# COMPARATIVE FOLIAR EPIDERMAL STUDY ON SOME SPECIES OF *Senna* FOUND IN MINNA, NIGER STATE, NIGERIA

Supported by tetfund

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**Received:** December 12, 2020 **Accepted:** February 16, 2021

Abstract: Comparative foliar epidermal morphology of some species of *Senna* were studied in Minna. These include *Senna alata* (L.) Roxb, *Senna hirsuta* (L.) Irwin and Barneby, *Senna obtusifolia* (L), *Senna occidentalis* (L.). All species were shrubs. Leaves of four species of *Senna* were collected from different areas in Minna. Strips of epidermal layers were gotten from the adaxial and abaxial surfaces of the leaves and viewed under the microscope. The number, length and breadth of the stomata and epidermal cells were taken for both adaxial and abaxial surfaces. The morphological and anatomical data obtained were subjected to Analysis of Variance (ANOVA), while Duncan Multiple Range Test was used to separate the means where significant. Stomata were paracytic and anisocytic in most of the studied species except for *S. hirsuta* which was paracytic all through. There was variation in the length of stomata which was highest in *S. hirsute* (28.11±0.90 µm) and lowest in *S. alata* (20.38±0.62 µm). Trichome height was longer in *S. hirsuta* (595.27±30.89 µm) and shorter in *S. alata* (230.45±25.76 µm) reflects their taxonomic delimitation. Trichome was absent on both the adaxial and abaxial surface of *S. occidentalis* in both seasons. Stomata were found on both surfaces of the studied plants (amphistomatic).All species were Amphistomatic with an anisocytic and paracytic type of stomata, a sinuous to polygonal cell shapes with a non glandulartrichome. No trichome present in *Senna occidentalis.* In terms of stomata size, *Senna hirsuta* and *Senna alata* varied significantly. Stomatal index varied significantly as it is higher on the abaxial surface than on the adaxial surface in both seasons.

**Keywords:** *Senna*, foliar epidermal, stomata, trichomes, Minna

## Introduction

*Senna* is a flowering plant in the legume family Fabaceae, the subfamily Caesalpinoideae and the tribe Cassieae (Azani *et al.*, 2017). *Senna* Mill of Caesalpinoideae is a large, widespread genus and exhibits a high diversity of habits including herbs, shrubs and tall trees. The genus comprises 350 species and about 80% of its species occur in the American continent, while most of the remaining members are found in tropical Africa, Madagascar and Australia, and only a few species occur in South-eastern Asia and Pacific Island (Marazzi *et al*., 2006; Aworinde and Fawibe, 2014). It is native throughout the tropics, with a small number of species in temperate regions which is estimated to be from about 260 to 350 (Marazzi *et al*., 2006; Nuru *et al*., 2018).

In West Africa, the genus contains about 22 indigenous species apart from those introduced or cultivated (Hutchinson and Daziel, 1958; Nuru *et al*., 2018). Mike *et al*. (2010) reported about 19 species in West African floristic region with the whole 19 species in Nigeria (Soladoye and Lewis, 2003), at least 8 species in South Western Nigeria especially in Oyo and Ogun States and at least 7 species in Northern Nigeria especially in Zaria, Kaduna (Nuru *et al.*, 2018). They are characterized by presence of extra-floral nectaries, ebracteolate pedicels, straight or simply incurved filaments, flattened or cylindrical, irregularly dehiscent pods and areolate seeds. Economically *Senna* species have ornamental and natural medicine purposes, wood production, degraded area restoration, weeds and food for man (Nuru *et al.*, 2018) and also vegetable sources. Despite its usefulness in pharmacognocy, other botanical approaches remain fragmentary. Therefore, this research aims to evaluate the Comparative Leaf epidermal morphology of some species of *Senna* found in Minna, Niger state. Nigeria.

## Materials and Methods

Minna is located at latitude 9˚,16' N, and longitude 6˚,54' E with an elevation of 258.5 m above sea level), in the Southern Guinea savannah zone of Nigeria. Climate of Minna is sub humid with mean annual rainfall of about 1284 mm and a distinct dry season of about 5 months duration occurring from November to March. The mean maximum temperature remains high throughout the year, about 33.5˚C particularly in March and June (Ojanuga, 2006).

### *Collection of plant materials*

Leaves of four species of *Senna* were collected from different areas in Minna, Southern Guinea savannah region of Nigeria. These species include: *Sennaalata* (candle plant), *Senna obtusifolia*, (Sickle pod), *Sennahirsuta* (hairy Senna), and *Senna occidentalis* (coffee Senna). The plant species were authenticated at the Herbarium unit of the Department of Botany, faculty of life sciences, Ahmadu Bello University Zaria, Kaduna Nigeria.

**Table 1: Sampling locations of *Senna* species in Minna, Southern Guinea Savannah**

| S/N | Species name | Longitude | Latitude | Voucher Number | Habit | Collection site |
|---|---|---|---|---|---|---|
| 1 | *Sennaalata* | 4°30'51"E | 9°52'51"N | ABU1236 | Shrub | Camp quarters |
| 2 | *Senna hirsute* | 4°34'53"E | 9°49'21"N | ABU7174 | Shrub | College of wildlife |
| 3 | *Sennaobtusifolia* | 4°30'42"E | 9°53'33"N | ABU1370 | Shrub | Millionaire quarters |
| 4 | *Sennaoccidentalis* | 4°30'52"E | 9°52'50"N | ABU1047 | Shrub | Ibadan way |

***Macro- morphological study of Senna leaves***

Fifty (50) samples of matured leaf per species were randomly selected and used for assessment of morphological character. This include the measurement of leaflet length, leaflet width, length of petiole, which was done using a meter rule. The morphological characters such as leaf shape, leaf apex, leaf margin, leaf arrangement, and leaf base were physically examined and recorded. This followed the techniques of (Soladoye *et al*., 2010).

***Epidermal studies***

The method of Abdulrahman and Oladele, (2005) was adopted. Fresh matured leaves were collected from mature plants in the study area. The leaves were fixed and preserved in formalin acetic alcohol (FAA) for 24 h. A portion of the leaf was then transferred into a small container containing sodium hypochlorite solution which was left for 24 h to remove the chlorophyll content. The peels were rinsed in tap water andplaced on a microscope slide, stained with lactophenol cotton blue, covered with a clean cover slip and observed under the microscope. Characters of adaxial and abaxial surfaces such as; epidermal cell number, stomata type, stomata number on both epidermal cell surfaces, stomata length, stomata width were measured and recorded. In addition, trichome type, number, length, width and size were also measured and recorded using an Ocular eye piece graticule and Stage micrometer at a ×40 objective of the light microscope as described by Baker and Silverton (1982); Abubakar *et al*. (2011); Nuru *et al*. (2018) using an average of 50 randomly selected stomata. Photomicrographs were taken using a HD camera model attached to a light microscope. The stomatal index (SI) was calculated using a standard formula (Salisbury, 1927; Bolarinwa *et al*., 2018).

