

The prepared slides were left to dry in an oven adjusted at 60^{o}c for the least three days, after that they were examined under the microscope (Azeiss microscope) at X4, X10, X50, X100 magnification. From each sample 3-5 sections were examined. Photomicrographs were taken by microscope equipped with a 35 mm automatic camera. The prepared slides were used to study and to compare different anatomical structure of stems and leaves.

Study of hairs and stomata:

The epidermal strips of desired lengths were removed from lower surface of the leaves by conventional method, these were fixed in 20% glycerine. The slides were examined under the light microscope at 10x and 40x.Various anatomical features,such as number and type of stomata ,length and width of stomata ,types of trichomes and their length and width were studied .The size of the stomata and hairs were recorded with the help of a calibrated eyepiece. Ten different observations were made for each species and their mean was calculated. The stomatal index

(S.I.) was calculated using the formula adopted from [4] as under: SI=X/X+Yx100 , where is X=Number of stomata per unit leaf area, Y=Number of epidermal

RESULTS

The two studied species were taxonomically described and their photographs were presented.

A. Taxonomical Description:
Cordia africana Lam., Tab.Encycl.1:420(1792). **Plate (1**).
Vernacular name: Gimbil, Azanaya, Tumbareib, Indrab (Arab). Sudan teak (English).
Syn: ***Cordia abyssinica*** R.Br.var.acutifolia A.Rich., Tent. FI.Abyss. 2:81 (1850).
Varronia abyssinica (R.Br) DC. &A.DC.,Prodr.9:469 (1845).
Cordia holstii Gurke.in P.O.A.C:335,t.41(1895).

Small to medium-sized evergreen tree, 4-15 m high, heavily branched with Spreading, umbrella-shaped or rounded crown. Bole typically curved or crooked. Bark grayish-brown to dark brown, smooth in young trees, but soon becoming Rough and longitudinally fissured with age; young branch lets with sparse long hairs. Leaves alternate, simple, ovate to sub circular, rounded to acuminate at the apex. Flowers sweetly scented, sessile, hairy, compacted conspicuous panicles of scorpioid cymes; calyx tubular, wide at the throat; corolla white, funnel shaped; stamens included; anthers blackening; ovary ovoid with sweet mucilaginous flesh.

Distribution: widely distributed in North and central Sudan.

(a)

(b)

Plate (1): (a&b) *Cordia africana* Lam.
Cordia sinensis Lam.,Tab.Encycl.1:423 (1792). **Plate (1.5).**
Syn***: C. reticulata.*** Roth; in Rome& Schultes, Syst. Veg.4:454 (1819).
C .rothii Rome & Schultes,Syst.Veg.4:798 (1819).
Vernacular name: Andrab (Arab) Indrab , Gimbil.

Small tree, 5-7m high, young stems ridged, young bark pale , smooth but later brownish grey or yellowish brown to almost black, branches glabrous. Leaves light green, oblong elliptic or oblanceolate, glabrous with longer hairs in nerve axils and along the midrib. Flowers sweet scented, calyx glabrous. Fruit yellow, orange or bright red, mucilaginous and edible.

Distribution: widely distributed in Northern and Central Sudan.

(a) (b) (c)

Plate (2): (a, b, c) *Cordia sinensis* Lam.

B. Anatomical results:

The epidermal cells are rectangular and show the presence of an external cuticular layer .The upper epidermal cells are somewhat larger than the lower. Unicellular epidermal trichomes have been noted on both surfaces.

Stomata are of anomocytic type and are distributed on the upper and lower epidermis of the leaves. Their frequency of distribution and the stomatal indices are presented in table (1).

Species	Nuumber of Epiderms cell in microscope felid	No of Stomata in microscope felid	Stomata index (mm)	Stomata length (mm)	Stomata width (mm)
C. abyssinica	0.06	0.042	242.86	0.025	0.013
C. sinensis	0.054	0.072	175.0	0.024	0.017

