BIODIVERSITAS
Volume 27, Number 2, February 2026
Pages: 8

ISSN: 1412-033X
E-ISSN: 2085-4722
https://doi.org/10.13057/biodiv/d270221

Foliar trichome variations in 49 accessions of *Solanum aethiopicum* (Solanaceae)

LAILANI A. MASUNGSONG[1,2,♥], MARIA CELESTE N. BANATICLA-HILARIO[1], NONNATUS S. BAUTISTA[1], LERMA SJ. MALDIA[3], NELSON M. PAMPOLINA[3], INOCENCIO E. BUOT JR.[1,4]

[1]Plant Biology Division, Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines. Los Baños, Laguna 4031, Philippines. Tel.: +63-049-536-2893, ♥email: lamasungsong@up.edu.ph

[2]UPLB Graduate School, University of the Philippines. Los Baños, Laguna 4031, Philippines

[3]Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines. Los Baños, Laguna 4031, Philippines

[4]Faculty of Management and Development Studies, University of the Philippines Open University. Los Baños, Laguna 4030, Philippines

Manuscript received: 13 June 2025. Revision accepted: 18 February 2026.

Abstract. *Masungsong LA, Banaticla-Hilario MCN, Bautista NS, Maldia LS, Pampolina NM, Buot Jr. IE. 2026. Foliar trichome variations in 49 accessions of* Solanum aethiopicum *(Solanaceae). Biodiversitas 27 (2): d270221. https://doi.org/10.13057/biodiv/d270221.* Trichomes are essential micromorphological structures that mediate plant-environment interactions. Although trichome diversity has been extensively documented across the genus *Solanum*, available information for *Solanum aethiopicum* remains limited. This study aimed to investigate foliar trichomes in 49 accessions from Hortanova Farm and Research Center, Eastwest Seed Company, Inc., in Lipa City, Batangas, Philippines, to characterize their morphology, classify trichome types, and analyze patterns of intraspecific variation. Observations were performed using light microscopy (200x magnification), supported by standardized morphometric and structural criteria. A diagnostic dichotomous key was subsequently developed to aid in identification. Ten distinct trichome types were recognized, consisting of glandular (Types 3 and 6) and non-glandular forms (Types 1, 2, 4, 5, 7, 8, 9, and 10). Stellate trichomes were dominant, and four newly described stellate types (Types 7, 8, 9, and 10) were reported. Among these, Type 9, a non-glandular stellate trichome with straight radial rays, appeared consistently across all accessions and emerged as a robust diagnostic feature, whereas Types 1 and 2 occurred only in specific accessions, indicating potential trait exclusivity. The widespread distribution of Type 9 and contrasting morphological differences suggest adaptive significance. These findings expand micromorphological knowledge and present taxonomic implications for *S. aethiopicum*.

Keywords: Glandular types, micromorphological structures, plant defense, *Solanum aethiopicum*, stellate types

INTRODUCTION

Trichomes are key micromorphological structures located on the aerial parts of plants, playing diverse roles in both ecological interactions and physiological processes. These epidermal outgrowths vary widely in form, structure, and function, ranging from simple unicellular hairs to complex multicellular glands (Dilcher 1974; Stace 1984; Fahn 1990; Werker 2000). The occurrence and variation of trichomes are commonly influenced by environmental conditions, thus contributing to plant defense against herbivores, protection from ultraviolet radiation and pathogens, and minimizing water loss (Wagner et al. 2004; Glas et al. 2012). The trichomes' reflective property mitigates thermal and water stress, improving leaf physiology and overall plant resilience in arid environments (Araújo et al. 2024).

The genus *Solanum* (Solanaceae) is known to exhibit significant trichome variations, which are very useful for studying their morphological differentiation (Ifrim and Gatu 2015). Glandular and non-glandular trichomes are both present in *Solanum*, in domesticated crops and wild weeds, serving as one of the bases for their species identification and classification (Watts and Kariyat 2023). As an adaptive mechanism, some *Solanum* species exhibit a wide range of glandular trichome subtypes that produce secretions used in herbivore defense and have been found to detoxify heavy metals, such as cadmium, nickel, and zinc (Koul et al. 2021; Kaur et al. 2023).

Solanum aethiopicum L. is an African indigenous vegetable whose origin is traced to Eritrea and Ethiopia, where it was domesticated (Lin et al. 2009). It is believed to have evolved from the wild species *Solanum anguivi* through the semi-domesticated intermediate *Solanum distichum* (synonym) (Lester and Seck 2004). Both progenitor species are widely distributed in tropical Africa, occurring in disturbed habitats or cultivated areas. *S. aethiopicum* has been introduced to several countries, including Angola, Madagascar, Nigeria, Taiwan, Mongolia, and Vietnam. It is particularly widespread in West Africa, where it is commonly cultivated in home gardens and small village farms. Despite being one of the most important traditional vegetables in Africa, its productivity remains relatively low because research and breeding efforts have focused more on other economically important *Solanum* crops, such as *Solanum melongena* (Aguessy et al. 2021).

