

Systematic implications of trichomes in the species of *Stachytarpheta* found in Awka, Nigeria

Chisom F. Iroka¹, Clement U. Okeke¹ and Chukwu N. Okereke²

¹Department of Botany, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

²Department of Applied Biology, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria

ABSTRACT

A trichome study was conducted on the various parts of *Stachytarpheta* species present in Awka South East Nigeria. *Stachytarpheta* is a plant of the family Verbenaceae, it is an erect and branched half-woody plant, with stem slightly angled. The study was carried out using standard plant anatomical methods by various authors with some modifications. The study revealed the presence or absence and distribution of trichomes on various parts of the plants including the adaxial and abaxial surfaces of the leaf, stem, petiole, midrib, calyx, veins and petal. On the other hand, the trichome density study of the epidermal surfaces revealed the various trichome densities on the epidermal surfaces of the three *Stachytarpheta* species. The highest trichome density was on the abaxial surface of *S. angustifolia* (12.00 ± 8.485) and least trichome density was on the adaxial surface of *S. jamaicensis* (1.00 ± 1.414). The indications from the species grouping as shown by the Duncan multiple Range Test shows there is no significant difference in the trichome density between *Stachytarpheta* species and between epidermal surfaces as they all bear the same alphabets in the superscript. More so, the mean trichome density on epidermal surface (figure 2) showed that mean trichome density was higher on the adaxial surface than on the abaxial surface; the high frequency of these trichomes on the adaxial surface of the three species can be related to protection against excessive radiation and higher temperature and even as protection against some form of predators. Trichome size (μm) was highest on the abaxial surface of *S. cayannensis* (501.3 ± 119.9) and lowest on the abaxial surface of *S. angustifolia* (98.1 ± 15.7); the analysis of variance shows a significant difference in the trichome size between *Stachytarpheta* species ($p < 0.05$) but not between epidermal surface ($p > 0.05$). The study however, reaffirms the taxonomic relationship that exists between these three *Stachytarpheta* species.

Keywords: *Stachytarpheta*, *Cayannensis*, *Angustifolia*, *Jamaicensis*, Trichome, Epidermal, Adaxial, Abaxial

INTRODUCTION

Verbenaceae is predominantly a tropical family exhibiting a wide range of growth habit and inhabiting diverse habitats [1]. The family has about 98 genera and 3,000 species [2]. They are low shrubs, herbs or trees. Flowers are in spikes. The genus *Stachytarpheta* Vahl. belongs to the family Verbenaceae and is represented in West Africa and Nigeria by three species namely: *Stachytarpheta cayannensis* (Rich.) Vahl; *S. angustifolia* (Mill.) Vahl and *S. jamaicensis* (L.) Vahl [3]. They are economic plants and may be grown as ornamentals [4]. Members of family Verbenaceae are popular in traditional medicine. Moreover, all the *Stachytarpheta* species have been used ethnomedically as anti-diabetic, arbotifacient, emmenagogue, sedative, antihypertensive, anti-asthmatic and anti-fever [5].

Stachytarpheta is an erect and branched half-woody plant, with stem slightly angled. The leaves are elliptic to oblong-ovate and 2 to 10cm long. The leaf tips are pointed with toothed margins. The leaf base is decurrent on the petiole. The spikes are terminal, rather slender, 10-30cm long, 3-4mm thick, green and continuous. The calyx is small, oblique and 4-toothed. The corolla is deep-blue or blue-purple, 1cm long. The fruit is enclosed in the calyx

and oppressed to and somewhat sunk in the rachis which is smooth, oblong and about 4mm long [2]. Plant anatomy has been found to be very essential in plant taxonomy. The purpose is to develop a system of classifying plants in a way that all the differences and similarities are set out in ordered manner [6]. In spite of the fact that vegetative and floral characters are markedly modified in relation to the habitat and pollination mechanisms, the preceding observations and the summaries of character variation indicated that the taxonomic application of the diversity of epidermal morphology in plants cannot be over emphasized. The decision to choice epidermal characters to carryout studies in plants was informed by earlier declaration that these characters represented genetic variations and have been used to solve taxonomic problems in certain plant groups by Taxonomists [7], [8], [9].

