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THE MORPHOLOGY AND ANATOMY OF SOME MEDICINAL PLANTS IN SOUTHWESTERN NIGERIA

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Abstract

The morphological and anatomical characteristics of some medicinal plants in Southwestern, Nigeria were investigated to disseminate the dynamics of local knowledge and modern health care development. Commonly used medicinal plants were collected from forests in Ogun, Osun, Ondo and Oyo States. Morphological measurements were taken from each of ten species studied. Transverse sections of leaves were obtained in which two slides were prepared from both adaxial and abaxial surfaces from epidermal peelings. The results showed that the studied taxa have different morphological features; leaf arrangement is alternate, opposite and whorl. Leaf shape is oval/lanceolate, oval/cordate, linear, acicular, oblique or inequilateral, lanceolate or oblique, ovate oval. *Cymbopogon citratus* has the highest leaf length while *Panicum maximum* has the lowest leaf length. *Mangifera indica* has the highest leaf width while *Panicum maximum* and *Cymbopogon citratus* have the lowest. Anatomically, the leaves of four (4) were found to be amphistomatic while four (4) were hypostomatic and two (2) were epistomatic. The result showed that the studied taxa have different morphological and anatomical features. These findings serve as baseline for further research such as molecular studies.

Keywords: Anatomy, morphology, medicinal plants, epidermis, leaf, stomata

Introduction

The Nigeria flora has already made and will continue to make a great contribution to the health care of Nigerians. The indigenous medicinal plants form an important component of the National Wealth of Nigeria (Gbile and Adesina, 1987). If it is desired that indigenous plant materials should be exploited, processed and utilized for medicinal purpose, preliminary survey of the taxonomical, anatomical and phytochemical aspects of plants are important steps toward a sustainable development of the natural drug industry. Thus, it is very possible to differentiate between medicinal plants whose constituents and medicinal properties have been well established scientifically and plants that are regarded as medicinal but which have not yet been subjected to thorough investigation (Gill, 1992). Plants undoubtedly, play a central role in African indigenous systems of medicine. Plants form the main ingredients of the remedies dispersed by the medicine men and women. They perform very important functions in the healing processes and are also considered as sources of vital energy, in some sense a participatory entity rather than

a lifeless object used in healing (Maurice, 1993). Plants are numerous, having varieties of uses. Many of them occur in natural state particularly in the forest while a good number are cultivated for food, medicine and industrial uses. Plants may be grouped into different groups based on the uses attached to each one of them such as food, pulses, vegetables, timber, fibre, pulp, rubber, spices, medicine, oil seeds, fruit, sugar, paper and beverages. Some are exported to industrially advanced countries and essential drugs in raw or finished forms are imported from them. Nigeria is losing greatly by selling herbal materials cheaply and importing expensive essentially drugs (Edeoga and Eriata, 2001).

Plant materials are mostly prepared in three major ways which are; in powdery form, in form of fragment and dried form. Plants in powdery form are formed by the aggregation of small particles grinded together for example; powder of ginger and *myristica* (Dorland, 1988). When medicinal plants are in the form of fragments, it means two or more of the small pieces into which a larger plant material has been broken (Dorland, 1988). When a medicinal plant is in form of dried plant, it is mostly used for preservation in which two methods of dryness are available or applicable, one is sun dry and the other one is through heat. One or more than one plant organs needed for the uses as ingredients or materials needed. Examples; leaf, stem, bark, fruit and seldomly contain complete flowers. Medicinal plants of interest belong to different families and genera. Medicinal plants have been grouped into different families due to the characteristics found unique to each plant. Some plants are grouped together based on the shape of leaves, anatomical features, bark character, colour of the fruit and so on. Some of the families are Euphorbiaceae, Mimosaceae, Palmae, Meliaceae, Poaceae, Rutaceae, Rubiaceae, and many more. Herbs are not only used in the treatment but in the preparation of many allopathic and homeopathic drugs, no wonder these herbs are now being commercially exploited for the extraction of various ingredients (Haq, 1983). The study of anatomical features of some of these medicinal plants in Nigeria is to disseminate the dynamics of local knowledge and challenge modern health care development and therefore serve as the beginning of a large project ahead whereby curious researchers will carry out anatomical study of fragments in crude drugs of plant origin in Nigeria markets and other countries in the world at large but of the very many medicinal plants found in the world, little anatomical information about them are available. Plant has two organ systems (1) the root system and (2) the shoot system, the shoot system is above ground level and includes leaf as one of the organs in which this work was based on. So, objectives of this study are to provide anatomical knowledge for resolving the problems in the identification of natural drugs that are in fragments and powdery forms and to produce diagnostic anatomical features that distinguishes each plant from the other.

