



COMPARATIVE STUDIES IN STOMATAL ATTRIBUTES OF FICUS SPECIES GROWN IN ZARIA, NORTHWEST NIGERIA

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ABSTRACT

Leaves stomatal characteristics are basically the most commonly used characters in taxonomy and phylogenetic studies in plants. This study was conducted to compare stomatal attributes of eight different *Ficus* species obtained from Zaria, Northwest Nigeria. Leaves of Eight different species of *Ficus*: *Ficus natalensis*, *F. glomosa*, *F. religiosa*, *F. elastica*, *F. polita*, *F. platyphylla*, *F. capensis*, and *F. sycomorus* were used for the study. The stomatal characters were observed and measured using standard microscopic procedures during both the dry and rainy seasons. More so, the stomatal sizes of each *Ficus* species were measured using an ocular and stage micrometer. The experiment was laid out in a completely randomized design with fifty (50) replications. Data obtained was subjected to analysis of variance (ANOVA) with Duncan's New Multiple Range Test applied to separate significant means at 5% level. The result obtained revealed significant variations ($P \leq 0.05$) in stomatal sizes and number among the species of *Ficus* at the two different seasons. Stomatal sizes in *Ficus elastica* were larger than those of all other *Ficus* species studied during dry and wet seasons (50.24 μm and 46.43 μm in length and 43.25 μm and 35.43 μm in breadth) respectively. However, the highest number of stomata (47 stomata) during the dry season was recorded for *Ficus sycomorus* with *F. natalensis* having the highest number of stomata during the wet season (45 stomata). These findings inferred that, the species of *Ficus* grown in Zaria differ in stomatal size and number indicating their delimitation into separate species.

Keywords: *Ficus*, Leaves, Taxonomy, Zaria

Introduction

Ficus (L.) is one of the important genera in Moraceae family as it is one of the largest and

most diverse plant genera (Shi *et al.*, 2018). *Ficus* is the most popular genus that varies in habits as both woody trees, shrubs, vines, epiphytes and hemi epiphytes and is distributed in the tropics

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(Singh and Sharma, 2023) such as Africa, America, Asia and Australia (Ahmed and Urooj, 2010; Hamed, 2011). Although, some *Ficus* species were fruitless yet they possessed similar morphological characters that are problematic that make them difficult to be easily distinguished from other species within same genus (Singh and Sharma, 2023). *Ficus* plants were used extensively in the traditional treatment of peptic ulcers, piles, jaundice, hemorrhage, diabetes, asthma, diarrhea, dysentery, biliousness, and leprosy (Chandra *et al.*, 2023). There are about 800 *Ficus* species identified among the world's flora (Singh and Sharma, 2023).

The members of the genus *Ficus* therefore showed great morphological diversity which causes difficulties in identifying this genus. Therefore, there is difficulty in offering a well-organized classification of *Ficus* species (Al-Andal *et al.*, 2022). Morphological approach in plant taxonomy is a basic step towards characterization and diagnosis of plant species (Lutatenekwa *et al.*, 2020). Previous studies about morphological analyses for *Ficus* species were performed in Central Africa, Brazil, and Egypt (Ebika *et al.*, 2018; Teixeira *et al.*, 2018; Mostafa *et al.*, 2020). However, there is a lack of information regarding the comparison between *Ficus* species in Zaria, Nigeria on the basis of stomatal characters. More so, Al-Andal *et al.* (2022) stressed that proper understanding of the taxonomic relationships and estimate of the degree of morphological variation present in these species are lacking. Furthermore, species delimitation even though depends on increasingly diverse data types, its reliability remains ripe with arguments and opposing approaches. The use of foliar stomatal characters is of immense interest in taxonomy and has been applied by many taxonomists in plant identification (Onefeli and Fabowale, 2021). This study therefore aimed at comparing the stomatal features of eight different *Ficus* species grown in Zaria in order to identify variation in their stomatal features.

Materials and Methods

Study Area

The research was carried out within Zaria metropolis (Latitude 11°11'N; Longitude 7°73' E and on Altitude 613 m above sea level) in the Sudan Savannah zone of Nigeria. The area is influenced by two distinct seasons: rainy and dry season. The area experienced an annual temperature between 15.3-36.25 °C and receives an average annual precipitation of 772.6 mm. The rainy season is essentially between June-September and the dry season is between October and April. The area is characterized by shorter grasses and fewer scattered trees (Ayanlade, 2009).

