Vенация некоторых видов рода Ficus Linn. в Юго-Западной Нигерии

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Абстракт

Текущее исследование проводит венацию десяти видов рода Ficus, собранных из Обафи Аволоуна Иле-Ифа (latitude 7° 31’ 14.7612” N и longitude 4° 31’ 49.1340” E) и NACGRAB, Ибадан, Нигерия (latitude 7°23’4”N и longitude 3°50’31”E). Венации листьев видов проводили стандартными методами. Все фотомикрофотографии были получены с помощью цифровой камеры Amscope на бинокулярном микроскопе Celestone. Все данные были подвергнуты анализу с использованием SAS-софтура. Результаты показали, что венация листьев видов имеет большую вариацию в ареоле, длине и ширине, концах венул и трichомов. Листовая венация видов показывает, что они значительны в идентификации и определении исследованных видов рода Ficus с качественными и количественными данными. Присутствие цистолитовых клеток, trichomes и нет концов венул диагностирует Ficus mucuso. Исследование заключается в том, что венации являются важными в определении видов рода Ficus и эти характеристики могут быть использованы как дополнительная информация в существующих таксономических ключах рода.

Ключевые слова: ареола; цистолитовые клетки; лист; форма; венация

Введение

Род Ficus принадлежит к семейству Moraceae и является одним из самых многочисленных родов высших растений (Scott, 1996; Frodin, 2004). Ficus является одним из самых многочисленных родов древесных растений, которые включают деревья, кустарники, травы, клоны и лазающие растения (Chaudhary et al., 2012; Rahman and Khanom, 2013; Mawa et al., 2013). Члены рода Ficus являются

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**Academic Prestige**
recognised by highly characterized inflorescence, the syconium or hypanthodium, which are hollow bags of numerous male and female flowers with fleshy receptacle, the male flowers are arranged towards an ostiole located at the free end of the receptacle, the remaining part of the cavity are occupied by female flowers. The female flowers are located close to the orifice or opening and are usually protected by sterile scales (Olorode 1984; Sharma, 1993; Clement and Wieblen, 2009).

During the last decades, plant anatomical study and its data are often used in characterization of species within a genus and in determining evolutionary relationships. Several authors have referred to plant taxonomy and application as a remarkable evolution in vascular plants studies (Stant, 1973; Metcalfe and Chalk, 1979; Forbes, 1980; Abubakar and Yunusa, 1998; Ogunkunle and Oladele, 2000; Ahmad et al., 2010; Odedeji and Adefule, 2015; Talebi et al., 2017).

According to Sehgal and Paliwal (2008) and Ummu et al. (2014), anatomical studies of leaf venation have been proven to be useful for the identification of various species. Ummu et al. (2014) described the variation in the leaf venation of twenty-one species of Ficus in Peninsular Malaysia and observed eight leaf venation patterns. They also concluded that tracheid, cystolith cells and trichomes are anatomical characters that assist in delimiting the species. Siti-Khaulah and Noraini (2016) studied eight species of Ficus, the presence of complex veinlet, complete ultimate marginal and opened venation were observed. The report concluded that anatomical features of venation are of taxonomic significance in differentiating and identifying the studied species. Hickey (1973) indicated that the venations of leaves are associated with plant evolution and the significant role systematically in plant identification and classification. This study is to investigate the leaves venation patterns of ten species of Ficus identifying features that may be of taxonomic value in delimiting the species.

**Materials and Methods**

**Herbarium Survey**

A preliminary study of herbarium materials of the selected species of Ficus was carried out in Obafemi Awolowo University (IFE) herbarium and relevant literature were reviewed. The flora of West Tropical Africa by Hutchinson and Dalziel (1958) was also consulted.

Ten species of Ficus were collected at various locations in Southwestern Nigeria as shown in Table 1. The species of Ficus were authenticated at IFE herbarium, Obafemi Awolowo University, Ile-Ife. The Flora of West Tropical Africa by Hutchinson and Dalziel (1954-72) was also consulted. Fresh specimens collected at different collection sites were preserved in 50% ethanol.