While trichome diversity has been extensively characterized across numerous *Solanum* species, comprehensive studies on *S. aethiopicum* remain limited, especially with respect to its intraspecific variation. This species is agriculturally significant and exhibits a wide range of phenotypic plasticity, yet its micromorphological adaptations remain underexplored (Lester and Seck 2004; Bello et al. 2017). It provides essential nutrients and bioactive compounds with antioxidant, anti-inflammatory, and antidiabetic properties (Choi and Choi 2024). It is highly adaptable to diverse environments and offers high fruit yield, demonstrating its potential for sustainable production (Kabore et al. 2025). The species also shows resistance to soil-borne pathogens and nematodes, making it a valuable genetic resource for breeding resilient eggplant cultivars (Song et al. 2019). *S. aethiopicum* is taxonomically important for its extensive morphological and genetic diversity, with cultivar groups (Gilo, Kumba, Shum, Aculeatum) distinguished by diagnostic traits (Han et al. 2021). Genomic and phenotypic studies reveal its domestication from *S. anguivi* and resistance gene expansions, reinforcing its significance in Solanaceae taxonomy (Song et al. 2019; Shimira et al. 2024). In the study by Watts and Kariyat (2021a), fourteen *Solanum* species were examined for trichome morphological characterization to evaluate variations in shape, density, and size. Although *S. aethiopicum* was included, only a few trichome types were reported. This study hypothesized that several variations in foliar trichome traits exist among accessions of *S. aethiopicum* and can serve as distinguishing taxonomic characters. This research aimed to describe and characterize the foliar trichome morphology in *S. aethiopicum* and examine its intraspecific variations, with emphasis on the structural diversity and adaptive features in relation to its functional significance.

MATERIALS AND METHODS

Plant materials

A total of 147 leaves from 49 accessions of *Solanum aethiopicum* (three plants per accession) (Table 1) were collected from the Hortanova Farm and Research Center, Eastwest Seed Company Inc., Lipa City, Batangas, Philippines. Accessions were cultivated in a 144 m^2 greenhouse under uniform controlled conditions. Three mature, fully expanded leaves from the middle portion of each plant were harvested 60 days after sowing for anatomical analysis. Leaf images were captured using a Nikon D5600 camera equipped with a Yongnuo 50 mm lens. Permanent slides were prepared for each accession and deposited in the Plant Biology Division Herbarium (PBDH), Institute of Biological Sciences, University of the Philippines, Los Baños.

Procedures

All leaf samples were processed following the procedure of Carpenter (2005) with some modifications (immersion in 5% potassium hydroxide extended from 12-24 hours to 3 days). Processed leaves were then examined under the biological microscope equipped with a DinoEye camera mount and DinoCapture software available at the Plant Systematics Laboratory of the Institute of Biological Sciences, University of the Philippines, Los Baños, Laguna, Philippines.

Prepared slides of leaf samples from each *S. aethiopicum* accession were viewed under the microscope (magnification of 200x) and described using descriptors adapted from Watts and Kariyat (2021a) (Table 2). Trichome types were observed across three distinct fields of view per slide. For visual clarity and reference, line drawings of the identified trichome types were rendered by a graphic artist.

Table 1. List of *Solanum aethiopicum* accessions used in the study

Accession number	Accession name	Origin
GB-00072	Sa2 *S. aethiopicum*	Not indicated
GB-00074	*S. aethiopicum*	Not indicated
GB-00077	Agistar Morro Redondo	Sao Paulo, Brazil
GB-00160	PI 247828 (NSUA)	Congo
GB-00182	*S. aethiopicum*	Thailand
GB-00187	*S. aethiopicum*	Not indicated
GB-00254	PI 441839 (BGH 20)	Brazil
GB-00255	PI 441840 (BGH 21)	Brazil
GB-00256	PI 441841 (BGH 45)	Brazil
GB-00257	PI 441847 (BGH 319)	Brazil
GB-00258	PI 441848 (BGH 329)	Brazil
GB-00260	PI 441851 (BGH 404)	Brazil
GB-00261	PI 441853 (BGH 418)	Brazil
GB-00262	PI 441856 (BGH 494)	Brazil
GB-00263	PI 441858 (BGH 529)	Brazil
GB-00264	PI 441859 (BGH 555)	Brazil
GB-00265	PI 441860 (BGH 556)	Brazil
GB-00266	PI 441861 (BGH 557)	Brazil
GB-00267	PI 441865 (BGH 601)	Brazil
GB-00268	PI 441867 (BGH 610)	Brazil
GB-00269	PI 441872 (BGH 1017)	Brazil
GB-00270	PI 441873 (BGH 4156)	Minas Gerais, Brazil
GB-00271	PI 441874 (BGH 4991)	Minas Gerais, Brazil
GB-00272	PI 441875 (BGH 4992)	Minas Gerais, Brazil
GB-00273	PI 441876 (BGH 4993)	Minas Gerais, Brazil
GB-00274	PI 441877 (BGH 4994)	Minas Gerais, Brazil
GB-00275	PI 441878 (BGH 4995)	Minas Gerais, Brazil
GB-00276	PI 441879 (BGH 4996)	Minas Gerais, Brazil
GB-00277	PI 441880 (BGH 4997)	Minas Gerais, Brazil
GB-00278	PI 441881 (BGH 4998)	Minas Gerais, Brazil
GB-00279	PI 441882 (BGH 4999)	Minas Gerais, Brazil
GB-00280	PI 441883 (BGH 5000)	Minas Gerais, Brazil
GB-00281	PI 441884 (BGH 5001)	Minas Gerais, Brazil
GB-00282	PI 441885 (BGH 4163)	Brazil
GB-00283	PI 441886 (BGH 4962)	Brazil
GB-00284	PI 441887 (BGH 4963)	Brazil
GB-00285	PI 441888 (BGH 4964)	Brazil
GB-00286	PI 441889 (BGH 4965)	Brazil
GB-00287	PI 441890 (BGH 4966)	Brazil
GB-00288	PI 441891 (BGH 4967)	Brazil
GB-00289	PI 441892 (BGH 4968)	Brazil
GB-00290	PI 441895 (BGH 4972)	Brazil
GB-00291	PI 441896 (BGH 4973)	Brazil
GB-00292	PI 441897 (BGH 4974)	Brazil
GB-00293	PI 441898 (BGH 4975)	Brazil
GB-00294	PI 441899 (BGH 4979)	Brazil
GB-00295	PI 441900 (BGH 4989)	Brazil
GB-00296	PI 441001 (BGH 4000)	Brazil
GB-00297	PI 441902 (BGH 5002)	Brazil