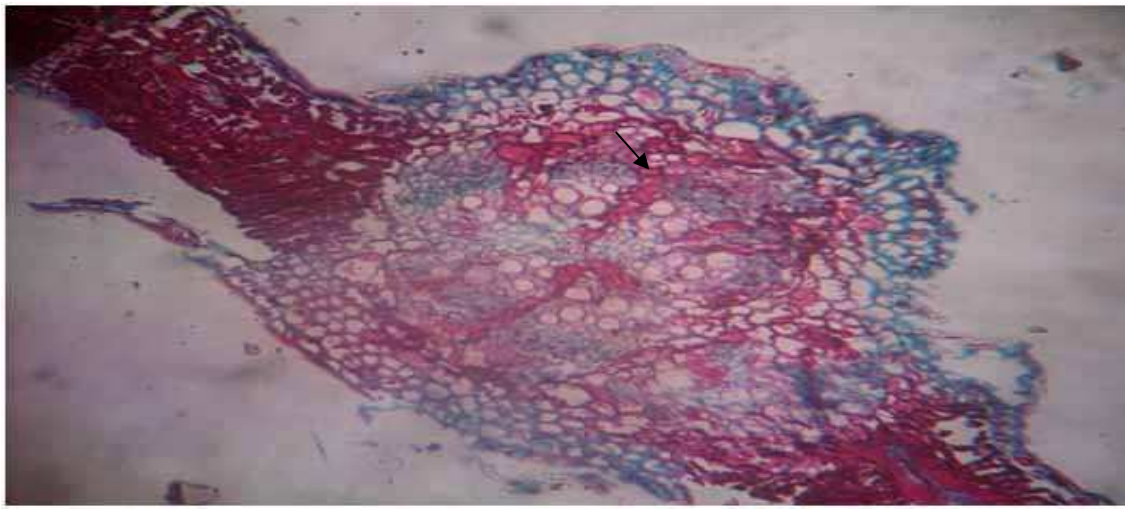

Plate (3): Transverse sections of *Cordia abyssinica* leaf showing main vascular bundle.

Plate (4): Transverse sections of *Cordia sinensis* leaf showing main vascular bundle.

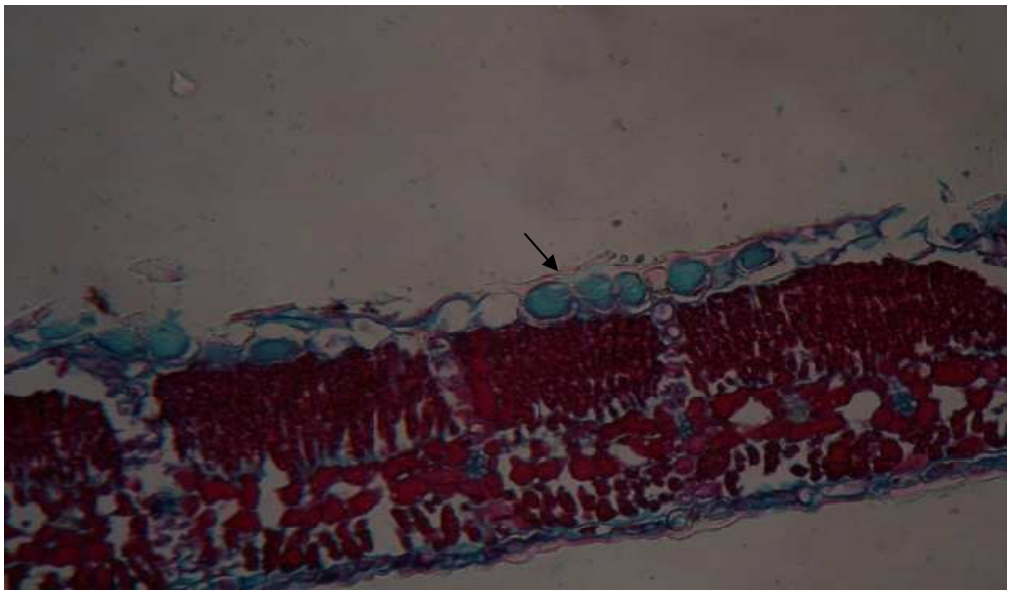

Plate (5): Cystolith of *C. abyssinica* on upper epidermis

Plate (6): Cystolith on upper epidermis of leaf of *C. sinensis*.