That is:

$$SI = \frac{S}{S + E} \, x \, 100$$

**Where:** *S* denotes the number of stomata per unit area and *E* the number of epidermal cells in the same unit area

***Data analyses***

Data obtained from micro morphological characters were subjected to analysis of variance (ANOVA) and Duncan`s Multiple Range Test (DMRT) was used to separate the means at 5% level of significance.

**Results and Discussion**

***Macromorphological examination of Senna Mill. found in Minna***

The leaf shapes were oblong (*S. alata*), lanceolate/obovate (*S. obtusifolia*) and ovate in *S. occidentalis* and *S. hirsuta*. The leaf base was round (*S. alata*), oblique/obtuse (*S. obtusifolia*), oblique/acute (*S. occidentalis*) and acute (*S. hirsuta*). The leaf margin for all the species was entire. The leaf apex of *S. alata* and *S. obtusifolia* are round, *S. occidentalis* was acuminate and *S. hirsuta* was acute. The leaves of *S. alata, S. occidentalis, S. hirsute* were oppositely arranged while *S. obtusifolia* was alternately arranged (Table 2).

**Table 2: Leaf qualitative morphological features of *Senna* species studied in Minna**

| S/N | Taxa name | Leaf shape | Leaf base | Leaf apex | Leaf arrangement | Leaf margin |
|---|---|---|---|---|---|---|
| 1 | *Senna alata* | Oblong | Round | Round | Opposite | Entire |
| 2 | *Senna obtusifolia* | Obovate/lanceolate | Oblique/obtuse | Obtuse | Alternate | Entire |
| 3 | *Senna occidentalis* | Ovate | Oblique/Acute | Acuminate | Opposite | Entire |
| 4 | *Senna hirsute* | Ovate | Acute | Acute | Opposite | Entire |

**Table 3: Quantitative data of *Senna* Mill. leaves found in Minna during rainy and dry season**

| Taxa | Rainy season | | | | Dry season | | | |
|---|---|---|---|---|---|---|---|---|
| | LN | LL | LB | LP | LN | LL | LB | LP |
| *S. alata* | 9.38±0.347$^{a}$ | 12.50±0.095$^{a}$ | 5.27±0.068$^{a}$ | 0.31±0.012$^{a}$ | 15.76±0.633$^{a}$ | 8.91±0.262$^{a}$ | 3.78±0.168$^{a}$ | 0.22±0.006$^{b}$ |
| *S. obtusifolia* | 5.20±0.146$^{c}$ | 4.26±0.080$^{d}$ | 2.85±0.048$^{c}$ | 0.16±0.007$^{d}$ | 5.54±0.212$^{c}$ | 2.20±0.068$^{d}$ | 1.27±0.037$^{d}$ | 0.14±0.071$^{c}$ |
| *S. occidentalis* | 8.24±0.258$^{b}$ | 4.91±0.073$^{c}$ | 2.34±0.044$^{d}$ | 0.20±0.008$^{c}$ | 5.72±0.256$^{c}$ | 4.94±0.139$^{c}$ | 2.33±0.049$^{c}$ | 0.20±0.011$^{b}$ |
| *S. hirsute* | 8.12±0.351$^{b}$ | 7.30±0.181$^{b}$ | 3.12±0.063$^{b}$ | 0.25±0.009$^{b}$ | 7.42±0.234$^{b}$ | 6.81±0.305$^{b}$ | 3.37±0.096$^{b}$ | 0.29±0.010$^{a}$ |

Mean±SE; LN= Leaflet Number, LL=Leaflet Length, LB=Leaflet Breadth, LP=Length of Petiolate
Values in column with same superscripts are not significantly different (p≥0.05)

Quantitative leaf morphology of *Senna* studied in Minna in the rainy and dry season (Table 3) showed that *S. alata* recorded high leaflet number in both seasons while *S. obtusifolia* recorded the least number of leaflet in both seasons. The leaflet length varied between 12.50±0.09 µm in *S. alata* to 4.26±0.08 µm in *S. obtusifolia* during the rainy season and 8.91±0.2 to 2.2±0.06 µm during the dry season.

***Micro morphological examination of Senna Mill. leaves found in minna in the rainy and dry season***

The forms and shapes of epidermal cells of all the examined species varied from sinuous to polygonal shape. *S. alata* shape was sinuous on both surfaces; *S. obtusifolia* shows a polygonal to irregular cell shape. However, significant difference was not observed on the length and number of epidermal cell in both the adaxial and abaxial surfaces. On the adaxial surface, *S. hirsute* recorded 26 epidermal number with a length of 36.04 µm while on the abaxial surface, *S. hirsute* recorded 15cell number with a length of 37.67 µm (Table 4).

Trichomes was present in *S. hirsuta* and absent in the other species on the adaxial surfaces during the rainy season. However, with the exception of *S. hirsute* which has a trichome number of 17 and length of 738.94 µm, trichomes were absent in the remaining *Senna* species on the adaxial surface. On the abaxial surface, trichome was present in all the species except in *S. occidentalis*. *S. alata* recorded the highest number of trichome (13) and a length of 230.45 µm and the least number was recorded in *S. obtusifolia* (9) with a length of 431.98 µm While trichomes was absent in *S. occidentalis* and present in the other species on the abaxial surface (Table 5).

The result for the variation in stomatal characteristics of various *Senna* species in Minna (Table 6) showedthat stomata was present on both surfaces in all the species

(Amphistomatic). Paracytic and Anisocytic were observed. The result showed that *S. hirsuta* has the highest number of stomata (18 stomata) on the abaxial surface which are 27.04 µm in length. While, *S. obtusifolia* has the least number of stomata (11) on abaxial surface with 25.15 µm in length. However, on the adaxial sides, *S. occidentalis* has the highest number of stomata (17) that are 27.21 µm in length while *S. hirsuta* has the least number of stomata (13) that are 28.11 µm in length. Furthermore, all the species of *Senna* were found to possessed paracytic type of stomata at the adaxial sides except in *S. alata* where anisocytic type of stomata was found in addition to paracytic type. *S. alata* recorded the highest number of trichomes (15) and (13) with a length of 180.99 and 137.13 µm on the abaxial and adaxial surfaces respectively in the dry season

However, the microscopic studies of *Senna* leaf epidermis found in Minna during the dry season revealed the presence of non-glandular trichomes. The distribution of these trichomes appeared to be uniform on both the abaxial and adaxial surfaces except for *S. occidentalis* where trichomes were not detected on both surfaces**.** The morphological characteristics of the four *Senna* species were shown in Plates 1 – 14.