Table 2. Terminologies used to describe trichome types in *S. aethiopicum* according to Watts and Kariyat (2021a)

Terms	Definition
Attenuate	Long and gradually tapering
Basilatus	Emerging from a broad base
Bifurcated	Divided into two branches
Compound	Having multiple rays
Glandular	Has secretory/excretory function
Cruciate	Shape as a cross with four equal arms
Hooked	Bent/incurved apex shape
Head	Enlarge terminal portion
Multiradiate	Multi-rayed
Multitangulate	Rays at many angles
Non-glandular	Without secretory/excretory function
Porrect-stellate	Resemblance with porrect rays of cacti with multiple horizontal rays and a central ray
Stellate	Star shaped
Subsidiary cells	Neighboring base cells
Stalk	Supporting part of the hair

Data analysis

Foliar trichome data were generated from microscopic examination of prepared leaf slides from 49 *S. aethiopicum* accessions. Trichome characterization was conducted through qualitative morphological analysis, focusing on trichome type, cellular composition (unicellular or multicellular), and the presence or absence of glandular structures. Observations were made on the abaxial leaf surface under 200x magnification, with each accession evaluated across three distinct fields of view to ensure consistency and reliability of trichome identification. Trichome classification followed standardized descriptors adapted from Watts and Kariyat (2021a). Only trichome types consistently observed across the examined fields of view were considered valid for each accession. The resulting trichome data were used to document intraspecific variation among accessions and to identify diagnostic trichome characters. Based on the morphological character assemblage of trichome types observed, a dichotomous key was constructed to enable comparative identification and classification of the *S. aethiopicum* accessions.

RESULTS AND DISCUSSION

General leaf morphology of *Solanum aethiopicum*

The leaves of *S. aethiopicum* are generally simple, alternate, medium-sized, and variable among accessions (Figure 1). Leaf margins vary from entire, subentire to weakly lobed. Leaf blade ovate to sometimes elliptic, while surfaces can be glabrous or densely pubescent. Leaf base cuneate to rounded and leaf apex acute (Lester 1986). Venation pattern is pinnate, with prominent midrib and well-developed lateral veins that provide structural support to the broad leaf blades. Petioles are present and exhibit variability in length depending on leaf size and developmental stage (Lester and Seck 2004). Compared to other species in the genus, such as *S. melongena*, *S. aethiopicum* displays a rougher leaf texture due to its dense covering of trichomes, whereas *S. melongena* tends to have smoother leaves with sparse and soft hairs (Figure 1) (Daunay et al. 2001; Watts and Kariyat 2023). This greater trichome density is believed to enhance the species' adaptation to arid environments, offering a protective advantage under drought stress (Prohens et al. 2013).

Foliar trichome types

The genus *Solanum* is the largest in the family Solanaceae with approximately 3,500 species of ecological and economic importance, exhibits a diverse array of trichomes that vary in both density and morphology. These diverse trichome types are considered valuable taxonomic characters for the classification and identification of species within the genus. In the study by Watts and Kariyat (2021a), 14 wild and domesticated *Solanum* species were examined for trichome classification and characterization, revealing approximately 48 distinct trichome types among the species studied. One of the studied species is *S. aethiopicum*, which displayed six (6) trichome types, including unicellular and multicellular forms, as well as both glandular and non-glandular structures.