Collection of Plant Materials

Leaves and fruits of eight (8) different *Ficus* species grown in Zaria were collected from wild and cultivated lands within the study area. The species include *Ficus polita* (ABU02665), *Ficus capensis* (ABU01618), *Ficus elastica* (ABU017011), *Ficus platyphylla* (ABU016178), *Ficus sycomorus* (ABU016123), *Ficus glumosa* (ABU021117), *Ficus religiosa* (ABU05674) and *Ficus natalensis* (ABU021116). The species were authenticated at the Herbarium section of the Department of Botany, Faculty of Life Sciences, Ahmadu Bello University Zaria, Kaduna Nigeria.

Stomatal Studies

Fresh leaves of eight different *Ficus* species (50 leaves from each species) were collected, fixed and preserved in formalin acetic alcohol (FAA) for 24 hours. Small portions of the leaves (1 cm length) were cut using a sharp blade and then transferred into small containers containing 100 ml of sodium hypochlorite solution and kept for 72 hours to extract the chlorophyll contents as described by Abdulrahman and Oladele (2005) and Nuru *et al.* (2018). The leaves were then placed on a clean slide and 2 drops of lactophenol cotton blue stain were added, covered with a clean

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cover slip and observed under the low and high-resolution objectives of a compound microscope. Stomatal sizes and number were counted from adaxial and abaxial surfaces using an Ocular eyepiece graticule and Stage micrometer at a $\times 40$ objective of the light microscope as described by Baker and Silverton (1982), Abubakar *et al.* (2011) and Nuru *et al.* (2018) using an average of 50 randomly selected stomata. First, the ocular micrometer was placed carefully on the ocular eye lens, the stage micrometer was also placed on the stage, the point where the ocular micrometer and stage micrometer calibration meet was taken to arrive at a calibration factor. All measurements were done using an ocular micrometer after which each value was multiplied with the calibration scale according to the method described by Jakada (2016). The number of stomata per field was counted and the values were recorded.

Data Analyses

Numerical data obtained from parameters of microscopic characters of the leaves was subjected to analysis of variance (ANOVA) with Duncan's New Multiple Range Test (DNMRT) used to separate significant means at 5% level.

Results

There are no stomata observed at the upper epidermal layer of the leaves of all eight species of *Ficus* grown in Zaria. The result presented was of the lower epidermal layers of the leaves. The result for the comparison of stomatal cell length of *Ficus* species found in Zaria during wet and dry seasons is presented in Table 1. The result showed a significant difference ($P \leq 0.05$) in stomata cell length. *Ficus elastica* has the largest cell length of $50.24 \mu\text{m}$ during the dry season and $46.43 \mu\text{m}$ during the rainy season; it is followed by *F. religiosa* with a cell length of $42.51 \mu\text{m}$ in the wet season and $34.46 \mu\text{m}$ in the dry season. However, *F. platyphylla* has the lowest value of cell length ($23.32 \mu\text{m}$) during the dry season while *F.*

glumosa has the lowest value for stomatal cell length of $25.95 \mu\text{m}$ during the wet season.

Table 1: Variation in stomatal cells length of *Ficus* species found in Zaria

Species	Wet	Dry
<i>F. religiosa</i>	42.51 ± 0.71^b	34.46 ± 0.16^b
<i>F. polita</i>	27.95 ± 0.09^d	30.45 ± 0.15^c
<i>F. sycomorus</i>	-	25.95 ± 0.06^d
<i>F. platyphylla</i>	26.78 ± 0.08^d	23.32 ± 0.09^e
<i>F. capensis</i>	29.41 ± 0.15^c	26.37 ± 0.18^d
<i>F. natalensis</i>	30.38 ± 0.11^c	24.84 ± 0.09^e
<i>F. glumosa</i>	25.95 ± 0.09^e	25.12 ± 0.13^d
<i>F. elastica</i>	46.43 ± 0.19^a	50.24 ± 0.19^a

Keys: Values down a column with the same superscripts are NOT significantly different at $P=0.05$

Table 2 also showed significant variation ($P \leq 0.05$) in stomatal cell breath across the studied species of *Ficus* grown in Zaria. *Ficus elastica* has the largest cell breath of $43.25 \mu\text{m}$ during the dry season and $35.43 \mu\text{m}$ during the rainy season; then followed by *F. religiosa* with a cell breath of $21.87 \mu\text{m}$ in the wet season and $23.67 \mu\text{m}$ in *F. polita* during the dry season. Moreover, *F. capensis* has the lowest value for cell breath ($14.81 \mu\text{m}$) during the dry season while *F. natalensis* has the lowest value for stomatal cell breath of $15.78 \mu\text{m}$ during the wet season.