Materials and Methods

The plant materials were freshly collected from the natural habitat of various localities ranging from forest to derived savanna to allow morphological observation to be *in situ*. Some commonly used medicinal plants were collected from forests in Ondo, Ogun, Osun and Oyo States respectively. The specimens were identified in the Herbarium of Department of Botany, University of Ibadan (UIH) and Forestry Herbarium Ibadan (FHI) both in Nigeria.

Morphological Study

The quantitative morphological characters of each species were studied and measured,

which are leaf length, width, arrangement using graduated metric ruler to take the measurement in the field. All measurements and counting were done in replicates to eliminate all bias for the purpose of accurate statistical analysis. At each location, detailed notes were taken on the nature of the location, the habits, the habitats of each plant species and the general state of growth. Table 1 showed the measurement of morphological parameters such as leaf width, shape, arrangement and surfaces of each studied taxa while table 2 showed the parts used, their family, common names and habit.

Table 1: Quantitative Characters of the Studied Taxa.

Species	Leaf Shape	Leaf Arrangement	Leaf Surface
Mi	Oval/Lanceolate	Alternate	Glabrous
Ks	Oval	Alternate	Glabrous
Ab	Ovate	Alternate	Glabrous
Co	Lanceolate/Oblique	Alternate	Tomentose
Bv	Linear	Opposite	Silky
Ai	Oblique/Inequilateral	Opposite	Glabrous
Cc	Acicular/needle	Whorl	Villous
Ca	Ovate	Alternate	Glabrous
Pm	Linear	Alternate	Glabrous
Ml	Oval/ Cordate	Opposite	Glabrous

Legend: *Mi: Mangifera indica, Ml: Morinda lucida, PM: Panicum maximum, Ca: Citrus aurantifolia, Cc: Cymbopogon citratus, Ai: Azadirachta indica, Bv: Bambusa vulgaris, Co: Corchorus olitorus, Ab: Alstonia boonei, Ks: Khaya senegalensis.*

Table 2: Family, Common Names, Habit and Part used of the Taxa Studied.

Species	Family	Common Name	Habit	Part Used
Ks	Meliaceae	Mahogany	Tree	Leaf
Ab	Apocynaceae	Stool wood	Tree	Leaf
Co	Tiliaceae	Jute plant	Shrub	Leaf
Bv	Gaminae	Common bamboo	Tree	Leaf
Ai	Meliaceae	Neem tree	Tree	Leaf
Cc	Poaceae	Lemon grass	Shrub	Leaf
Ca	Rutaceae	Lime	Tree	Leaf
Pm	Compositae	Elephant grass	Herb	Leaf
Ml	Rubiaceae	Brimstone	Tree	Leaf
Mi	Anacardiaceae	Mango Tree	Tree	Leaf

Legend: *Mi: Mangifera indica, Ml: Morinda lucida, PM: Panicum maximum, Ca: Citrus aurantifolia, Cc: Cymbopogon citratus, Ai: Azadirachta indica, Bv: Bambusa vulgaris, Co: Corchorus olitorus, Ab: Alstonia boonei, Ks: Khaya senegalensis.*