In this study, ten (10) distinct trichome types were identified across the examined *S. aethiopicum* accessions, four (4) of which are newly described and documented in the present work (Table 3). The Type 1 (T1) trichomes were described as subulate basilatus non-glandular hairs with distinct subsidiary cells, typically pointed and narrow, which function as a mechanical barrier against herbivores and environmental stress. This specific type of trichome was present in *S. aethiopicum* and *S. melanocerasum* as reported by Watts and Kariyat (2021a). As a non-glandular type of trichome, it is said to inflict mechanical damage on the peritrophic matrix (PM) of caterpillars, such as *Manduca sexta*, compromising digestion and development, even post-ingestion illustrating a broader defense mechanism (Kariyat et al. 2017). Type 2 (T2) represents multitangulate multiradiate stellate non-glandular hairs with 2-6 subulate rays emerging from a pedestal. This trichome type is also present in *S. anguivi*, the wild progenitor of *S. aethiopicum* (Song et al. 2019). Their stellate outline increases surface coverage and potentially enhances defense by limiting insect mobility (Werker 2000; Watts and Kariyat 2021a). These stellate hairs minimize water loss, protect against UV radiation, and moderate temperature extremes, with their phenolic-reinforced structure enhancing light reflectance and serving as an optical filter in stressful environments (Karabourniotis et al. 2020).

Types 3 (T3) and 6 (T6) are capitate glandular trichomes characterized by small globular heads that release sticky or toxic compounds, contributing to chemical defense by deterring herbivores and suppressing pathogen activity. Similar glandular trichome types have also been documented in *Solanum lycopersicum* and *S. melongena* (Glas et al. 2012; Watts and Kariyat 2021a). The difference between T3 and T6 is the presence or absence of prominent trichome base. Type 3 has prominent trichome base that provides anchorage, enhances transport of metabolites, supports secretion, and strengthens defense, making it more efficient and resilient protective structures (Anilkumar and Chandra 2025).

Type 4 (T4) is another subulate basilatus non-glandular hair, that lacks prominent subsidiary cells and may contribute to mechanical protection in a less structurally complex form. These types of trichomes act as cheap, disposable defenses that are weakly attached but rapidly produced in high densities, ensuring early protection of young leaves through a quantity-based strategy (Chen et al. 2025). Aside from *S. aethiopicum*, this type of trichome can also be observed in *S. melongena* and *Solanum incanum* (Watts and Kariyat 2021a). Type 5 (T5) is classified as a porrect-stellate multiradiate non-glandular hair with 5-10 subulate rays and a short central ray, with a radiating shield that potentially reduces herbivore attachment and sun exposure. This type is abundant on both leaf surfaces and serves dual ecological roles: (i) form a physical barrier that impedes herbivore movement and feeding, (ii) contribute to abiotic stress mitigation by reflecting solar radiation and reducing transpiration, in addition, it provides valuable taxonomic markers within the genus *Solanum* (Watts and Kariyat 2021a). Watts and Kariyat (2023) also documented this type of trichomes in *S. anguivi*, *Solanum lanceifolium*, *Solanum ovigerum* synonym of *S. melongena,* and *Solanum pyracanthos*.

A dichotomous key was developed to classify the foliar trichome types based on their distinct morphological characteristics. This key serves as a tool for identifying trichome types in various *S. aethiopicum* accessions and possibly in other *Solanum* species that exhibit similar trichome features.

A key to foliar trichome types of *Solanum aethiopicum*:
1a. Glandular foliar trichomes 2
1b. Non-glandular foliar trichomes 3
2a. With small globular head on the top and a prominent base .... Type 3
2b. With small globular head without a prominent base .... Type 6
3a. Subulate basilatus non-glandular trichomes........ 4
3b. Stellate types foliar trichomes 5
4a. With distinct subsidiary cells.............................. Type 1
4b. With prominent base... Type 4
5a. Multiradiate... 6
5b. Star-shaped or cross-shaped................................ 7
6a. Porrect-stellate with subulate rays (5-10) and short central ray .... Type 5
6b. Multitangulate-stellate with subulate rays (2-6) with presence of pedestal …... Type 2
7a. Star-shaped.. 8
7b. Cruciate cross-shaped with four equal arms........ Type 7
8a. With 5 unicellular rays/arms............................... Type 8
8b. With 6-8 rays/arms.. 9
9a. Straight multicellular uniseriate rays/arms .... Type 9
9b. Wavy unicellular rays/arms with short central ray .... Type 10

