



Seasonal Variation of Stomatal Characteristics of *Ficus* Species Grown in Zaria, North Western Nigeria

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ABSTRACT

Foliar stomatal characteristics are among the commonly used characters for the identification and delimitation of taxa. This study was carried out to determine variations in stomatal characteristics of some members in the Genus *Ficus* grown in Zaria, part of the Sudan Savanna zone of Nigeria. Eight different *Ficus* species grown in Zaria were used for the study. Microscopic observations of foliar stomatal characteristics were carried out following standard established protocols during both the dry and rainy seasons. Stomatal preparations were obtained using matured leaves by treating each leaf with sodium hypochlorite to clear the chlorophyll contents. Measurements of stomatal characters were made with the aid of an ocular micrometer and stage micrometer. Photomicrographs were taken. The data obtained were subjected to analysis of variance (ANOVA) with Duncan's New Multiple Range Test used to separate significant means at 5 % level. The result obtained revealed significant difference ($P \leq 0.05$) in the stomatal characteristics of the *Ficus* species with season. Anomocytic stomata was detected in all the species. There were variations with abaxial stomata cell length ranging from 23.32-50.24 μm in dry season and in the rainy season, the abaxial cell length ranged between 26.78-46.43 μm . Also, the stomatal index in the dry season ranged from 1.30% to 27.16% while in the rainy season, it ranged from 15.29 % to 23.19 %.

Keywords: *Ficus* species; Rainy and dry season; Stomata

INTRODUCTION

Ficus is among the most popular genera of flowering plants that vary in habits as either woody trees, shrubs, vines, epiphytes, or hemi epiphytes and is distributed in tropical and subtropical regions. Approximately 800 species are present in Tropical and Subtropical regions of the world (Adebayo *et al.*, 2009). These species of *Ficus* belong to the family Moraceae which was recently been placed in the order Rosales (APG II, 2003). Members of the genus *Ficus* are mostly recognized by their unique characteristic inflorescence, the syconium or hypanthodium, which are hollow bags of numerous male and female flowers (Ogunkunle and Oladele, 2008). The genus *Ficus* includes ornamental plants, roadside shrubs, climbers and evergreen or deciduous

trees (Shu, 2004). However, some members grow as independent trees but many start life as epiphytes (Ogunkunle and Oladele, 2008). There is therefore a close morphological similarity between members of the *Ficus* genus to the extent that some people mistakenly regard one for the other. Species delimitation is an integrative field that depends on increasingly diverse data types, yet it remains rife with arguments and opposing approaches. The use of leaf microepidermal features is found to be of immense interest in taxonomy and has been used by many authors in plant identification (Nwachukwu *et al.*, 2007). Stomatal variations serve as important strategy for plants to adapt to drought and hence evolved new species.



However, the understanding of how complexes of plant-functional traits vary along the continuum remains insufficient. This study therefore aimed at assessing variation in stomata characteristics of *Ficus* species within Zaria, North Western Nigeria.

MATERIALS AND METHODS

Study Site

The research was conducted at the Histology Laboratory of Department of Botany, Ahmadu Bello University, Zaria at latitude 11°11' N and longitude 7°73' E in the Northern Guinea Savannah zone of Nigeria.

Collection of Plant Materials

Leaves and fruits of eight (8) species representing the Genus *Ficus* of the family Moraceae were collected from the wild and cultivated lands. The species include: *F. polita*, *F. capensis*, *F. elastica*, *F. platyphylla*, *F. sycomorus*, *F. glumosa*, *F. reliogosa* and *F. natalensis*. These species were collected from different areas of Zaria metropolis, North-western Nigeria and the coordinates of the sampling collections were taken and documented. The area is characterized by a distinct rainy and dry season with an elevation of 613m above sea level. The area has an average annual temperature range of 15.3-36.25 °C and receives an average of 1050 mm of rainfall annually. Rainy season is essentially between June-September and dry season between October-April. The area is characterized by shorter grasses and the trees are fewer and more scattered. The species were authenticated at the Herbarium section of the Department of Botany, Faculty of Life Sciences, Ahmadu Bello University Zaria, Kaduna Nigeria.

Microscopic Examination of the Leaves of *Ficus* Species Stomatal studies

Fifty (50) fresh matured leaves from each species were collected from tree plants in the study area. The leaves were fixed and

preserved in formalin acetic alcohol (FAA) for 24 hours. Portions of the leaf (1 cm length) were cut and then transferred into a small container containing a 100ml solution of sodium hypochlorite which was left for 72 hours to remove the chlorophyll content (Abdulrahman and Oladele, 2005; Nuru *et al.*, 2018).