For the venation studies, sizeable portions of the matured leaves of the species were obtained from the median parts of well expanded leaves. The leaves were decolourised by boiling in 90% ethanol (to remove chlorophyll) at 20 °C for about 10-15 minutes, washed in 3-4 changes of water to remove all traces of alcohol. The leaves were later boiled in 5% sodium hydroxide for 15 minutes to enhance further clearing of leaves.

The leaves were washed thoroughly to remove alkaline solution. The partially cleared leaves were further cleared in 5% domestic bleach (parozone) for 20-30 minutes. The cleared leaves were rewashed in 3-4 changes of water, and stored in 50% ethanol as described by Olatunji (1983). These were stained in 1% aqueous solution of Safranin O and mounted on a clean slide in 25% glycerol for venation studies. Slides examinations were made under the light microscope. Photomicrographs of veins and areoles were made using Amscope digital camera mounted on a celesterone binocular microscope.
Table 1. The sites of collection and the coordinates of the *Ficus* species studied

| S/N | Species                | Voucher Number | GPS coordinates      | Description of collection sites                              |
|-----|------------------------|----------------|----------------------|----------------------------------------------------------------|
| 1.  | *Ficus exasperata*     | IFE- 17752     | 7°31’11"N4°31’38”E  | Adjacent Central Science Laboratory, OAU, Ile-Ife             |
| 2.  | *Ficus recurvata*      | IFE- 17757     | 7°31’11"N4°31’34”E  | Biological Garden, Behind Botany car park, OAU, Ile-Ife      |
| 3.  | *Ficus mucuso*         | IFE- 17755     | 7°31’13"N4°31’38”E  | Biological Garden, Behind Botany Car Park, OAU, Ile-Ife      |
| 4.  | *Ficus sur*            | IFE- 17758     | 7°31’4"N4°31’35”E   | OAU Bus stop, Ile-Ife.                                       |
| 5.  | *Ficus leprieurii*     | IFE-17753      | 7°31’13”N4°31’38”E  | Reforestation Garden, OAU, Ile-Ife                          |
| 6.  | *Ficus elastica*       | IFE- 17751     | 7°31’21”N4°31’47”E  | Parks and Garden, OAU, Ile-Ife                              |
| 7.  | *Ficus benjamina*      | IFE-17750      | 7°23’7”N3°50’28”E7°31’16”N4°31’29”E | 1. Moor Plantation, Apata, Ibadan  
|     |                        |                |                      | 2. Opposite First bank lecture theatre, OAU                  |
| 8.  | *Ficus lutea*          | IFE- 17754     | 7°31’11”N4°31’34”E  | Biological Garden, Behind Botany car park, OAU, Ile-Ife      |
| 9.  | *Ficus polita*         | IFE- 17756     | 7°31’11”N4°31’34”E  | Biological Garden, Behind Botany Car Park, OAU, Ile-Ife      |
|     |                        |                | 7°23’4”N3°50’31”E  | 1. Biological Garden, Behind Botany car park, OAU, Ile-Ife   |
|     |                        |                | 7°31’10”N4°31’29”E | 2. Moor plantation, Apata, Ibadan                           |
|     |                        |                |                      | 3. Beside OAU Library, Ile-Ife                              |
| 10. | *Ficus thonningii*     | IFE- 17759     | 7°31’11”N4°31’34”E  | Biological Garden, Behind Botany car park, OAU, Ile-Ife      |

*Collectors’ names: Akinlabi Adebisi A.

**Statistical analysis**

Data collected were subjected to analysis of variance based on completely randomized design to test for significant difference among the accessions of the ten species of *Ficus* studied. The means were separated using Duncan’s Multiple Range Test (DMRT) and photographs of some of the morphological characters of the taxa were also taken. The data were analyzed using SAS software (2003).

**Results**

The leaf morphology of the ten *Ficus* species studied showed brochidodromous venation which is a type of camptodromous venation. The secondary veins of the leaf do not terminate at the margin but were joined together forming series of prominent arches (Table 2 and Figure 1).