**Table 4: Micro morphological examination of *Senna* Mill. leaves found in Minna during the rainy and dry season**

| Taxa | Southern Guinea Savannah( Minna) Rainy | | | | | | | | Southern Guinea Savannah (Minna) Dry | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Abaxial Epidermal cell (µm) | | Adaxial Epidermal cell (µm) | | Epidermal cell Number | | Epidermal cell Types | | Abaxial Epidermal cell (µm) | | Adaxial Epidermal cell (µm) | | Epidermal cell Number | | Epidermal cell Types | |
| | L | B | L | B | Ab | Ad | Ab | Ad | L | B | L | B | Ab | Ad | Ab | Ad |
| *S. alata* | 36.91 ±1.82$^{a}$ | 21.19 ±1.11$^{b}$ | 29.43 ±0.69$^{b}$ | 18.59 ±0.83$^{b}$ | 30.60 ±1.14$^{a}$ | 22.92 ±0.68$^{b}$ | S | S | 30.99± 0.68$^{b}$ | 19.22 ±0.55$^{a}$ | 30.19 ±1.28$^{c}$ | 19.13± 0.72$^{c}$ | 32.26 ±1.09$^{b}$ | 29.80 ±1.02$^{b}$ | S | S |
| *S. obtusifolia* | 31.71 ±1.48$^{b}$ | 16.80 ±0.79$^{c}$ | 38.16 ±1.83$^{a}$ | 19.13 ±0.92$^{b}$ | 23.94 ±0.69$^{b}$ | 23.08 ±0.89$^{b}$ | P | P | 34.69± 1.75$^{a}$ | 16.26 ±0.74$^{b}$ | 33.06 ±1.48$^{c}$ | 14.15± 0.53$^{d}$ | 34.32 ±0.99$^{ab}$ | 33.80 ±1.09$^{a}$ | P | P |
| *S. occidentalis* | 28.94 ±1.04$^{b}$ | 24.69 ±1.78$^{a}$ | 29.65 ±0.85$^{c}$ | 16.37 ±0.77$^{c}$ | 24.68 ±1.55$^{b}$ | 23.84 ±1.18$^{b}$ | P | P | 29.21± 0.95$^{b}$ | 16.91 ±0.94$^{b}$ | 40.76 ±2.01$^{b}$ | 22.60 ±1.09$^{b}$ | 35.34 ±1.04$^{a}$ | 24.14 ±1.05$^{c}$ | I/P | I/P |
| *S. hirsute* | 37.67 ±1.48$^{a}$ | 18.10 ±0.85$^{bc}$ | 36.04 ±1.29$^{a}$ | 25.58 ±0.42$^{a}$ | 15.52 ±0.84$^{c}$ | 26.62 ±0.84$^{a}$ | P | P | 34.47± 1.39$^{a}$ | 20.76 ±0.88$^{a}$ | 48.08 ±1.48$^{a}$ | 29.38± 1.26$^{a}$ | 35.80 ±1.08$^{a}$ | 34.78 ±0.98$^{a}$ | P | P |

**N.B: *Means with the same letter per column is not significantly different (P≥0.05);** S.E (±) = Standard Error, L= Length, B= Breadth, Ab= Abaxial, Ad= Adaxial; **S.E (±) = Standard Error, S= Sinuous, P= Polygonal, I= Irregular**

**Table 5: Micro morphological examination of *Senna* Mill. leaves found in Minna during the rainy and dry season**

| Taxa | Southern Guinea Savannah (Minna) Rainy | | | | | | | | Southern Guinea Savannah (Minna) Dry | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Abaxial Trichome (µm) | | Adaxial Trichome (µm) | | Trichome Number | | Trichome Types | | Abaxial Trichome (µm) | | Adaxial Trichome (µm) | | Trichome Number | | Trichome Types | |
| | L | B | L | B | Ab | Ad | Ab | Ad | L | B | L | B | Ab | Ad | Ab | Ad |
| *S. alata* | 230.45 ±25.76$^{c}$ | 39.19 ±1.36$^{b}$ | 0.00± 0.00$^{b}$ | 0.00± 0.00$^{b}$ | 13.38± 0.85$^{a}$ | 0.00± 0.00$^{b}$ | NG | ND | 180.99 ±8.39$^{b}$ | 38.07± 1.36$^{b}$ | 137.15 ±6.85$^{b}$ | 37.13± 1.54$^{b}$ | 15.38 ±0.57$^{a}$ | 13.38± 0.68$^{ab}$ | NG | NG |
| *S. obtusifolia* | 431.98 ±21.76$^{b}$ | 44.78 ±2.76$^{a}$ | 0.00± 0.00$^{b}$ | 0.00± 0.00$^{b}$ | 9.36± 0.66$^{c}$ | 0.00± 0.00$^{b}$ | NG | ND | 454.37 ±17.77$^{a}$ | 42.54± 0.81$^{a}$ | 482.36 ±21.27$^{a}$ | 41.43± 1.04$^{a}$ | 10.16 ±0.30$^{c}$ | 14.228 ±0.69$^{a}$ | NG | NG |
| *S. occidentalis* | 0.00± 0.00$^{d}$ | 0.00± 0.00$^{d}$ | 0.00± 0.00$^{b}$ | 0.00± 0.00$^{b}$ | 0.00± 0.00$^{d}$ | 0.00± 0.00$^{b}$ | ND | ND | 0.00± 0.00$^{c}$ | 0.00± 0.00$^{c}$ | 0.00± 0.00$^{c}$ | 0.00± 0.00$^{c}$ | 0.00± 0.00$^{d}$ | 0.00± 0.00$^{c}$ | ND | ND |
| *S. hirsute* | 595.27 ±30.89$^{a}$ | 34.71 ±1.16$^{b}$ | 738.94 ±19.92$^{a}$ | 43.48 ±1.09$^{a}$ | 11.44 ±0.55$^{b}$ | 17.40± 1.66$^{a}$ | NG | NG | 462.74 ±24.06$^{a}$ | 35.83± 0.89$^{b}$ | 507.49 ±23.83$^{a}$ | 33.96± 1.11$^{b}$ | 13.54 ±0.77$^{b}$ | 12.42± 0.73$^{b}$ | NG | NG |

**N.B: *Means with the same letter per column is not significantly different (P≥0.05);** S.E (±) = Standard Error, L= Length, B= Breadth, Ab= Abaxial, Ad= Adaxial; **S.E (±) = Standard Error, NG Non Glandular, ND= Not Detected**