The treated leaves were placed on a microscope slide and stained with 2 drops of lactophenol cotton blue, covered with a clean cover slip and observed under the microscope ($\times 40$ mg, $\times 100$ mg and $\times 400$ mg). Characteristics of adaxial and abaxial surfaces such as; upper epidermal cell number, lower epidermal cell number, stomata type, stomata number on both epidermal cell surfaces, stomata length on both surfaces, stomata width on both surfaces, stomata size on both surfaces and frequency were observed and recorded. In addition, trichome type, number, length, width and size were also observed, measured and recorded using an Ocular eyepiece graticule and Stage micrometer at a $\times 40$ mg objective of the light microscope (Baker and Silverton, 1982; Abubakar *et al.*, 2011; Nuru *et al.*, 2018) using an average of 50 randomly selected stomata. First, the ocular micrometer was placed carefully on the ocular eye lens and 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 by the calibration scale (Jakada, 2016). The number of stomata per field and epidermal cells per field was counted and the values were recorded. A photomicrograph was taken using a camera attached to the light microscope.

The stomatal index (SI) was calculated using the formula described by Salisbury (1927) as cited by Munir *et al.* (2011) that is:



$$S.I = \frac{S}{S+E} \times 100$$

Where:

S denotes the number of stomata per unit area

E is the number of epidermal cells in the same unit area.

Data Analyses

Numerical data obtained from parameters of microscopic characters of the leaves was subjected to analysis of variance (ANOVA) using SAS (2008) version 9.0 to test for significance. The mean and standard error for each measured character were also calculated at 5% level of significance and Duncan's New Multiple Range Test (DNMRT) was used to separate the means.

RESULTS

The variation in stomatal characters in adaxial and abaxial surface of the selected eight *Ficus* species found in Zaria during the period of dry season (Table 1) showed that the length of the abaxial stomata ranged from 23.32 (*F. platyphylla*) to 50.24 μm (*F. elastica*). Also the abaxial stomatal breadth ranged from 14.81 (*F. capensis*) to 43.25 μm (*F. elastica*). However, the adaxial stomata for both the length and breadth were not detected in all the eight species. Also, the stomata number of the abaxial surface ranged from 3.86 (*F. polita*) to 47.40 μm (*F. sycomorus*). The stomata types of the abaxial surface were all anomocytic (Plate I) except for *F. natalensis* where stomata were absent. On the adaxial surfaces stomata was absent across (Plate II)

The variation in stomatal characters in adaxial and abaxial surface of the eight selected *Ficus* species found in Zaria during

the period of rainy season (Table 2) showed that the length of the abaxial stomata ranged from 26.78 (*F. platyphylla*) to 46.43 μm (*F. elastica*) and the abaxial stomata breadth ranged from 15.78 (*F. natalensis*) to 35.43 μm (*F. elastica*).

However, the adaxial stomata for both length and breadth were not detected in all the selected species of *Ficus*. Moreover, the stomata cell number of the abaxial surface ranged from 10.08 (*F. reliogosa*) to 42.26 μm (*F. natalensis*) but for the adaxial surface, the stomata cell number was absent. Furthermore, the stomata types of the abaxial surface were all anomocytic except for *F. sycomorus* and *F. Natalensis*.

The stomatal index (SI) of abaxial surface of eight selected *Ficus* species found in Zaria during the dry and rainy season is presented in Table 3. The stomatal index in the dry season ranged from 1.30 (*Ficus polita*) to 27.16 % (*Ficus sycomorus*) while in the rainy season it ranged from 15.29 (*Ficus platyphylla*) to 23.19% (*Ficus capensis*). There is significant difference ($P \leq 0.05$) in the stomatal index of *F. polita*, *F. capensis*, *F. glumosa* and *F. elastica* with variation in season. Also, the stomatal index was absent in *Ficus natalensis* for both seasons while in *Ficus sycomorus* the stomata were detected only in the rainy season



Table 1: Variation in Stomata Characters of *Ficus* species in Zaria during Dry Season