*Ficus leprieurii* (Miq) CC, Berg

Areoles well developed. The shape of the areole is polygonal. Size ranges from 92.00 - 180.00 μm long and 76.00 - 116.00 μm wide. Veinlets ending is simple and are mostly branched, ranges from 0 - 6 in number.
**Ficus thonningii Blume**
Areoles are well developed and their shape ranges from rectangular to pentagonal, size ranges from 88.00 ± 3.20 μm wide and 116.80 ± 5.61 μm long. Veinlets ending are mostly linear and occasionally branched or forked, 0 - 3 per areole.

**Ficus mucuso Welw. Ex Ficalho**
Areole are well developed, shape varies from triangular to rectangular, 84.00 - 160.00 μm long and 60.00 - 120.00 μm wide. Silicified bodies with cellulose skeleton (Cystolith cells) and trichomes were present. It has no veinlets ending.

**Ficus lutea Vahl**
Areoles are developed with shape ranging from triangular to polygonal, about 88.00 - 148.00 μm long and 68.00 - 112.00 μm wide. Veinlets ending are simple, linear and occasionally branched and 0 - 3 veinlets per areole.

**Ficus polita Vahl**
Areoles are well developed, rectangular to triangular in shape. Shape ranges from 112.00 - 180.00 μm long to 64.00 - 128.00 μm wide. Veinlets ending are simple, linear and branched, 0 - 1 per areole.

**Ficus sur Forssk**
Areoles are well developed with shape largely triangular to polygonal. Areole size ranges from 56.00 - 120.00 μm long to 52.00 - 96.00 μm wide. Veinlets ending are simple and forked, 0 - 2 per areole.

**Ficus benjamina Vahl**
Areoles are well developed, shape vary from triangular, rectangular and quadrangular, about 60.00 - 100.00 μm long to 40.00 - 60.00 μm wide. Veinlets ending are simple, linear and mostly bifurcated. Veinlet ending ranges from 0 - 3 per areole.

**Ficus exasperata Vahl**
Areoles are well developed, largely rectangular to triangular. Areole length varies from 92.00 - 160.00 μm and areole width ranges from 60.00 - 116.00 μm. Veinlets ending are linear to branched and ranges from 0 - 3 per areole.

**Ficus recurvata De Wild**
Areoles are well developed; shape vary from rectangular to polygonal and size from 44.00 - 100.00μm long to 40.00 - 84.00 μm wide. Veinlets ending are simple, linear and branched and with about 0 - 3 per areole.

**Ficus elastica Roxb. Ex Hornem**
Areoles are well developed with shape ranging from triangular to pentagonal to polygonal. Areole size varies 84.00 - 192.00μm long and 64.00 - 180.00 μm wide. The veinlets ending are singly divided and ranges between 0 - 3 per areole.
Figure 1. The venation patterns of the species studied
a) F. leprieurii; b) F. thonningii; c) F. mucuso; d) F. lutea; e) F. polita; f) F. sur; g) F. benjamina; h) F. exasperata; i) F. recurvata; j) F. elastica
Legend: MV= Main Vein, VL=Veinlet, AR= Areole, CY=Cystolith, TR = Trichome

Table 2. Quantitative parameter of the venation pattern of ten Ficus species studied

| Plant species  | Areole width (µm)  | Areole length (µm)  | Number of veinlets ending |
|----------------|-------------------|---------------------|---------------------------|
| Ficus lutea    | 92.27±7.54ab      | 120.00±4.84a        | 0 - 3                     |
| F. thonningii  | 88.00±3.22b       | 116.80±5.61a        | 0 - 3                     |
| F. exasperata  | 87.47±3.84bc      | 120.00±3.84a        | 0 - 3                     |
| F. mucuso      | 84.27±4.05bc      | 116.27±5.16a        | 0 - 3                     |
| F. recurvata   | 54.40±4.15c       | 70.40±4.38b         | 0 - 3                     |
| F. leprieurii  | 107.00±4.70a      | 132.80±4.83c        | 0 - 6                     |
| F. polita      | 96.53±3.84bc      | 130.67±3.88bc       | 0 - 1                     |
| F. sur         | 68.53±3.29c       | 82.67±5.20b         | 0 - 2                     |
| F. elastica    | 103.2±9.54c       | 131.47±8.76c        | 0 - 3                     |
| F. benjamina   | 55.73±3.47b       | 80.8±2.80c          | 0 - 3                     |