Anatomical Study

Anatomical analysis was carried out in the laboratory of Biological Sciences Department, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria by studying the epidermal cells of the adaxial (upper) and abaxial (lower) surfaces of matured leaves. Ten different medicinal plants were collected from mid region (diameter between 0.8-1.0cm^2) of fresh specimens. For the preparation of permanent slides with internal structures of the organs, transverse sections (perpendicular to the long axis) of leaves (through the midrib region) were obtained following the method by Olowokudejo (1990) while the leaves were cleared with the method outlined by (Oladipo and Oyeniran, 2013). For epidermal peeling, the materials were soaked in concentrated HNO_3 and followed by peeling before dehydrated in series of ethanol (30% - 95%) for 10 minutes each, stained with Safranin O (5minutes), counterstained with Alcian blue for 5seconds and cleared in clove oil for 10 minutes and mounted in DPX. And for the preparation of permanent slides, the materials were revived by boiling in water for few minutes and fixed in FAA for 24hours followed by dehydration in series of ethanol (30% -95%). Stained for three minutes in Safranin O, rinsed thrice in water, after which they were counter stained for three minutes in Alcian blue to improve the contrast and rinse in water twice. Counter stained sections were treated in series of grades of ethanol solution (50%, 70%, 80%, 90%, and 100%) to remove water molecules (dehydration process) and to remove excess stain (differentiation process). The dehydrated and differentiated sections were transferred into absolute xylene in two series to remove the last trace of water, to clear the sections (making it more transparent) and to remove the last trace of ethanol. The stained sections were mounted on a glass slide in DPX (R) mountant prior to photo-microscopy views (Oladipo and Oyeniran, 2013). Microscopically, observations of each prepared slides were made at 10×, 40×, 100× objectives using LEICA DM500 binocular light microscope in order to show the anatomical features of the leaves.

Results

Morphological Study

The studied taxa have different morphological features such as leaf length, width, shape and arrangement Table 1. *Mangifera indica, Panicum maximum, Citrus aurantifolia, Corchorus olitorus, Alstonei boonei* and *Khaya senegalensis* are having alternate leaf arrangement, *Morinda lucida, Azadirachta indica and Bambusa vulgaris* are having opposite leaf arrangement while *Cymbopogon citratus* is having whorl leaf arrangement. In term of leaf shape, *Mangifera indica* has oval/lanceolate shape, *Morinda lucida* has oval/cordate shape, *Bambusa vulgaris* and *Panicum maximum* have linear shape while *Cymbopogon citratus* has needle-like or acicular shape, *Azadirachta indica* has oblique or inequilateral shape, *Corchorus olitorus* has lanceolate or oblique shape, *Alstonia boonei* and *Citrus aurantifolia* have ovate with *Khaya senegalensis* has oval shape. *Cymbopogon citratus* has the highest leaf length (58.5cm) while *Panicum maximum* has the lowest leaf length (3.4cm). Leaf width ranges from 1.1 – 8.2 cm in which *Mangifera indica* has the highest, *Panicum maximum* and *Cymbopogon citratus* have the lowest. Seven of the studied taxa have glabrous leaf surface while others are having silky, villous and tomentose leaf surface Table 1.

Midrib/ Midvein

Photomicrographs of the studied taxa using LEICA DM500 binocular light microscope attached to the laptop followed Metcalfe and