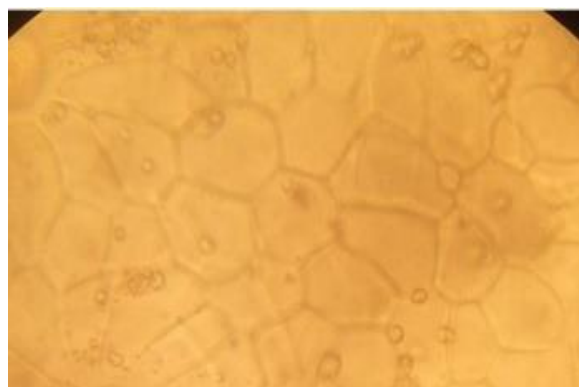
Taxa	Abaxial Stomata cells (µm)		Adaxial Stomata cells (µm)		Stomata cell No		Stomata cell type	
	Length	Breadth	Length	Breadth	Abaxial	Adaxial	Abaxial	Adaxial
<i>F. reliogosa</i>	34.46±1.1 ^b	22.91±0.4 ^b	-	-	25.74±0.5 ^e	-	Anomocytic	N-D
<i>F. polita</i>	30.45±1.0 ^c	23.67±0.6 ^b	-	-	3.86±0.3 ^h	-	Anomocytic	N-D
<i>F. sycomorus</i>	25.95±0.4 ^{de}	18.48±0.4 ^d	-	-	47.40±0.5 ^a	-	Anomocytic	N-D
<i>F. platyphylla</i>	23.32±0.7 ^e	18.20±0.5 ^d	-	-	33.98±0.5 ^c	-	Anomocytic	N-D
<i>F. capensis</i>	26.37±1.2 ^d	14.81±0.4 ^e	-	-	29.90±0.7 ^d	-	Anomocytic	N-D
<i>F. natalensis</i>	24.84±0.7 ^{de}	17.65±0.6 ^d	-	-	45.48±0.9 ^b	-	N-D	N-D
<i>F. glumosa</i>	25.12±0.9 ^{de}	20.91±0.5 ^c	-	-	21.62±0.7 ^f	-	Anomocytic	N-D
<i>F. elastica</i>	50.24±1.3 ^a	43.25±1.1 ^a	-	-	16.78±0.5 ^g	-	Anomocytic	N-D

Key: Values (means) with the same superscript(s) along column are not significantly different; **ND= Not detected**

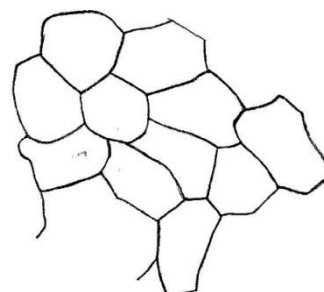
Table 2: Variation in Stomata Characters of *Ficus* species in Zaria during Rainy Season

Taxa	Abaxial Stomata cells (µm)		Adaxial Stomata cells (µm)		Stomata cell No		Stomata cell type	
	Length	Breadth	Length	Breadth	Abaxial	Adaxial	Abaxial	Adaxial
<i>F. reliogosa</i>	42.51±1.2 ^b	21.87±0.8 ^b	-	-	10.08±0.4 ^f	-	Anomocytic	N-D
<i>F. polita</i>	27.95±0.7 ^{cd}	19.58±0.5 ^c	-	-	31.86±0.6 ^c	-	Anomocytic	N-D
<i>F. sycomorus</i>	-	-	-	-	-	-	N-D	N-D
<i>F. platyphylla</i>	26.78±0.5 ^d	21.73±0.5 ^{bc}	-	-	31.94±0.3 ^c	-	Anomocytic	N-D
<i>F. capensis</i>	29.78±0.5 ^d	20.97±0.7 ^{bc}	-	-	34.00±0.6 ^b	-	Anomocytic	N-D
<i>F. natalensis</i>	30.38±0.8 ^c	15.78±0.5 ^d	-	-	42.26±0.5 ^a	-	N-D	N-D
<i>F. glumosa</i>	25.95±0.6 ^b	20.97±0.4 ^{bc}	-	-	22.82±0.8 ^d	-	Anomocytic	N-D
<i>F. elastica</i>	46.43±1.3 ^a	35.43±1.1 ^a	-	-	14.48±0.4 ^e	-	Anomocytic	N-D

Key: Values (means) with the same superscript(s) along column are not significantly different; **ND= Not detected**