The result for the number of stomatal cells in the lower leaves of eight *Ficus* species grown in Zaria is shown in Table 3. The result also revealed a significant difference ($P \leq 0.05$) in the number of stomatal cells across seasons. During the wet season, *F. natalensis* recorded the highest number of stomatal cells (45 cells) followed by *F. capensis* with 34 cells. *F. religiosa* has the least number of stomatal cells during the wet season. In contrast, during the dry season, *Ficus sycomorus*

recorded the highest number of stomatal cells (47 cells) followed by *F. natalensis* with 45 cells. However, *Ficus polita* recorded the least number of cells (4 cells).

Table 2: Variation in stomatal cells breadth of *Ficus* species found in Zaria

Species	Wet	Dry
<i>F. religiosa</i>	21.87±0.11 ^b	22.91±0.06 ^b
<i>F. polita</i>	19.58±0.07 ^{cb}	23.67±0.08 ^b
<i>F. sycomorus</i>	-	18.48±0.05 ^d
<i>F. platyphylla</i>	21.73±0.07 ^b	18.20±0.07 ^d
<i>F. capensis</i>	20.97±0.09 ^c	14.81±0.06 ^f
<i>F. natalensis</i>	15.78±0.07 ^d	17.65±0.09 ^e
<i>F. glumosa</i>	20.97±0.06 ^c	20.90±0.07 ^c
<i>F. elastic</i>	35.43±0.16 ^a	43.25±0.16 ^a

N.B: Value(s) with the same superscripts down a column are NOT significantly different at P=0.05

Table 3: Variation in stomatal number of *Ficus* species found in Zaria with seasons

Species	Wet	Dry
<i>F. religiosa</i>	10.08±0.05 ^f	25.74±0.07 ^e
<i>F. polita</i>	31.86±0.08 ^c	3.86±0.04 ^h
<i>F. sycomorus</i>	-	47.4±0.07 ^a
<i>F. platyphylla</i>	31.94±0.04 ^c	33.98±0.07 ^c
<i>F. capensis</i>	34±0.08 ^b	29.9±0.09 ^d
<i>F. natalensis</i>	45.26±0.07 ^a	45.48±0.13 ^b
<i>F. glumosa</i>	22.82±0.11 ^d	21.62±0.09 ^f
<i>F. elastica</i>	14.48±0.05 ^e	16.78±0.08 ^g

N.B: Value(s) with the same superscripts down a column are NOT significantly different at P=0.05

Discussion

Stomatal morpho-anatomy has proved to be vital in taxonomic studies due to their vast taxonomic characteristics as stressed by Omolokun *et al.* (2023). The present study reported that *Ficus elastica* and *F. religiosa* have the highest values for stomatal length and width. This finding contradicts that of Shakir and Baji (2016) who reported low values for stomatal length and width in these species found in Iraq. This disparity could probably be attributed to the variation in climatic and edaphic conditions of the areas of study. Iraq where the latter was reported is more of a Sahel and Sahara compared to where the present study was carried out which is the Sudan Savanna zone of Nigeria. This study revealed the presence of stomata at the lower part of the leaves which conforms to the finding of Valenzuela (1998) and Sonibare *et al.* (2006) who individually reported stomata found on the lower surface only of *Ficus*.

Stomata are important structures involved in the exchange processes of the plant with the environment, balancing the CO₂ influx during photosynthesis and water vapor efflux during transpiration as reported by previous studies of Segev *et al.* (2015), Zhu *et al.* (2018) and Petra *et al.* (2020). Stomata exhibit a diverse range of shapes, sizes, and numbers across different plant species as stressed by Bertolino *et al.* (2019). The stomatal cell number of *Ficus* species during wet and dry seasons showed a significant difference in the lower epidermis. There were no stomata detected in the upper epidermis in all the species of *Ficus* grown in Zaria. This could be attributed to the fact that all the species of *Ficus* identified were grown close to the transition zone between the Sudan savanna and Sahel savanna of Nigeria as such adaptation to the xerophytic environment was set in. This finding conforms with that of Sanibore *et al.* (2005a, b) who also reported that similar growth patterns in plants result in close ranges in the number of stomata in *Ficus* species. Leaf stomata in plants from the same genus or

different plants of the same species are variable (Jia *et al.*, 2015).

Conclusion

There were no stomata detected in the upper epidermis in all the species of *Ficus* grown in Zaria. *Ficus elastica* has the stomata with the longest cell length of $46.43 \pm 0.19 \mu\text{m}$ and $50.24 \pm 0.19 \mu\text{m}$ in the wet and dry seasons respectively. Similarly, the same *Ficus elastica* have the stomata with the widest diameter across all the seasons while *Ficus sycomorus* has the highest number of stomatal cells.

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