Chalk (1998) method, shown the characteristics anatomical features in the midribs of *Cymbopogon citratus, Alstonia boonei, Bambusa vulgaris, Mangifera indica, Khaya senegalensis, Azadirachta indica, Citrus aurantifolia* and *Morinda lucida* as illustrated in plates 1a, b, c, d and 2a, b, c, d as well as 3a and b. Xylem vessels occupy greater part of the midrib complex especially in *Morinda lucida, Citrus aurantifolia* and *Mangifera indica*. They are arranged in polygonal shape and also in dome-shaped fashion. (Plate 1a), Palisade cells of *Cymbopogon citratus* are arranged in dome shape, epidermal cells are double, presence of xylem vessels, spongy mesophylls cells. (Plate 1b), *Alstonia boonei*, presence of spongy cells, vacuoles, double epidermal cells, and palisade cells are arranged in polygonal shape and others circular shape. (Plate 1c), *Bambusa vulgaris,* there is presence of palisade cells, vacuoles and epidermal cells. (Plate 1d), *Mangifera indica,* single epidermal cells clustered together, polygonal shape of palisade cells and spongy cells scattered around. (Plate 2a), *Khaya senegalensis* has spongy mesophyll numerous with xylem vessels having circular shape, (Plate 2b), *Azadirachta indica* has single upper epidermal cells arranged closed to each other, Palisade cell in rod-like shape and xylem vessels present. (Plate 2c) *Citrus aurantifolia* has presence of epidermal cells, numerous xylem vessels, spongy mesophyll and vacuoles. (Plate 2d), *Morinda lucida* has polygonal spongy mesophyll, double epidermal cells, xylem vessels and vacuoles. For the epidermal cells, *Morinda lucida* and *Panicum maximum* showing polygonal walls in the upper epidermal with parishia/ maingayi stomata structure in the epidermis of *Panicum maximum. Alstonia boonei, Corchorus olitorus Azadirachta indica, Mangifera indica, Bambusa vulgaris* are having anomocytic stomata. Cyclocytic stomata are present in the lower epidermal of *Morinda lucida*, *Citrus aurantifolia* shows helicocytic stomata in the upper epidermal. Staurocytic stomata is present with polygonal guard cells in the lower epidermis of *Citrus aurantifolia* and epidermis of *Alstonia boonei,* presence of anticlinal walls in the upper epidermis of *Azadirachta indica*, *Khaya senegalensis* and C*ymbopogon citratus.* Both upper and lower epidermis of *Corchorus olitorus* are having anomocytic stomata. Stomata index ranges from 12.01 (*Corchorus olitorus*) to 20.00 (*Citrus aurantifolia*), while adaxial of *Mangifera indica, Morinda lucida, Cymbopogon citratus* and *Azadirachta indica* are with no stomata, abaxial surface of *Bambusa vulgaris* and *Cymbopogon citratus* are also with no stomata. Table 3 showed the summary of the stomata types and stomata index in both adaxial and abaxial surfaces of the studied taxa and the stomata types were showed in figures (1-5).

Table 3: Stomata name, types and index of the studied taxa.

Taxa	Adaxial	Abaxial	Stomata Index (%) (Adaxial Surface)	Stomata Index (%) (Abaxial Surface)
Mi	———	Anomocytic	———	12.30
Ml	———	Cyclocytic/Tetracytic	———	14.30
Pm	Parishia/Maingayi	Parishia/Maingayi	16.70	16.70
Ca	Helicocytic	Staurocytic	14.30	20.00
Cc	———	———	———	———
Ai	———	Anomocytic	———	16.70
Bv	Anomocytic	———	20.00	———
Co	Anomocytic	Anomocytic	12.01	16.74
Ab	Staurocytic	Anomocytic	16.70	16.70
Ks	Paracytic	Paracytic	12.40	12.40

Legend: ___ represents absence of stomata. *Mi: Mangifera indica, Ml: Morinda lucida, PM: Panicum maximum, Ca: Citrus aurantifolia, Cc: Cymbopogon citratus, Ai: Azadirachta indica, Bv: Bambusa vulgaris, Co: Corchorus olitorus, Ab: Alstonia boonei, Ks: Khaya senegalensis*