Moreover, trichome is another taxonomic significant feature in the species of many families. Occurrence of trichomes on the abaxial surface of all the species may support the claim that trichome themselves transpire. According to [10] living trichomes which themselves lose water do not protect the plant from excessive transpiration as do dead trichomes which form protective layers. Similar observation was made in two species of *Jatropha*, where *J.gossypifolia* with high trichome density and index, transpired faster than *J.curcas* which possessed lower trichome density and index.

Now-a-days virtually every anatomical aspect of plants has been studied by Taxonomists and the quality of information accumulated is enormous. Particularly valuable taxonomic evidence has been obtained from the study of pollen, wood, leaf, epidermis, cuticle, trichomes and stomata. Some of these anatomical features are so diagnostic that they are now commonly used in routine identification, rather than being confined to a use in problems of phylogeny or classification or in the identification of fragments of plants. Trichome anatomy is of immense significance in classification at all the levels, from the circumscription of the family down to the separation of species and even varieties. Leaf epidermis and the leaf cross-sectional anatomy provide extensive taxonomic data and the literature on this subject is now vast. Characters such as the differentiation of epidermal long-cells and short-cells and the form and distribution of silica-bodies and various types of trichomes and papillae have played a big part in the modern re-classification of the family Curcubitaceae at all levels [11]. A number of research workers have recognized and reported unmistakably taxonomic importance of epidermal characteristics such as the shape and size of the epidermal cells, type of trichomes and type of stomata. These variations in the epidermis on the other hand, have been attributed to the functional multiplicity of the dermal tissue. The variation in the epidermal anatomy has also been studied in family Boraginaceae. Major and diverse uses of stomata have been made in plant classification. [12] have emphasized the systematic application of stomata types while [13] considered the stomata as a weak point in taxonomic classification. But they felt that like other characters they can be advantageously used for that purpose. The aim of this study therefore, is to study the trichome features of these plants so as to know their various attributes and then to delimit the species and as well establish a relationship.

MATERIALS AND METHODS

Samples of *S.cayannensis* and *S.jamaicensis* were collected from Nnamdi Azikiwe University Premises. *S.angustifolia* was collected from Adabebe village in Amawbia Community; Awka South L. G. A. Samples of *S.cayannensis*, *S.angustifolia* and *S.jamaicensis* collected were properly and authenticated by Prof. J.C Okafor and vouchers deposited at the Herbarium, Department of Botany, Nnamdi Azikiwe University, Awka.

For the trichome studies and epidermal structure of the different plant organs, epidermal peels and transverse sections of different plant parts except the petals and petal tube (which were observed directly) were made, stained with safranin O and mounted in 70% glycerol. Photomicrographs were taken using a light microscope attached with a nikkon camera.

RESULTS

Table 1: Trichome Distribution on various Parts of *Stachytarpheta* Species

Species	Adaxial Epidermal Surface	Abaxial Epidermal Surface	Midrib	Petiole	Stem	Petal	Caylx	Veins
<i>S.angustifolia</i>	+++	+	+++	++	+++	-	++	+++
<i>S.cayannensis</i>	+++	+++	+	++	++	-	+	++
<i>S.jamaicensis</i>	++	+	++	++	++	-	+	++

+++ Largely present
 ++ Moderately present
 + Sparsely present
 - Absent

Table 2: Trichome Density on the Adaxial and Abaxial Surfaces of *Stachytarpheta* species

<i>Stachytarpheta</i> species	Epidermal Surface	Trichome Density
<i>S. angustifolia</i>	Adaxial	11.00±9.899 ^{ab}
<i>S. cayannensis</i>	Adaxial	9.00±5.657 ^a
<i>S. jamaicensis</i>	Adaxial	1.00±1.414 ^a
<i>S. angustifolia</i>	Abaxial	12.00±8.485 ^a
<i>S. cayannensis</i>	Abaxial	5.00±5.657 ^a
<i>S. jamaicensis</i>	Abaxial	1.50±0.707 ^a
p-value	Epidermal surface	ns
	<i>Stachytarpheta</i> species	ns

Results are in Mean ± STD

*Column with the same superscript is not significantly different

Table 2 shows the trichome density on the epidermal surface of *Stachytarpheta* species. The table indicates that the trichome density is highest in the abaxial surface of *S. angustifolia* (12.00±8.485) and lower in the adaxial surface of *S. jamaicensis* (1.00±1.414). The analysis of variance shows no significant difference in the trichome density between *Stachytarpheta* species ($p > 0.05$) and between epidermal surface ($p > 0.05$)