The diverse range of foliar trichomes in *S. aethiopicum* contributes significantly to its ecological adaptability. The most common types observed include simple non-glandular trichomes, which are unicellular or multicellular structures primarily responsible for their physical defense against herbivores and excessive light exposure (Fahn 1986; Wagner et al. 2004). Dwi and Ermayanti (2025) also documented non-glandular foliar trichomes in *S. aethiopicum*, ranging from uniseriate, unicellular forms to multi-angular types, highlighting structural adaptations that contribute to its ecological resilience. Stellate non-glandular trichomes, characterized by their star-like multicellular rays, provide increased surface area for protection, thus aiding in moisture retention and deterrence of herbivores due to their physical barrier (Watts and Kariyat 2021a). The presence of multicellular glandular trichomes was also observed in the *S. aethiopicum* accessions, reportedly secreting secondary metabolites such as terpenes or phenolics, flavonoids, acyl sugars, or methylketones, that act as anti-herbivore compounds while some are found to be pharmaceutically important (Werker 2000; Glas et al. 2012; Kaur et al. 2023). Furthermore, capitate glandular trichomes with distinct glandular heads are involved in the excretion of volatile compounds that may influence plant-insect interactions and deter herbivory (Wagner et al. 2004; Bello et al. 2017). This diversity of trichome types reflects their multifunctional ecological roles in plant defense, microclimate regulation, and possibly allelopathic interactions, reinforcing the adaptive significance of micromorphological traits in *S. aethiopicum* (Watts and Kariyat 2021a).

According to Watts and Kariyat (2021a), the stellate trichomes, distinguished by their star-shaped structure with multiple radiating arms (Types 2 and 5), were the most prevalent trichome form in *S. aethiopicum*. However, upon closer morphological examination, four (4) previously unrecorded stellate types (Types 7, 8, 9, and 10) were identified and described (Figure 2 and Table 3). *Solanum aethiopicum* also demonstrates that trichome types consistently vary at the intraspecific level, influencing defense effectiveness against specialist herbivores (Watts and Kariyat 2021b).

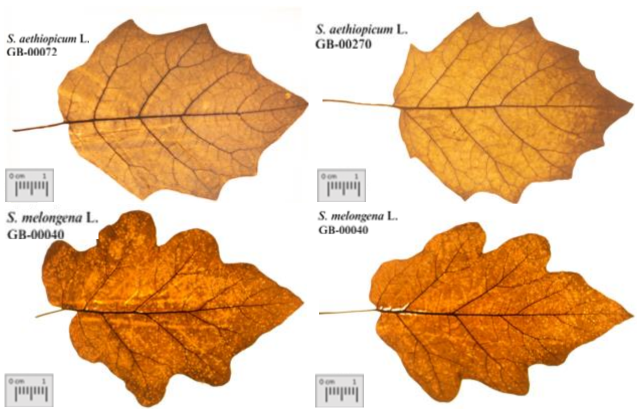
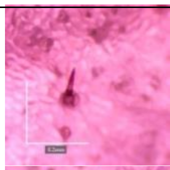
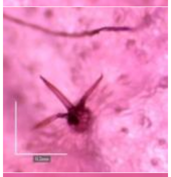
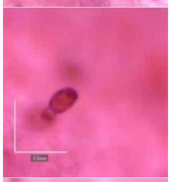
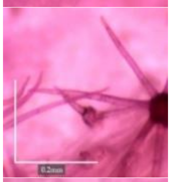
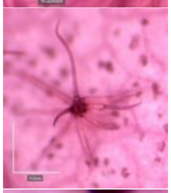
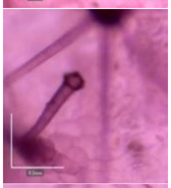
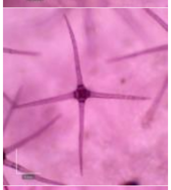
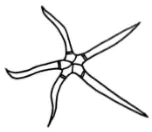
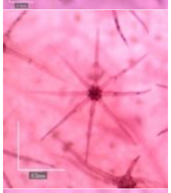


Figure 1. Leaf morphology of selected accessions of *Solanum aethiopicum* and *Solanum melongena*

Table 3. Foliar trichome types observed across selected accessions of *Solanum melongena*

Type	Line art	Actual photo	Accession present	PBDH exsiccata
Type 1: Subulate basilatus non-glandular trichome with distinct subsidiary cells			GB-0277	7991
Type 2: Multitangulate multiradiate stellate non-glandular hair with subulate rays (2-6 in number) with the presence of pedestal			GB-0277	7991
Type 3: Glandular hair with small globular head on the top and a prominent base			GB-0160,GB-0263, GB-0269, GB-0274, GB-0277, GB-0292, GB-0294	7966, 7977, 7983, 7988, 7991, 8006, 8009
Type 4: Subulate basilatus non-glandular hair with prominent base			GB: 0077, GB-0265	7965, 7979
Type 5: Porrect-stellate multiradiate non-glandular hair with subulate rays (5-10 in number) and short central ray			GB-0279, GB-0280, GB-0290	7993, 7994, 8004
Type 6: Glandular hair with small globular head without prominent base			GB-0264, GB-0267, GB-0273, GB-0289	7978, 7981, 7987, 8003
Type 7: Cruciate - cross shaped non-glandular with four equal arms			GB-0187, GB-0266, GB-0268, GB-0270, GB-0272, GB-0274, GB-0275, GB-0276, GB-0277, GB-0278, GB-0280, GB-0282, GB-0286, GB-0287, GB-0289, GB-0290, GB-0293, GB-0294	7968, 7980, 7982, 7984, 7986, 7988, 7989, 7990, 7991, 7992, 7994, 7996, 8000, 8001, 8003, 8004, 8007, 8008
Type 8: Stellate - star-shaped non-glandular trichomes with unicellular arms			GB-0270, GB-0272, GB-0278, GB-0282, GB-0285, GB-0287	7984, 7986, 7992, 7996, 7999, 8001
Type 9: Stellate - star-shaped non-glandular trichomes with 6-8 straight multicellular uniseriate rays/arms			All accessions except GB-0277	7963 to 7990, 7992 to 8012
Type 10: Stellate - star-shaped non-glandular trichomes with 6-8 wavy unicellular rays/arms with short central ray			GB-0077, GB-0256, GB-0268, GB-0272, GB-0274, GB-0275, GB-0277, GB-0278, GB-0279, GB-0280 to GB- 0293, GB-0295, GB-0296, GB-0297	7965, 7971, 7982, 7986, 7988, 7989, 7991, 7992, 7993, 7994 to 8007, 8010, 8011, 8012