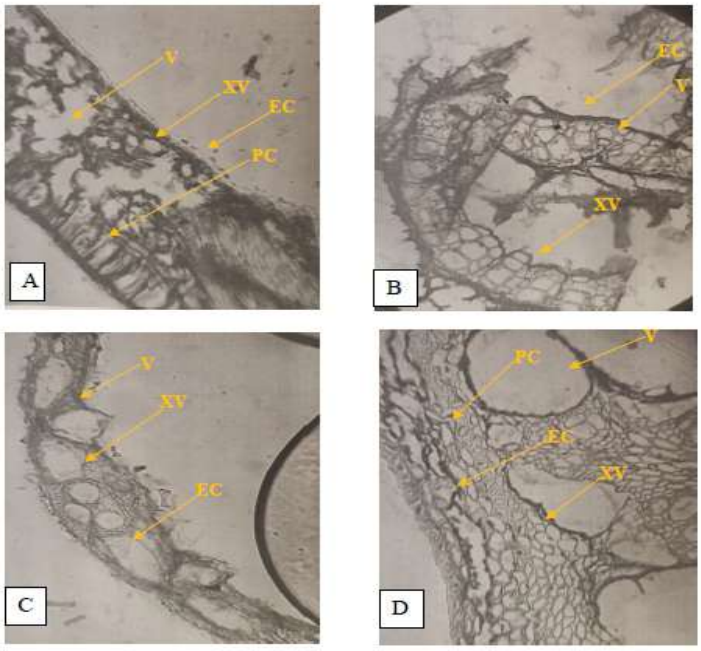

Plate 1: Transverse Sections (T/S) of the Studied Species

Legend:
A: Transverse Section through the Midrib of *Cymbopogon citratus*
B: Transverse Section through the Midrib of *Alstonia boonei*
C: Transverse Section through the Midrib of *Bambusa vulgaris*
D: Transverse Section through the Midrib of *Mangifera indica*

Key:
EC: Epidermal cell
SP: Spongy mesophyll
XV: Xylem vessel element
V: Vacuole, PC: Palisade cell

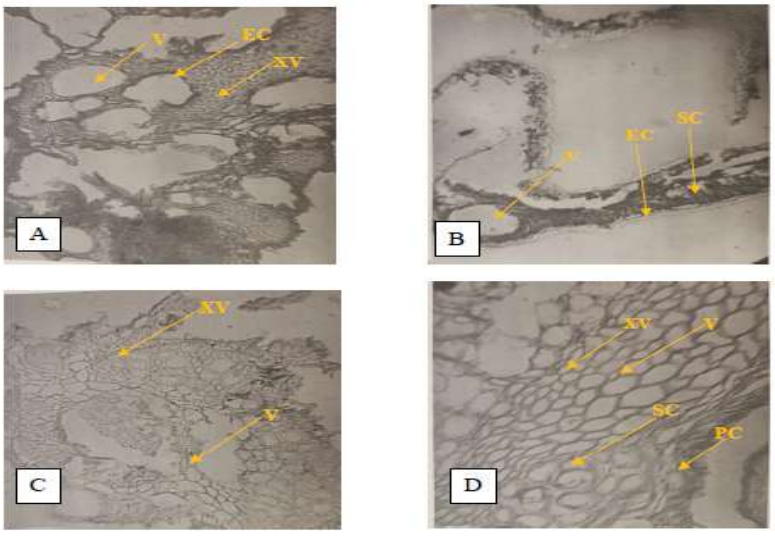

Plate 2: Transverse Sections (T/S) of the Studied Species

Legend:
A: Transverse Section through the Midrib of *Khaya senegalensis*
B: Transverse Section through the Midrib of *Azadirachta indica*
C: Transverse Section through the Midrib of *Citrus aurantifolia*
D: Transverse Section through the Midrib of *Morinda lucida*

Key:
EC: Epidermal cell
SP: Spongy mesophyll
XV: Xylem vessel element
V: Vacuole, PC: Palisade Cell

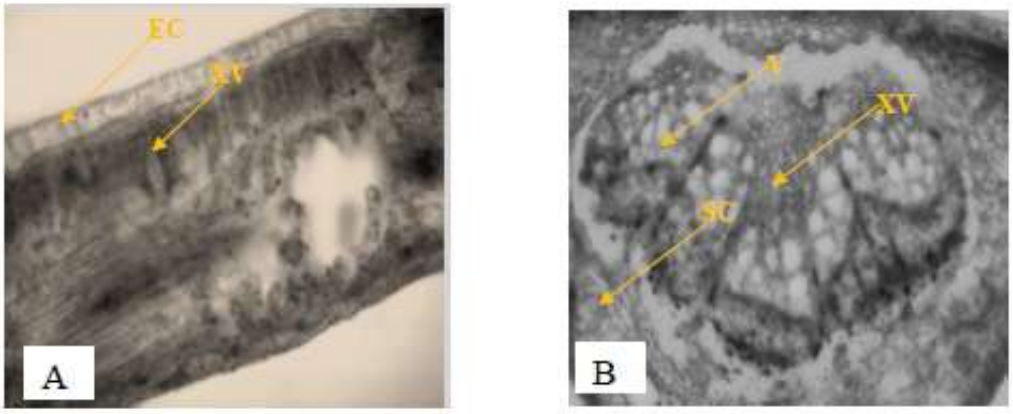

Plate 3: Transverse Sections (T/S) of the Studied Species

Legend:
A: Transverse Section through the Midrib of *Panicum maximum*
B: Transverse Section through the Midrib of *Corchorus olitorus*