**Table 6: Micro morphological examination of *Senna* Mill. leaves found in Minna during the rainy and dry season**

| Taxa | Southern Guinea Savannah (Minna) Rainy | | | | | | | | Southern Guinea Savannah (Minna) Dry | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AbaxialStomatal cell(µm) | | Adaxial Stomatal cell (µm) | | Stomatal cell No. | | Stomatal cell Types | | Abaxial Stomatal cell(µm) | | AdaxialStomatal cell(µm) | | Stomatal cell No. | | Stomatal cell Types | |
| | L | B | L | B | Ab | Ad | Ab | Ad | L | B | L | B | Ab | Ad | Ab | Ad |
| *S. alata* | 20.38 ±0.62$^{b}$ | 12.57 ±0.49$^{c}$ | 28.18 ±0.81$^{a}$ | 16.64 ±0.71$^{b}$ | 13.74 ±0.58$^{b}$ | 11.34 ±0.65$^{b}$ | P | P | 19.94 ±0.70$^{c}$ | 11.54 ±0.35$^{b}$ | 23.90 ±0.48$^{c}$ | 13.01 ±0.31$^{a}$ | 12.34 ±0.79$^{c}$ | 10.94 ±0.41$^{b}$ | P | P |
| *S. obtusifolia* | 25.75 ±1.12$^{a}$ | 15.34 ±0.65$^{b}$ | 25.15 ±0.51$^{b}$ | 14.96 ±0.69$^{bc}$ | 14.04 ±1.04$^{b}$ | 11.04 ±0.38$^{b}$ | A | P | 24.44 ±0.85$^{b}$ | 14.54 ±0.49a | 25.85 ±1.13$^{bc}$ | 14.09 ±0.59$^{a}$ | 10.72 ±0.33$^{c}$ | 10.96 ±0.51$^{b}$ | A | A |
| *S. occidentalis* | 27.21 ±0.66$^{a}$ | 14.91 ±0.55$^{b}$ | 17.29 ±1.03$^{c}$ | 13.12 ±0.31$^{c}$ | 17.34 ±0.95$^{a}$ | 17.64 ±0.67$^{a}$ | A | P | 28.24 ±0.54$^{a}$ | 14.09 ±0.54$^{a}$ | 28.51 ±0.74$^{ab}$ | 11.33 ±0.41$^{b}$ | 34.34 ±1.02$^{a}$ | 20.30 ±0.80$^{a}$ | A | A |
| *S. hirsuta* | 28.11 ±0.90$^{a}$ | 17.67 ±0.89$^{a}$ | 27.05 ±0.81$^{ab}$ | 19.46 ±0.86$^{a}$ | 13.32 ±0.49$^{b}$ | 18.14 ±0.73$^{a}$ | P | P | 28.78 ±0.67$^{a}$ | 13.55 ±0.29$^{a}$ | 30.51 ±1.16$^{a}$ | 13.33 ±0.46$^{a}$ | 19.34 ±0.79$^{b}$ | 19.36 ±0.98$^{a}$ | P | P |

**N.B: *Means with the same letter per column is not significantly different (P≥0.05);** S.E (±) = Standard Error, L= Length, B= Breadth, Ab= Abaxial, Ad= Adaxial; **S.E (±) = Standard Error, A= Anisocytic, P= Paracytic**