Note: Trichome types 1-6 line arts (adapted from Watts and Kariyat 2021a), Trichome types 7-10 line arts are drawn by JP Cruz

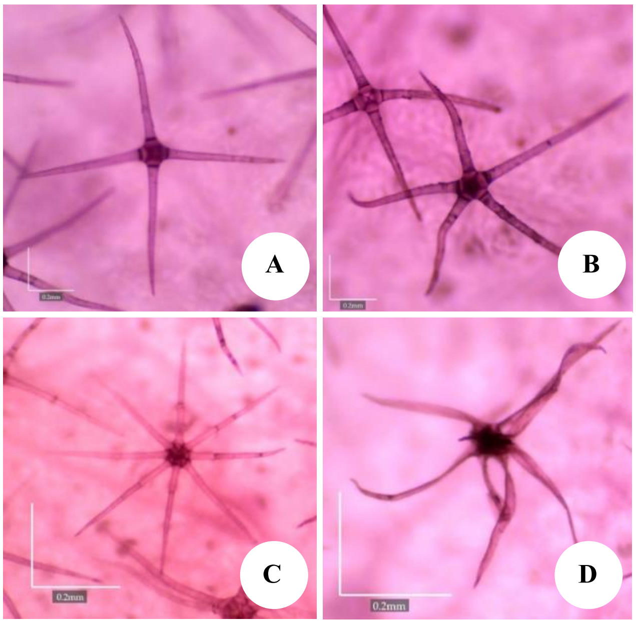


Figure 2. New stellate trichome types observed in *S. aethiopicum* accessions. A. T7, B. T8, C. T9, D. T10

Among the observed trichome types, Type 9 was the most abundant and present type in all the examined *S. aethiopicum* accessions. This is in congruence with Taher et al. (2019), who classified trichome types in *S. aethiopicum* accessions and reported that nonglandular stellate trichomes, characterized by multiple straight rays and similar to what is termed Type 9, were the most abundant and occurred in all examined accessions. All the accessions exhibited Type 9 trichomes except for GB-0277, which instead exhibits Type 2: a multitangulate multiradiate stellate non-glandular hair with subulate rays (2-6 in number) with the presence of pedestal. Notably, GB-0277 was the sole accession to exhibit Type 1 trichomes, which is a subulate, basilatus non-glandular trichomes characterized by distinct subsidiary cells. This observation aligns with a previous study confirming the presence of this trichome type in *S. aethiopicum* more broadly (Watts and Kariyat 2021a), although our findings indicate that its occurrence may be accession specific. Additionally, Types 7 and 10 were nearly abundant across the examined accessions. The identification and categorization of these additional types suggest that trichome morphology in *S. aethiopicum* is more diverse than previously reported. This trichome morphological diversity indicates ecological adaptation to diverse environmental conditions and morphoanatomical differentiation among accessions.

Trichomes are among the most significant and extensively studied epidermal outgrowths found on various plant organs (such as stems and leaves), displaying remarkable morphological diversity (Metcalfe and Chalk 1957; Dilcher 1974; Payne 1978; Stace 1984; Oksanen 2018); Putra et al. 2022). They are considered a primary line of defense in plants, providing protection against various abiotic stresses such as ultraviolet radiation, water loss, extreme temperatures, and herbivory (Kaur and Kariyat 2020). Additionally, trichomes contribute to plant water-use strategies by maintaining leaf water content and influencing stomatal attributes, among other physiological functions (Pan et al. 2021). Araújo et al. (2024) reported that trichomes were found to play a significant role in leaf ecophysiology, particularly in regulating gas exchange and water balance during drought in *Croton* species. Their results revealed a novel foliar water uptake (FWU) pathway in *Croton blanchetianus*, consisting of stellate trichomes, epidermal cells, and sclereids interconnected across both leaf surfaces. This system enabled lateral redistribution of absorbed water through pectin protuberances on mesophyll cell walls, thereby enhancing the leaf's efficiency in water absorption.