Key:
EC: Epidermal cell
SP: Spongy mesophyll
X: Xylem vessel, V: Vacuole

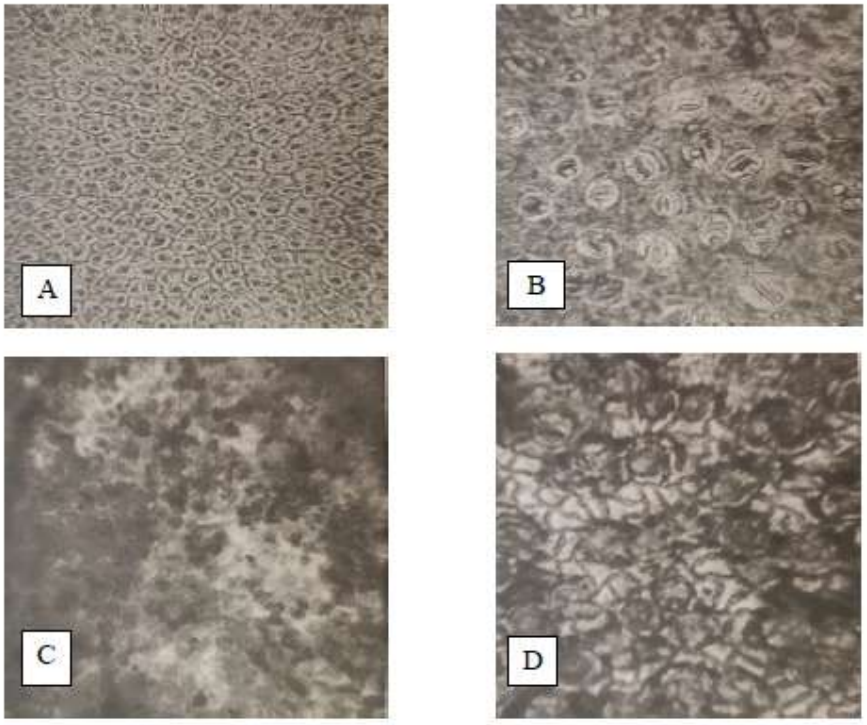

Figure 1: Adaxial and abaxial surfaces of the studied species
Legend:
A: Showing polygonal walls in the upper epidermis of *Morinda lucida.*
B: Showing cyclocytic stomata structure in the lower epidermis of *Morinda lucida.*
C: Showing helicocytic stomata structure in the upper epidermis of *Citrus aurantifolia.*
D: Showing staurocytic stomata in lower epidermis of *Citrus aurantifolia.*