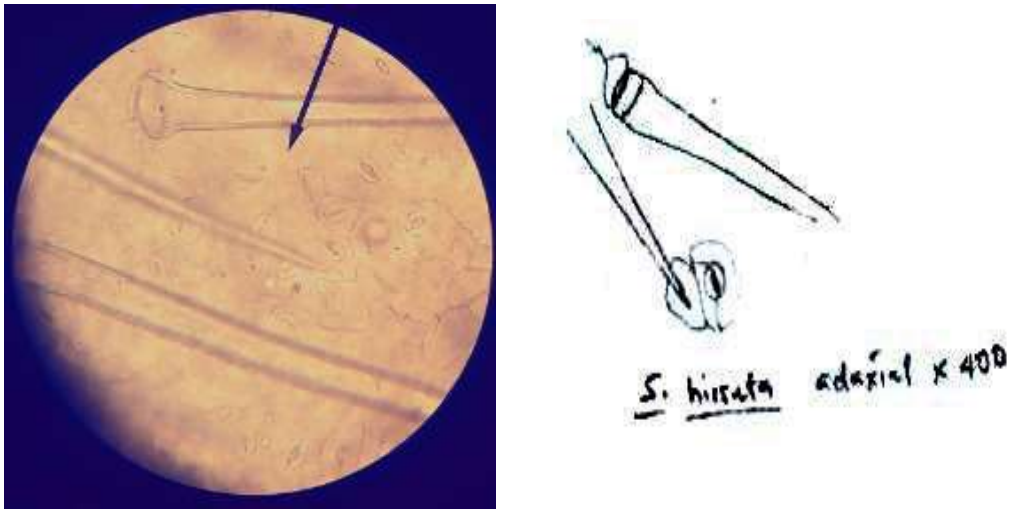


**Plate 1: *S. hirsuta* Non glandular trichome (adaxial) x400**


**Plate 2: *S. hirsuta* Non glandular trichome (abaxial) x400**

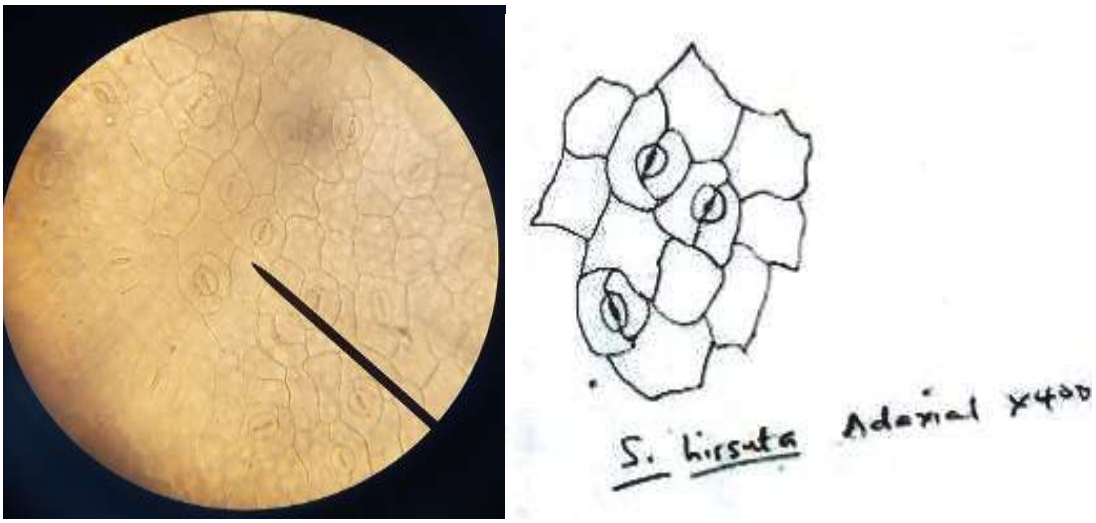


**Plate 3: *S. hirsuta* Paracytic stomata and polygonal/ irregular epidermal cell (adaxial) x400**

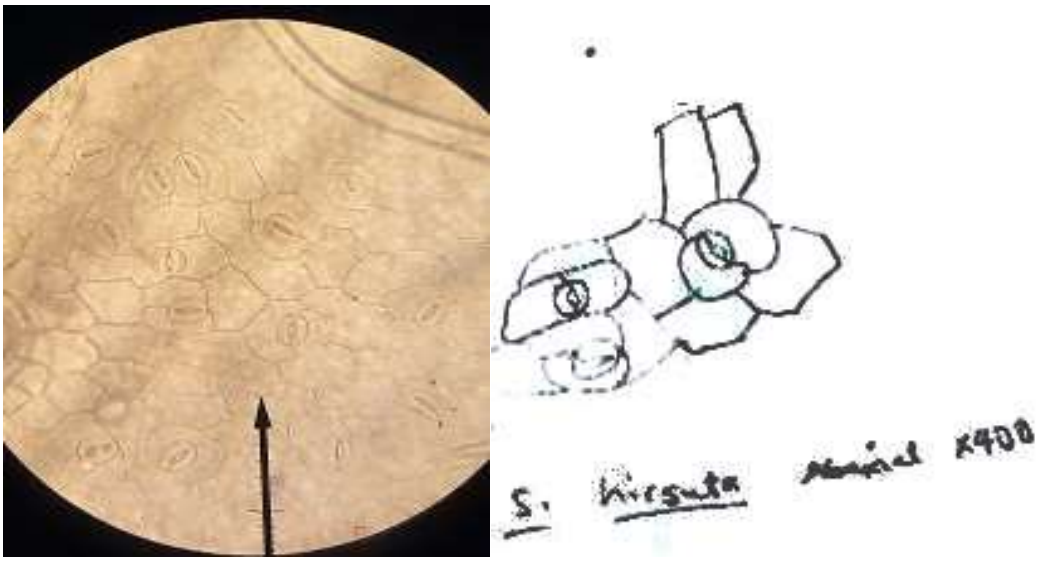


**Plate 4: *S. hirsuta* Paracytic stomata and polygonal/ irregular epidermal cell (abaxial) x400**

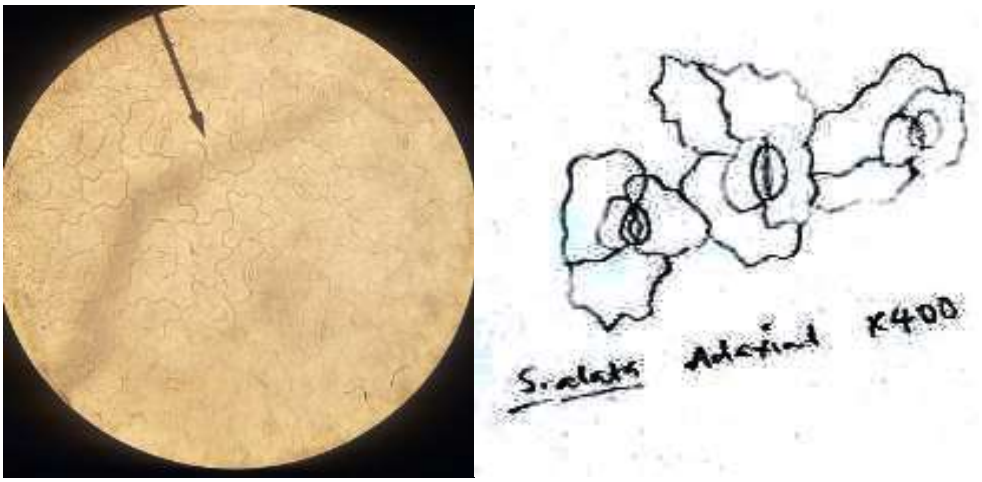


**Plate 5: *S. alata* Anisocytic stomata and sinuous epidermal cell (adaxial) x400**

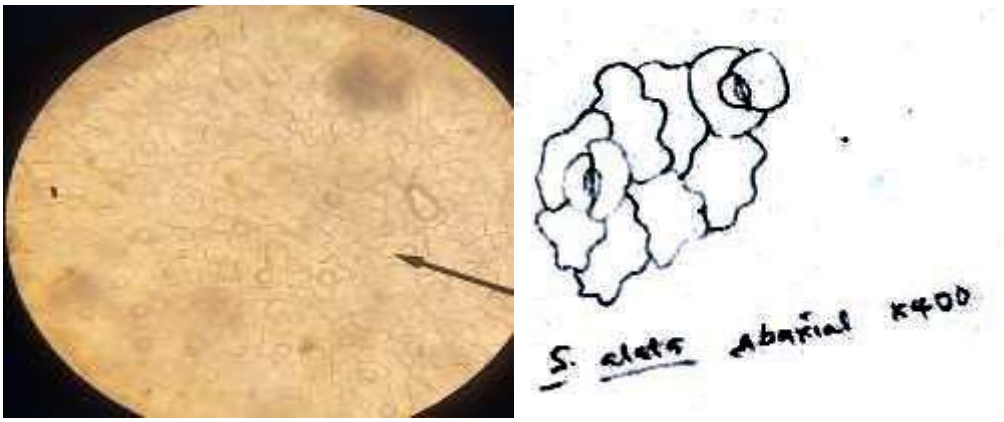


**Plate 6: *S. alata* Anisocytic stomata and sinuous epidermal cell (abaxial) x400**

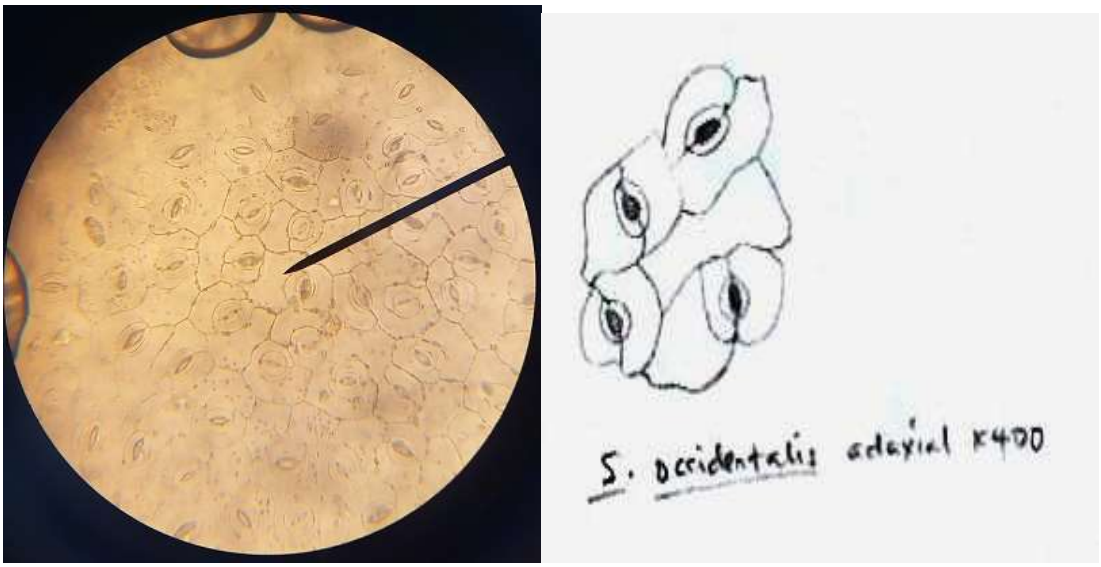


**Plate 7: *S. occidentalis* Anisocytic stomata and polygonal epidermal cell (adaxial) x400**

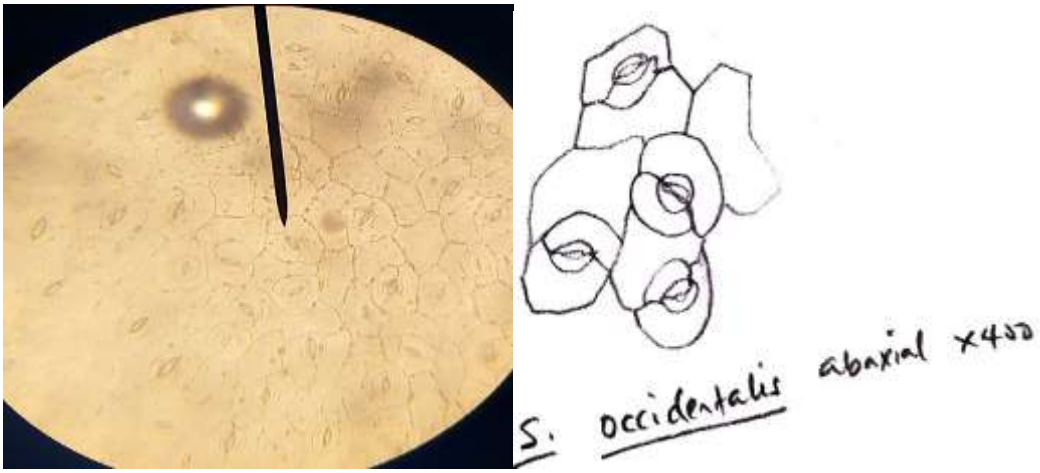


**Plate 8: *S. occidentalis* anisocytic stomata and polygonal epidermal cell (abaxial) x400**

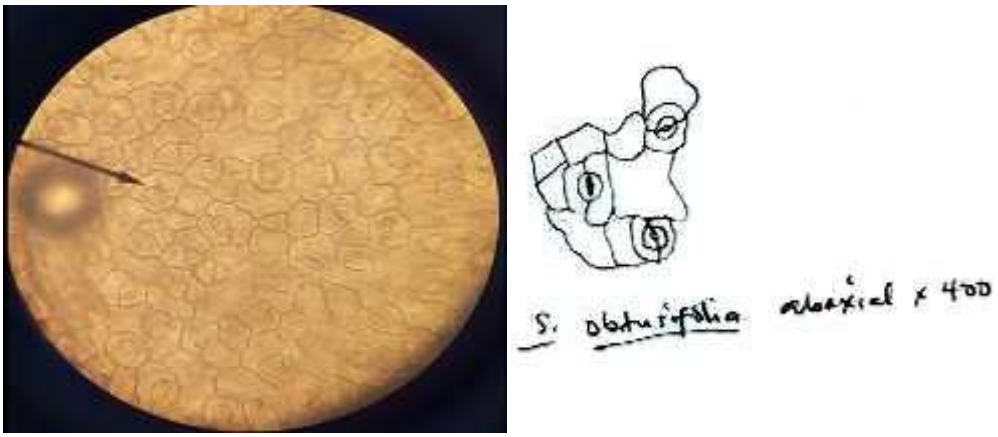