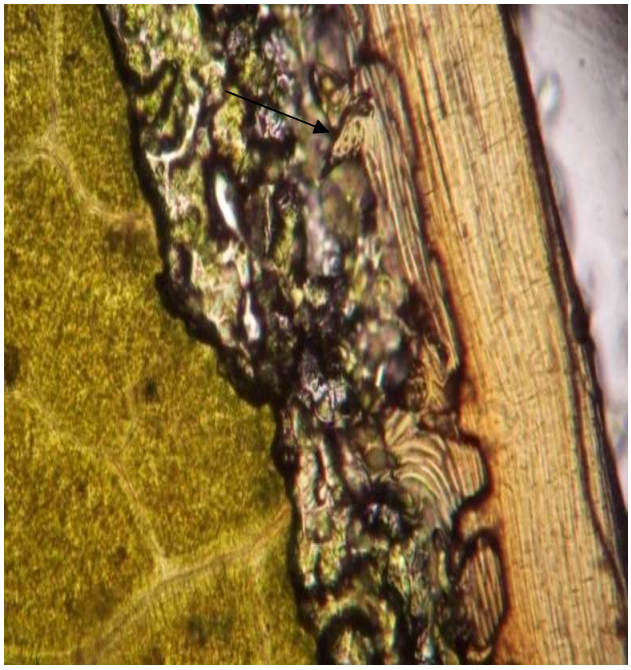

Plate (7): Hairs of *C. abyssinica*

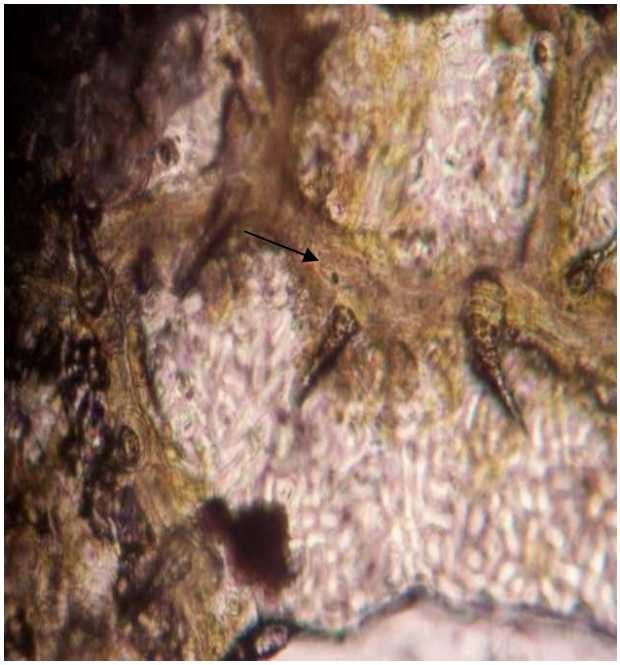

Plate (8). *Hairs of C. sinensis*

The mesophyll consist of palisad and spongy parenchymatous tissue. The presence of spongy parenchyma with large intercellular spaces is a common feature of two studied species. Two categories can be defined on the bases of presence of hairs and their two types unicellular and multicellular hairs, the two *Cordia* species have unicellular hairs. Palisade layers range from 2 to 4 in all studied species. The main vascular are five bundles. Cystoliths were present in upper epidermis of the species *Cordia abysinica and Cordia sinensis* Plate (5&6). Hairs restricted around the midrib only on the two species. The hairs without distinct basal cell and have scaly walls (plate 7&8).

DISCUSSION

From the study of all the morphological characters in this work it is clear that there are similarities and variations between the studied species. The two species have hairs *C. abyssinica* and *C. sinensis* have sparsely hairs; which is restricted around the midrib only. Cystolith were present in the two species of the genus *Cordia*. The main vascular bundle were five bundles in Transverse sections of *C. abyssinica* and *C. sinensis*. Stomata width ranges from.025 *(C. abyssinica)* to 0.024 (*C. sinensis*). Whereas the length of stomata was found to be 0.013 *(C. abyssinica*) to 0.017 *(C. sinensis).*Stomatal indecis varied from 242.86 (*C. abyssinica*). to 175.0 (*C. sinensis*), so stomat measurements have a nearly reading, there for we can noted that the leaf anatomy don't shows vast differences among the two species. This confirmed with [11], [9].significance, because the stomata types become modified following its development.

From this study we can conclude that *Cordia abyssinica* and *cordia sinensis* anatomically are found to be similar .The morphology is ideal study to classify them to their species.

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