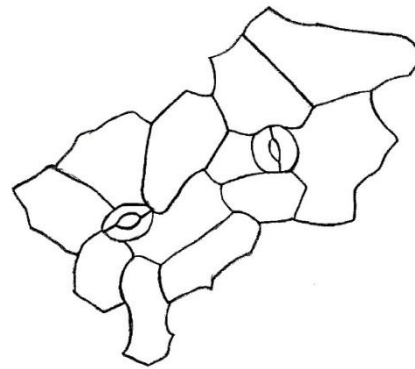
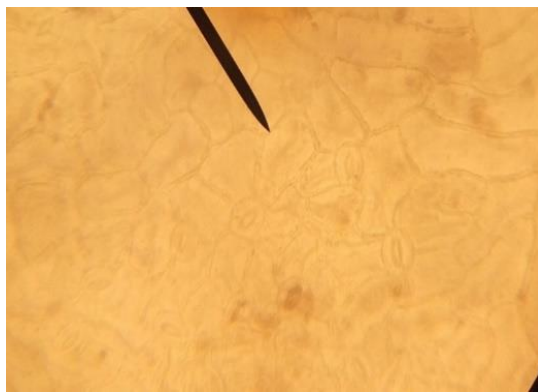


(a)



(b)

Plate I (a) Photomicrograph of Adaxial surface of *Ficus glumosa* found in Zaria during the dry season showing only epidermal cells with no stomata detected. Mg: x400. (b) Adaxial surface of *Ficus glumosa* found in Zaria during the dry season showing only epidermal cells with no stomata detected



(a)

(b)

Plate II (a): Photomicrograph of Abaxial surface of *Ficus glumosa* found in Zaria during the dry season showing Anomocytic type of stomata. Mg: x400.(b) Abaxial surface of *Ficus glumosa* found in Zaria during the dry season showing Anomocytic type of stomata

Table 3: Variation in Stomatal index (SI) lower epidermis (Abaxial) surface of Eight *Ficus* species in Zaria during Dry and Rainy Seasons

Taxa	Dry season (%)	Rainy season (%)
<i>F. reliogosa</i>	18.23±0.28 ^a	19.23±0.57 ^a
<i>F. polita</i>	1.30±0.10 ^b	16.00±0.26 ^a
<i>F. sycomorus</i>	27.16±0.27 ^a	-
<i>F. platyphylla</i>	16.14±0.26 ^a	15.29±0.38 ^a
<i>F. capensis</i>	21.29±0.35 ^b	23.19±0.32 ^a
<i>F. natalensis</i>	-	-
<i>F. glumosa</i>	14.59±0.43 ^b	19.32±0.53 ^a
<i>F. elastica</i>	11.00±0.32 ^b	15.29±0.14 ^a

Key: Means with the same superscript across a row are not significantly different at P=0.05.

DISCUSSION

This study confirms the presence of anomocytic stomata only on the abaxial surface of all the species of *Ficus* selected from Zaria in both rainy and dry season except for *Ficus natalensis* where there were no stomata on both the abaxial and adaxial surface of the species in both rainy and dry season. Although *Ficus sycomorus* showed the absence of stomata during the rainy season on both surfaces, the absence has been earlier reported by the findings of Shakir and Baji (2016) who also reported no stomata on the adaxial surface of some species of *Ficus* such as *Ficus carica*, *Ficus reliogosa* and *Ficus elastica*

The variation on the abaxial stomatal characteristics of *Ficus* species selected

from Zaria during dry season showed that there is significant difference in the length and breadth of the stomata found in *Ficus elastica* when compared to other species. The present study reported high stomatal size in *Ficus elastica* above all that of the remaining species probably due to its larger leaves. The finding corroborates with that of Sonibare *et al.* (2006)

However, this study reported no stomata detected on the abaxial surface of all the *Ficus* species which is in line with the finding of Valenzuela (1998), Sanibore (2006) and Shakir and Baji (2016) who individually reported similar findings among *Ficus* species.



Similarly, the absence of stomata on the abaxial surface of *Ficus sycomorus* leaves in the rainy season could be ascribed to the relative concentrations of trichomes which make the stomata invisible. Although, during the rainy season there were no stomata detected on both the abaxial and adaxial surface of *Ficus sycomorus*. This could have been due to the variations in environmental conditions in the growing seasons of these plants as stressed by Berg (2003). The variation in the stomatal index

of all the species of *Ficus* selected from Zaria in the dry season agrees with the work of Shakir and Baji (2016) in some species of *Ficus* in Iraq.

CONCLUSION

It was concluded that there is variation in the stomatal characteristics of *Ficus* species across seasons, with all the species having Anomocytic stomatal type. The stomatal size also varies with season and species with *F. elastica* having the largest stomata.

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