**Plate 9: *S. obtusifolia* anisocytic/paracytic stomata and polygonal epidermal cell (abaxial) x400**

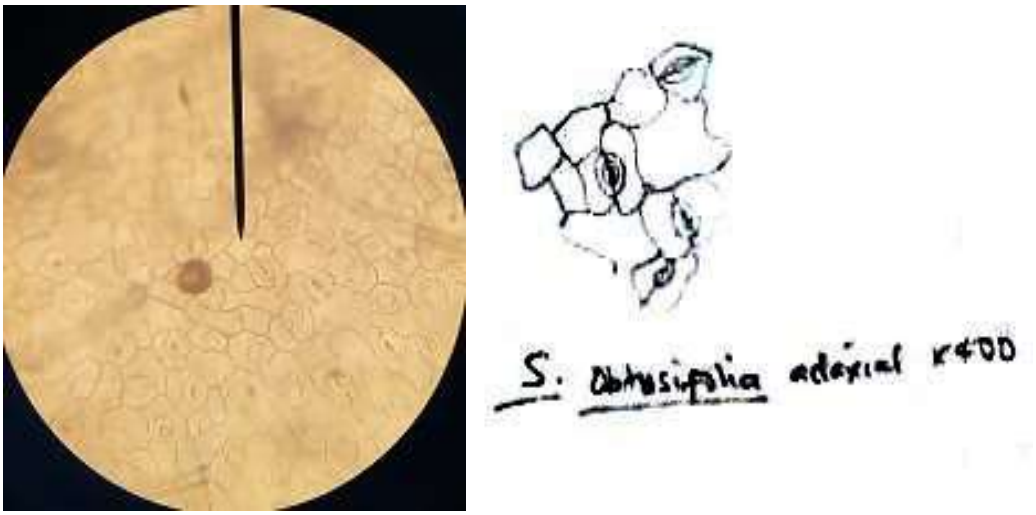


**Plate 10: *S. obtusifolia* anisocytic/paracytic stomata and polygonal epidermal cell (adaxial) x400**

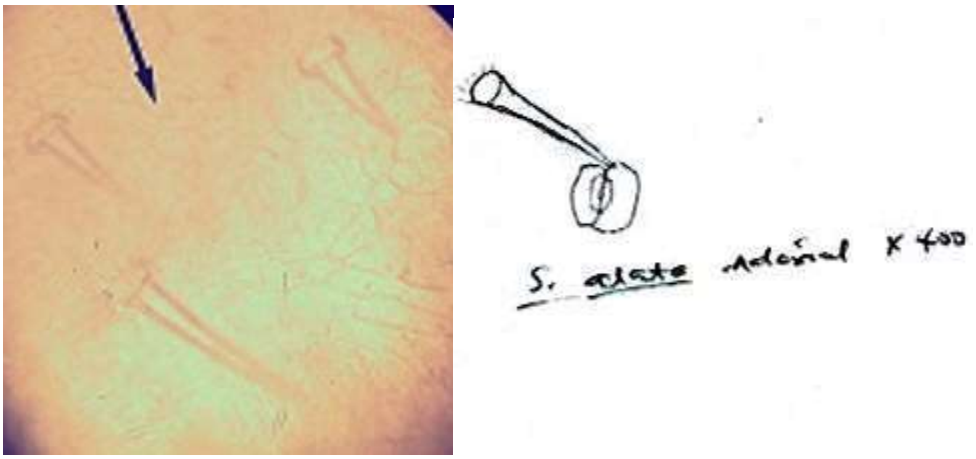


**Plate 11: *S. alata* non glandular trichome (adaxial) x400**

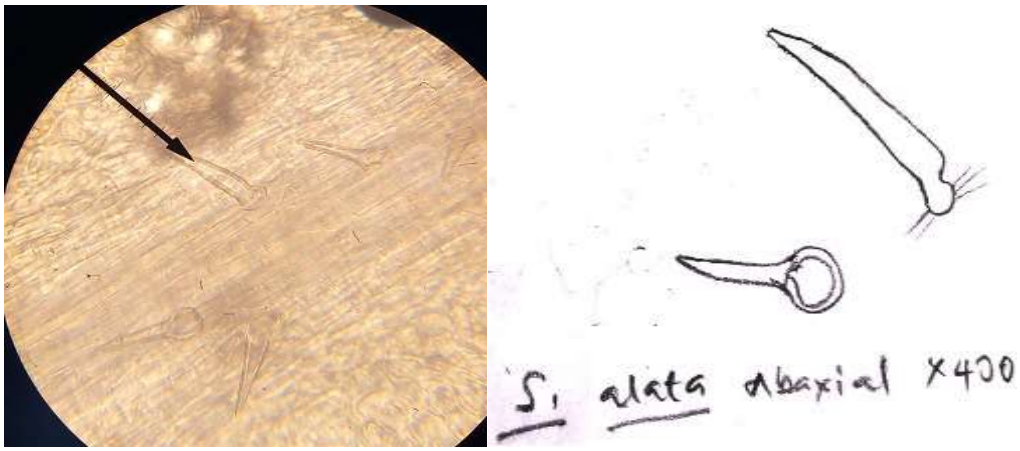


**Plate 12: *S. alata* non glandular trichome (abaxial) x400**

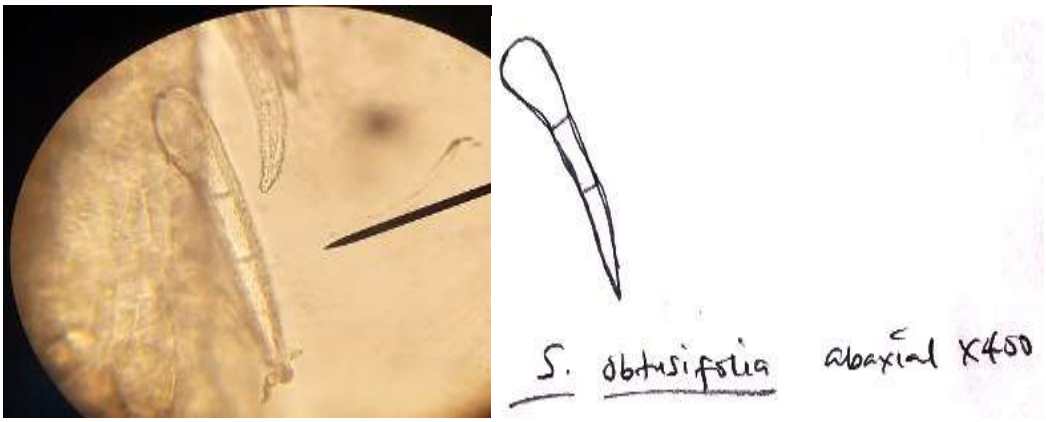


**Plate 13: *S. obtusifolia* non glandular trichome (abaxial) x400**

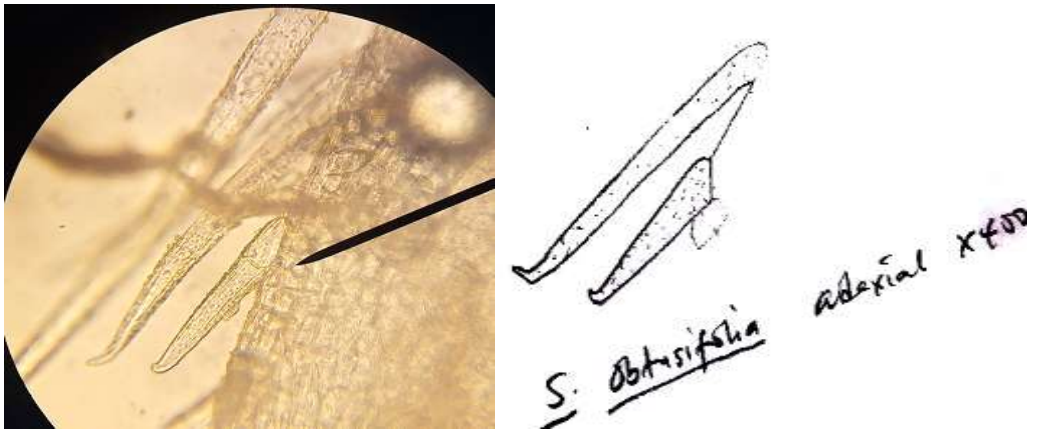


**Plate 14: *S. obtusifolia* Non glandular trichome (adaxial) x400**

***Comparative stomatal index of Senna Mill. leaves found in Minna during the rainy and dry season***

The Stomatal Index ranges between 37.15 to 41.96% on the adaxial surface and 27.13 to 54.08 % on the abaxial surface, while it ranges from 24.75 to 45.96% on the adaxial surface and 24.17 to 49. 26% on the abaxial surfaces in the two seasons respectively. Significant differences were observed on the abaxial surfaces in the two seasons except in *S.* hirsute which is significant at p=0.69 (Table 7).