Trichomes are critical epidermal structures involved in defense, specialized metabolic processes, and insect resistance in Solanaceae (Adedeji et al. 2007). According to Taher et al. (2019), *S. aethiopicum* was among the taxa evaluated to identify genetic resources resistant to spider mites, with potential application in the development of improved cultivars for eggplant breeding programs. Our results showed that some accessions of *S. aethiopicum*, with high density of trichomes, are resistant and can be exploited in breeding programs to develop spider mite-resistant cultivars, not only in *S. aethiopicum* species, but also in the more common eggplant (*S. melongena*). In another study, *Solanum* species were used to examine the effect of trichomes in a Solanaceae specialist caterpillar (*M. sexta*), and results showed that trichomes, specifically on the abaxial leaf surface, increase feeding delays and developmental constraints in the caterpillar, affecting their performance, and exposure to predation and abiotic stressors (Watts and Kariyat 2021b).

Variations in trichomes play a crucial role in agriculturally important crops, such as *S. lycopersicum, S. melongena*, and *S. aethiopicum.* Among the various trichome types, stellate trichomes are widely recognized as a distinctive feature of the genus *Solanum,* serving as an important taxonomic marker for species identification and classification due to their stability, diagnostic value, and evolutionary significance, particularly in morphologically complex plant groups (Dilcher 1974; Stace 1984; Ali and Al-Hemaid 2011; Ifrim and Gatu 2015; Bello et al. 2017). Beyond their taxonomic value, stellate trichomes contribute significantly to plant defense (e.g., deterring herbivores) and environmental adaptation (e.g., increasing leaf surface area to minimize water loss during drought), among other ecological functions. These findings underscore the importance of detailed anatomical investigations in uncovering hidden diversity within species and reinforce the value of trichome structure as a tool for both taxonomy and ecological studies (Oksanen 2018), particularly in *S. aethiopicum*, which often exhibits close morphological similarities with related taxa.

The alignment of these results with the trichome-based dichotomous key developed in the study validates the systematic reliability of foliar trichome traits for accession characterization (Abdul Rashid et al. 2022). This trichome diversity analysis indicates that the *S. aethiopicum* accessions studied are morphologically related, as most accessions showed the consistent presence of Type 9 stellate trichomes. This shared trait highlights their close morphological affinity, reflecting a unique divergence within the overall relatedness of the group. These findings show the important role of trichomes not only in taxonomic differentiation, but also in ecological fitness and adaptive strategies. The documented trichome diversity provides a valuable resource for breeding programs, particularly for selecting traits linked to stress resilience, pest resistance, and improved ecological performance in *S. aethiopicum* (Dalin et al. 2008; Tian et al. 2012).

In conclusion, the present study effectively described and characterized the foliar trichome morphology of *S. aethiopicum* and revealed notable intraspecific variations in trichome structures and distribution among the examined accessions. The observed diversity reveals the structural complexity and adaptive significance of trichomes, reflecting their functional roles in regulating plant-environment interactions. These micromorphological traits highlight valuable intraspecific variation with important implications for taxonomy, germplasm characterization, and breeding programs. Moreover, the functional attributes associated with trichome diversity suggest potential adaptive responses to environmental stress, providing practical markers for the development of climate-resilient cultivars. Overall, foliar trichome analysis offers an integrative framework for linking plant structure to function, reinforcing its relevance in advancing ecological understanding and crop improvement strategies.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to Eastwest Seed Company, Inc., for generously providing the *S. aethiopicum* leaf samples used in this study. Sincere appreciation is extended to Mr. Jamil P. Cruz for his invaluable work in producing the line art illustrations and photographing the *S. aethiopicum* leaves, and to Mr. Marlon V. Palisoc and Mr. Paulo L. Masungsong for their assistance in the laboratory, particularly in the collection and preservation of leaves and seeds. We are likewise thankful to the Plant Systematics Laboratory, Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños (UPLB), for the use of their laboratory facilities and equipment, which made the completion of this research possible. This research was financially supported by the SEARCA University Consortium (UC) Student Thesis Grant for Research and the REPS Development Fund, Office of the Vice Chancellor for Research and Extension, UPLB, for which the authors are truly grateful.

REFERENCES

Adedeji O, Ajuwon OY, Babawale OO. 2007. Foliar epidermal studies, organographic distribution and taxonomic importance of trichomes in the family Solanaceae. Intl J Bot 3 (3): 276-282. https://doi.org/10.3923/ijb.2007.276.282.

Aguessy S, Idossou R, Loko YLE, Agre AP, Dassou AG, Dadonougbo E, Dansi A, Agbangla C. 2021. Agromorphological characterization of scarlet eggplant (*Solanum aethiopicum* L.) grown in the Republic of Benin. J Plant Breed Crop Sci 13 (3): 87-102. https://doi.org/10.5897/JPBCS2021.0944.

Ali MA, Al-Hemaid FMA. 2011. Taxonomic significance of trichomes micromorphology in cucurbits. Saudi J Biol Sci 18 (1): 87-92. https://doi.org/10.1016/j.sjbs.2010.10.003.