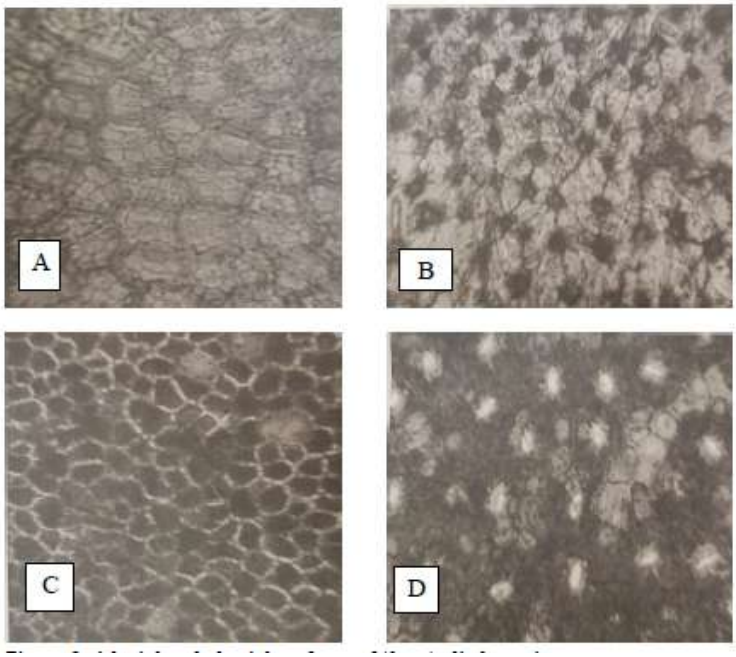

Figure 2: Adaxial and abaxial surfaces of the studied species

Legend:
A: Showing staurocytic stomata structure in the upper epidermis of *Alstonia boonei*
B: Showing anomocytic stomata structure in the lower epidermis of *Alstonia boonei*
C: Showing anticlinal walls in the upper epidermis of *Azadirachta indica*
D: Showing anomocytic stomata structure in the lower epidermis of *Azadirachta indica*

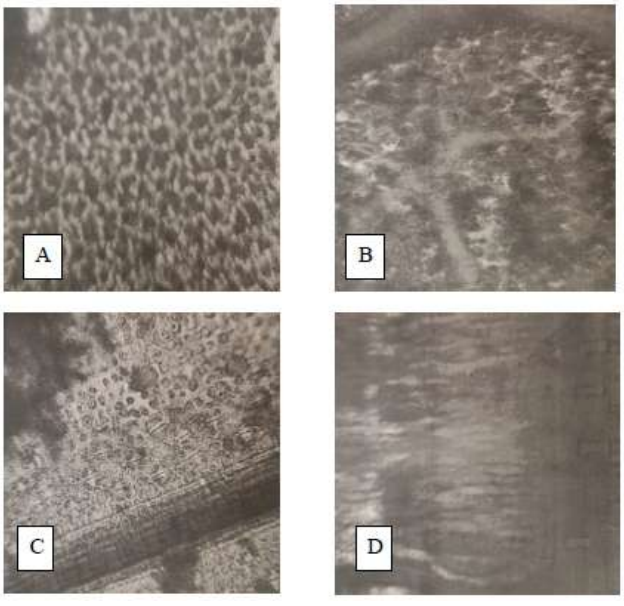

Figure 3: Adaxial and abaxial surfaces of the studied species

Legend:
A: Showing epidermal walls in the upper epidermis of *Mangifera indica*
B: Showing anomocytic stomata structure in the lower epidermis of *Mangifera indica*
C: Showing anomocytic stomata structure in the upper epidermis of *Bambusa vulgaris*
D: Showing epidermis structure in the lower epidermis of *Bambusa vulgaris*

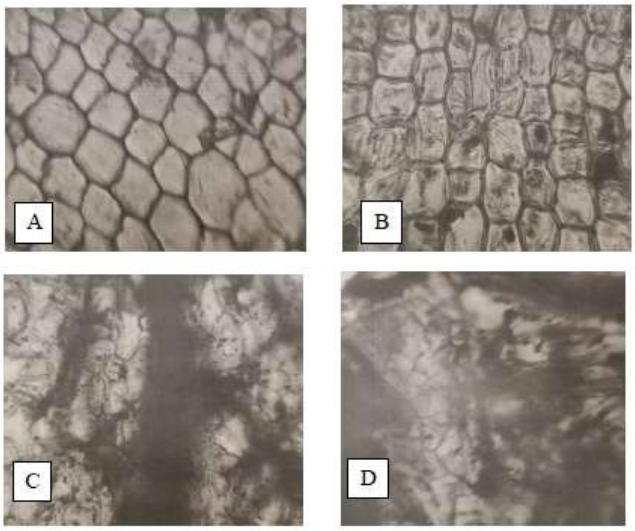

Figure 4: Adaxial and abaxial surfaces of the studied species

Legend:
A: Showing polygonal walls with parishia/maingayi stomata structure in the upper epidermis of *Panicum maximum*
B: Showing polygonal walls with parishia/maingayi stomata structure in the lower epidermis of *Panicum maximum*
C: Showing anticlinal walls with paracytic stomata structure in the upper epidermis of *Khaya senegalensis*
D: Showing anticlinal walls with paracytic stomata structure in the lower epidermis of *Khaya senegalensis*