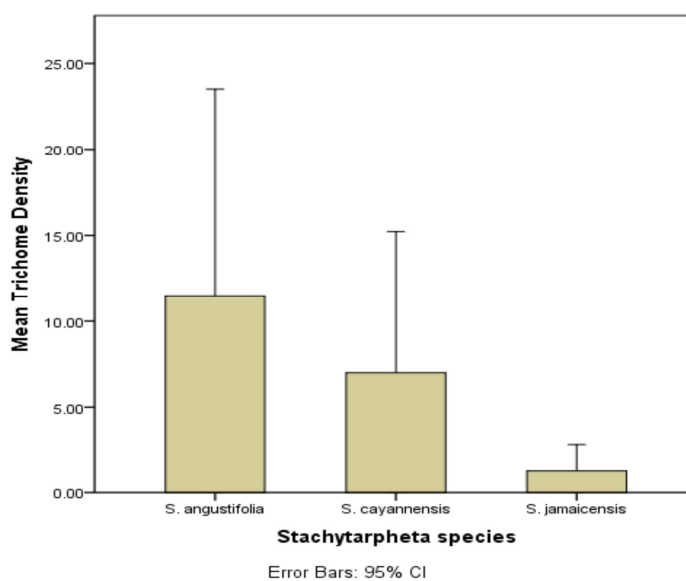
Figure 1: Mean Trichome Density on the Three *Stachytarpheta* species

Figure 1: Showing the mean trichome density between *Stachytarpheta* species. The figure depicts that the mean trichome density is higher *S. angustifolia* and lower in *S. jamaicensis*.

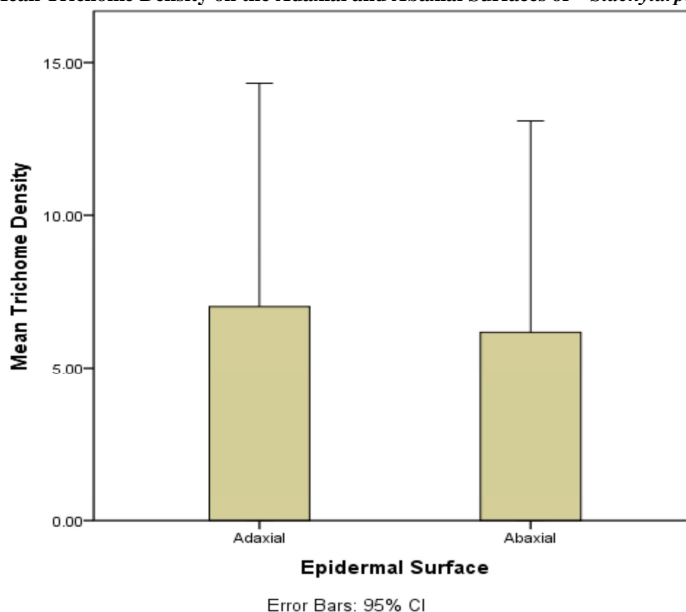
Figure 2: Mean Trichome Density on the Adaxial and Abaxial Surfaces of *Stachytarpheta* species

Figure 2: Showing the mean trichome density between epidermal surfaces of *Stachytarpheta* species. The figure depicts that the mean trichome density is higher in adaxial surface and lower in abaxial surface.

Table 3: Trichome Size on Epidermal Surfaces of the *Stachytarpheta* species

Treatment	Trichome size (μm)
<i>S. angustifolia</i> (Adaxial)	138.4 \pm 32.0a
<i>S. cayannensis</i> (Adaxial)	295.9 \pm 23.9 ^{ab}
<i>S. jamaicensis</i> (Adaxial)	411.6 \pm 164.3 ^b
<i>S. angustifolia</i> (Abaxial)	98.1 \pm 15.7 ^a
<i>S. cayannensis</i> (Abaxial)	501.3 \pm 119.9 ^b
<i>S. jamaicensis</i> (Abaxial)	403.5 \pm 75.0 ^b
p-value	
Epidermal surface	ns
<i>Stachytarpheta</i> species	**

Results are in Mean \pm STD

*Columns with the same superscript (or sharing a common letter) are not significantly different.