**Table 7: Comparative Stomatal Index of *Senna* Mill. leaves found in Zaria during the rainy and dry season**

| Taxa | Surface | Rainy | Dry | P- value |
|---|---|---|---|---|
| *Sennaalata* | Adaxial | 37.22±0.18 | 27.26±0.14 | 0.10 |
| | Abaxial | 27.13±0.18 | 27.91±0.23 | 0.09 |
| *Sennaobtusifolia* | Adaxial | 37.15±0.26 | 24.75±0.14 | 0.30 |
| | Abaxial | 31.97±0.14 | 24.17±0.12 | 0.84 |
| *Sennaoccidentalis* | Adaxial | 41.96±0.27 | 45.96±0.19 | 0.30 |
| | Abaxial | 43.29±0.33 | 49.26±0.17 | 0.55 |
| *Sennahirsuta* | Adaxial | 32.85±0.22 | 35.63±0.17 | 0.59 |
| | Abaxial | 54.08±0.24 | 35.56±0.20 | 0.69 |

Mean±SE, P≥0.05

The epidermal cell length varied significantly on both surfaces with a sinuous to polygonal or irregular shape. This has proved a distant relatedness of the species to other species within Minna and the presence of polygonal epidermal cells in the other species indicated a close relationship among them. These shapes could be modified by environmental conditions and as well seasonal change.