*Means with the same letter along columns are not significantly different at P ≤ 0.05

Discussion

Variations in patterns of leaf venation are not just useful in identifying taxon, but can also be used in differentiating between species of a genus. Rich diversity of venation patterns was observed in monocotyledons by Inamdar et al. (1983) and dicotyledous plants by Hickey (1973). Areole shape in the Ficus species studied ranges from triangular, rectangular, and pentagonal to polygonal. Ogundipe and Wujek (2004) identified the significance of veinlet termination endings in the family Bignoniaceae. Characters of venation such as well-developed areole are classificatory for the species of Ficus studied. 0 - 3 veinlets ending were classificatory for F. exasperata, F. benjamina, F. thonningii and F. lutea, F. elastica and F. recurvata. Ficus sur has 0 - 2 veinlets ending, Ficus polita had 0 - 1 veinlets ending and Ficus mucuso had no veinlets ending. The 0 - 6 veinlets ending in Ficus leprieurii is diagnostic of the species.

Cystolith cells are silicified bodies with cellulose skeleton and trichomes were present only in F. mucuso and are diagnostic of the species. Siti-Khaulah and Noraini (2016) also reported the presence of cystolith cells in F. pubigera and opened areolar venation in most Ficus species studied but concluded that leaf venation has taxonomic significance in differentiation and identification of species. The cystolith cells are made of calcium carbonate located in lithocysts and occur in either papillate or hair-like form, usually found in the epidermis of leaves (Mauserth 1988; Ummu et al., 2014). Also, as far back as 1950, Metcalfe and Chalk have reported the presence true cystoliths in some genera of Moraceae, such as Broussonetia, Chlorophora, Conocephalus, Ficus
and *Morus*. Consequently, the presence of cystoliths in *F. mucuso* is a common characteristic of the genus *Ficus* which is unique to certain species.

Also, the importance of trichomes have been emphasized in literatures (Ramayya and Rao, 1976; Rao and Ramayya, 1977; Adedeji et al., 2007). Among the ten *Ficus* species studied, trichomes were only present in *F. mucuso*. Various type of trichomes, such as straight and long, short and peltate have been observed on leaves in *Ficus* taxa according to Klimko and Truchan (2006). Ummu et al. (2014) also reported, simple and unicellular trichomes in the leaf venation of some species, such as in *F. aurantiacea* var. *aurantiacea*, *F. aurata*, *F. benghalensis*, *F. fulva*, *F. hispida*, *F. lepicaarpa*, *F. sagittata* and *F. superba*.

The venation pattern revealed intraspecific and interspecific differences among the *Ficus* species studied based on quantitative attributes i.e the areole width and areole length. However, characters like long areole length is classificatory for species such as *F. polita*, *F. elastica*, *F. lutea*, *F. exasperata*, *F. mucuso*, *F. thonningii* and *F. leprieurii* having significantly longer areole length. This agrees with current sectional grouping of the species in Galoglychia excluding *F. exasperata* and *F. mucuso* in section Sycidium and Sycomorous respectively. *F. sur*, *F. benjamina* and *F. recurvata* have short areole length. The significantly wide areole in *F. leprieurii* and *F. elastica* with (107.00 ± 4.70μm and 103.2 ± 9.54μm) respectively is also classificatory of the species and this distinguishes them from other *Ficus* species and they are both in section galoglychia and it agrees with the sectional classification of Berg (1989).

Conclusions

The venation patterns in all the ten *Ficus* species studied are unique with respect to the areole shape, width and length as well as the veinlets ending. The study emphasized the taxonomic importance of leaf venation and its pattern usefulness in delimiting the species of the taxon. The study therefore concluded that the information will be useful in further taxonomic study of the genus *Ficus*.

Authors’ Contributions

Both authors read and approved the final manuscript.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.
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