Trichome size (μm) is highest on the abaxial surface of *S. cayannensis* (501.3 \pm 119.9) and lowest on the abaxial surface of *S. angustifolia* (98.1 \pm 15.7); the analysis of variance shows a significant difference in the trichome size between *Stachytarpheta* species ($p < 0.05$) but not between epidermal surface ($p > 0.05$)

DISCUSSION

The study revealed the presence of trichomes on various parts of the plants (Table I). Trichome was moderately present on the adaxial surface of *S. jamaicensis* but largely present on the adaxial surface of *S. angustifolia* and *S. jamaicensis* from the other species. On the abaxial surface trichome was sparsely present in *S. angustifolia* and *S. jamaicensis* and largely present in *S. cayannensis* thereby delimiting it from other *stachytarpheta* species studied. Trichome was also largely present on the midrib of *S. angustifolia*, moderately present on that of *S. jamaicensis* and sparsely present on that of *S. cayannensis*. Trichome was moderately present on the *Stachytarpheta* species.

On the stem of *S. angustifolia*, trichome was sparsely present but was moderately present on the stem of *S. cayannensis* and *S. jamaicensis*. *S. angustifolia* is therefore delimited from the other two species. No trichome was seen on the petals of the three species but on the calyx, trichomes were moderately present in *S. angustifolia* but sparsely present in *S. jamaicensis* and *S. angustifolia*. On the veins as well, trichome was largely present in *S. angustifolia* but moderately present in *S. cayannensis* and *S. jamaicensis*.

[14] reported the importance of trichome distribution types in the different organs and parts of the plant body in the delimitation of genera and species within the family Solanaceae, [15], [16] have all emphasized the taxonomic implication of trichome. It should however be noted that trichome distribution in this genus is not abundant, although they are present but not very prominent to be a taxonomic tool to distinguish it from other genus of family Verbenaceae. More so, [17] have noted that trichome distribution can be under the influence of environmental factors. The micromorphological characteristics of foliar trichomes have played an important role in plant systematic especially of particular groups at generic and specific levels [18]. Hence, such studies on the field have brought interest to plant morphologists and systematists towards the diversity of trichome features [15].

On the other hand, the trichome density study of the epidermal surfaces revealed the various trichome densities on the epidermal surfaces of the three *Stachytarpheta* species (Table II). The highest trichome density was on the abaxial surface of *S. angustifolia* (12.00 \pm 8.485) and least trichome density was on the adaxial surface of *S. jamaicensis* (1.00 \pm 1.414). The indications from the species grouping as shown by the Duncan multiple Range Test shows there is no significant difference in the trichome density between *Stachytarpheta* species and between epidermal surfaces as they all bear the same alphabets in the superscript. More so, the mean trichome density on epidermal surface (figure II) showed that mean trichome density was higher on the adaxial surface than on the abaxial surface; Trichome size (μm) which was highest on the abaxial surface of *S. cayannensis* (501.3 \pm 119.9) and lowest on the abaxial surface of *S. angustifolia* (98.1 \pm 15.7) and then the high frequency of these trichomes on the adaxial surface of the three species can be related to protection against excessive radiation and higher temperature and even as protection against some form of predators [18], [19], [20]. However, in most cases the true ecological function of the trichomes has not really been supported by experimental data [21]. The penetration of herbicides in the plant tissues is essential for the effective chemical control of weed [22].

Relatively, the anatomical characteristics practically determine the case with which these products can be absorbed [23]. Trichomes in the leaf surface can intercept pulverized drops, preventing these from reaching the epidermis. Aromatic plants grow in sunny environments and the trichomes which protect the abaxial surface allow the secretion

to remain for an extended period of time in the plant. [24] have reported the presence of glandular trichomes secreting essential oils in the Verbenaceae family. These oils usually evaporate and are released under high temperature and low humidity as well. Thus, their occurrence on the abaxial surface is mostly for protection. Moreover, the sites of accumulation have an important influence on the effectiveness of anti-herbivory substance [25]. The high density of trichomes occurring on the abaxial surface of *S. angustifolia* is thus, a diagnostic tool for the species, supporting its ability for secretion of these essential oils more than in the other two species of *Stachytarpheta* [26]. The trichome also poses an ecological significance in association with plant interaction with the environment thereby interfering efficiently against attacks from herbivores and pathogens [27]. Also, evidences from wild and cultivated species gives support to this ecological role [26], [29].

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