The presence of non-glandular unicellular type of trichome was observed on the abaxial surface in both season of all the species except in *S. occidentalis*. Significant difference was observed in the trichome number of all the species while the species with the highest trichome length on both surfaces during the rainy season was in *S. hirsute* **(**595.27±30.89 µm, 738.94±19.92 µm) and the least was in *S. alata* (230.45±25.76 µm, 0.00±0.00 µm). In the dry season, *S. hirsute* was still the highest and *S. alata* was the least on both surfaces**.** Hightrichome number could be attributed to the fact that in dry season the environmental condition tends to change. Dallin *et al*. (2008) reported that trichome density and morphology vary among species and within individual plant and that trichomes evolved as a result of response to several environmental factors as plants with high trichome density are expected in areas that are dry or cold and the ultraviolet radiation is high.

Furthermore, stomatal distribution of *Senna* species studied showed an amphistomatic type, meaning stomata occurring on both surfaces. The types of stomata were paracytic in *S. alata*and *S. hirsute* while *S. obtusifolia* and *S. occidentalis* revealed an aniso/paracytic type of stomata in both seasons respectively. There was significant difference in the length and number of stomata studied in both surfaces in both seasons. This concord with the work of Saheed and Illoh (2010), who reported the presence of amphistomatic stomata, paracytic and anisocytic type of stomata among different *Senna* species in Nigeria and suggested a close affinity between them.

The stomatal index of the *Senna* species studies varied considerably. Significant difference was not observed in all the species except in *S. hirsute* on the abaxial surface. The difference recorded in this case could be as a result of the effect of environmental factors such as light intensity, temperature, $CO_2$ as well as difference in locations. This is in concordance with Adedeji and Jewoola (2008) in the foliar epidermal studies of Solanaceae family, who stated that stomatal index is constant for any given species and the value is more uniform on the abaxial surface. Schoch (1980) reported that leaves exposed to high light intensity produce more stomata without dramatic changes in patterning than those exposed to lower light intensity. It is also useful in determining the level of atmospheric $CO_2$.

**Conclusion**

All species were Amphistomatic with an anisocytic and paracytic type of stomata, a sinuous to polygonal cell shapes with a non glandulartrichome. No trichome present in *S. occidentalis.* In terms of stomata size, *S. hirsuta* and *S. alata* varied significantly. Stomatal index varied significantly as it is higher on the abaxial surface than on the adaxial surface in both seasons.

**Acknowledgment**

The author wishes to appreciate the effort and contribution of the technical staffs and supervisors of the department of Botany, Ahmadu Bello University, Zaria.

**Conflict of Interest**

Authors declare that there is no conflict of interest reported in this work.

**References**

AbdulRahaman AA & Oladele FA 2005. Stomata, trichomes and epidermal cells as (Leguminosae) based on analysis of the plastid matK gene resolves many well-supported subclades within the family. *Amer. J. Botany*, 91: 1846–1862.

Abubakar BY, Muazu S, Khan AU & Adamu AK 2011. Morpho-anatomical variation in some accession of *Moringa oleifera* Lam. from Northern Nigeria. *Afri. J. Plant Sci.*, 5(12): 742-748.

Adedeji O & Jewoola DA 2008. Importance of leaf epidermal characters in the Asteraceae family. *Notulae Botanicae, Horti, Agrobotanicclu*j*-Napoca*, 36(2): 7-16.

Aworinde DO & Fawibe OO 2014. Taxonomic significance of foliar epidermal characters in the Ceasalpinoideae. *Afri. J. Plant Sci.*, 8(10): 462-472.

Azani N, Babineau M, Bailey CD, Banks H & Barbosa AR 2017. The legume phylogeny working grouping. *Int. Assoc. Plant Taxonomy*, 66: 44 – 77.

Baker FJ & Silverton RE 1982. *Introduction to Medical Laboratory*. Butterworths Scientific London 5th edition, pp. 47-49.

Bolarinwa KA, Oyebanji OO & Olowokudejo JD 2018. Comparative morphology of leaf epidermis in the genus *Ipomoea* (Convolvulaceae) in Southern Nigeria. *Annals of West University of Timişoara, Ser. Biology,* 21 (1): 29-46.

Dallin P, Jon A, Christer B, Pirita H & Katri K 2008. Leaf Trichome Formation and Plant Resistance to Herbivory Book Chapter, p. 4.

Hutchison J & Dalziel JM 1958. Flora of West Tropical Africa. *The Whitefraius Press Ltd.* London, 1(2).

Marazzi B, Endress KP, de Queiroz LP & Conti E 2006. Phylogenetic relationships within *Senna* (Leguminosae, Cassiinae) based on three chloroplast DNA regions: Patterns in the evolution of floral symmetry and extrafloralnectaries. *Amer. J. Botany*, 9(2): 288-303.

Mike OS, Monsurat AO, Emmanuel CC & Mubo AS 2010. Morphometric study of the genus *Senna* Mill. in South-western Nigeria. *Afr. J. Plant Sci.*, 4(3): 044-052.

Nuru FG, Abubakar BY, Adamu AK & Ambi AA 2018. Taxonomic delimitation of species of *Senna* and *Cassia* in Ahmadu Bello University, Zaria. *FUW Trends in Sci. & Techn. J.*, 3(2): 488-495.

Ojanuga AG 2006. Agroecological Zones of Nigeria Manual. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, p. 124.

Saheed SA & Illoh HC 2010. A taxonomic study of some species in *Cassiinae* (Leguminosae) using leaf epidermal characters. *Notulae Botanicae Horti Agrobotanici Cluj*, 38(1): 21-27.

Salisbury EJ 1927. On the causes and ecological significance of stomatal frequency with special reference to the woodland flora. *Philosophical Transactions of the Royal Society*, London, 216: 1–65.

Schoch PG 1980. Dependence of the stomatal index on environmental factors during stomatal differentiation in leaves of *Vignasinensis* L. *Journal of Experimental Botany*, 31: 1211-1216.

Soladoye MO & Lewis GP 2003. A checklist of Nigerian legumes. *Centre for Envit., Renewable Nat. Resou. Mgt. and Devt.*, pp. 12-14.

Soladoye M, Sonobare MA & Chukwuma EC 2010. Morphometric study of the Genus *Indigofera* Linn. (Leguminosae- Papilionoideae) in South-Western Nigeria. *Int. J. Botany*, 6(3): 227-23.