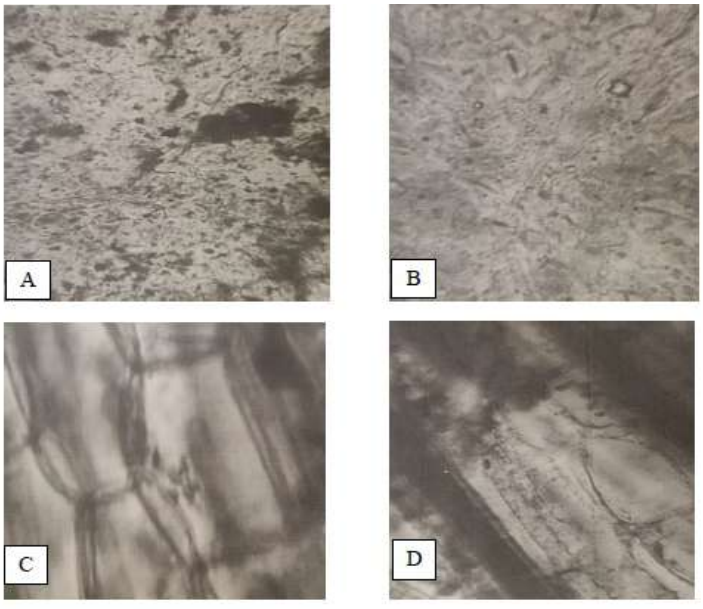

Figure 5: Adaxial and abaxial surfaces of the studied species

Legend:
A: Showing anomocytic stomata structure in the upper epidermis of *Corchorus olitorus*
B: Showing anomocytic stomata structure in the lower epidermis of *Corchorus olitorus*
C: Showing anticlinal walls in the upper epidermal cell of *Cymbopogon citratus*
D: Showing anticlinal walls in the lower epidermal cell of *Cymbopogon citratus*

Discussion

It was observed that different morphological features such as leaf length, width, shape and arrangement were present among the species studied. Anatomical features showed that among all the species, only *Panicum maximum* and *Corchorus olitorus* are having the same stomata types in the abaxial and adaxial surfaces (Parishia/ Maingayi and Anomocytic) while other species are having different stomata types at either abaxial surface or adaxial surface which are tetracytic, helicocytic, staurocytic and paracytic. Stomata index of the abaxial surface of *Citrus aurantifolia* and adaxial surface of *Bambusa vulgaris* are the highest (20.00) while adaxial surface of *Corchorus olitorus* has the lowest (12.01). Abaxial surface of *Morinda lucida* and adaxial surface of *Citrus aurantifolia* are the same (14.30), abaxial and adaxial surfaces of *Panicum maximum* and *Alstonia boonei* are of the same value (16.70) as well, while abaxial surface of *Mangifera indica* and adaxial surface of *Corchorus olitorus* are very close to each other (12.30 -12.01). Anatomical features in the midrib and lamina of *Cymbopogon citratus* are unique in the formation of chains of vascular bundles appearing in way loops. The shape of lamina could be due to parallel venation in the taxa. This makes any attempt to trace the source of these fragments in African traditional crude drugs a bit easy.

Conclusion

The tissue structures of these studied taxa have been established. Further study should be based on finished products of natural crude drugs commonly sold in the markets in order to proffer solution to the problem of adulteration, substitution, standardization and quality control in natural crude industry. When the tissue structures of plant raw materials are established, then they could serve as reference point to fragment in crude of plant origin. This idea has been utilized by earlier authors such as Murkerjee *et al.,* (2000) on *Camellia sinensis* (Tea). This present study forms the beginning of huge project ahead which shall look into the anatomy fragments in herbal drugs in Nigeria and African markets and compare them with the anatomical features of medicinal plants in the field. .

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