Anilkumar N, Chandra CA. 2025. A comprehensive review on glandular trichomes, gene regulating trichome development and how can we apply gene editing technologies to develop a specific type of trichome type. Intl J Res Agron 8 (2): 295-301. https://doi.org/10.33545/2618060X.2025.v8.i2e.2578.

Araújo KC, Souza BC, Carvalho ECD, Freire RS, Teixeira AS, Muniz CR, Martins FR, Oliveira RS, Eller CB, Soares AA. 2024. The multiple roles of trichomes in two Croton species. Plant Cell Environ 47 (5): 1685-1700. https://doi.org/10.1111/pce.14829.

Bello AO, Oladipo OT, Saheed A. 2017. Leaf epidermal studies of some *Solanum* (Solanaceae) species in Nigeria. Phytol Balcan 23 (1): 55-63.

Carpenter KJ. 2005. Stomatal architecture and evolution in basal angiosperms. Am J Bot 92 (10): 1595-1615. https://doi.org/10.3732/ajb.92.10.1595.

Chen T, Ma Y, Qi, J. 2025. Unraveling the complexity of plant trichomes: Models, mechanisms, and bioengineering strategies. Intl J Mol Sci 26 (14): 7008. https://doi.org/10.3390/ijms26147008.

Choi SM, Choi CI. 2024. Nutritional composition, phytochemical profiles, and pharmacological effects of Ethiopian eggplant (*Solanum aethiopicum* L.). Nutrients 16 (23): 4228. https://doi.org/10.3390/nu16234228.

Dalin P, Ågren J, Björkman C, Huttunen P, Kärkkäinen K. 2008. Leaf trichome formation and plant resistance to herbivory. In: Schaller A (eds). Induced Plant Resistance to Herbivory. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-8182-8_4.

Daunay MC, Lester RN, Laterrot H. 2001. The use of wild species for the genetic improvement of brinjal egg-plant (*Solanum melongena*) and tomato (*Lycopersicon esculentum*). Kew: The Royal Botanic Gardens 48: 293-302.

Dilcher DL. 1974. Approaches to the identification of angiosperm leaf remains. Bot Rev 40: 1-157. https://doi.org/10.1007/BF02860067.

Dwi A, Ermayanti. 2025. Anatomical structure study of Solanum torvum Sw. BIOMA: Jurnal Ilmiah Biologi 14 (2): 121-134. https://doi.org/10.26877/bioma.v14i2.2685.

Fahn A. 1986. Structural and functional properties of trichomes of xeromorphic leaves. Ann Bot 57 (5): 631-637. https://doi.org/10.1093/oxfordjournals.aob.a087146.

Fahn A. 1990. Plant Anatomy (4th ed.). Pergamon Press, Oxford.

Glas JJ, Schimmel BCJ, Alba JM, Escobar-Bravo R, Schuurink RC, Kant MR. 2012. Plant glandular trichomes as targets for breeding or engineering of resistance to herbivores. Intl J Mol Sci 13 (12): 17077-17103. https://doi.org/10.3390/ijms131217077.

Han M, Opoku KN, Bissah NAB, Su T. 2021. *Solanum aethiopicum*: The nutrient-rich vegetable crop with great economic, genetic biodiversity and pharmaceutical potential. Horticulturae 7 (6): 126. https://doi.org/10.3390/horticulturae7060126.

Ifrim C, Gatu I. 2015. Morphological features concerning epidermal appendages on some species of the *Solanum* genus. J Plant Dev 22: 3-12.

Abdul Rashid ZS, Che Amri CNA, Shahari R. 2022. The taxonomic study of trichome morphology in selected Asteraceae species of Pahang, Malaysia. Malays. Appl. Biol 51 (4): 1-4. https://doi.org/10.55230/mabjournal.v51i4.01.

Kabore D, Sawadogo P, Traore RE. 2025. Agronomic and nutritional performance of African eggplant (*Solanum aethiopicum*) cultivars from the Sudanian-Sahelian zone of Burkina Faso. Intl J Plant Soil Sci 37 (6): 286-297. https://doi.org/10.9734/ijpss/2025/v37i65508.

Karabourniotis G, Liakopoulos G, Nikolopoulos D. Bresta P. 2020. Protective and defensive roles of non-glandular trichomes against multiple stresses: Structure-function coordination. J For Res 31: 1-12. https://doi.org/10.1007/s11676-019-01034-4.

Kariyat RR, Smith JD, Stephenson AG, De Moraes CM, Mescher MC. 2017. Non-glandular trichomes of *Solanum carolinense* deter feeding by *Manduca sexta* caterpillars and cause damage to the gut peritrophic matrix. Proc Biol Sci 284 (1849): 20162323. https://doi.org/10.1098/rspb.2016.2323.

Kaur J, Kariyat R. 2020. Role of Trichomes in Plant Stress Biology. In: Núñez-Farfán J, Valverde P (eds.) Evolutionary Ecology of Plant-

Herbivore Interaction. Springer, Cham. https://doi.org/10.1007/978-3-030-46012-9_2.
Kaur S, Khanal N, Dearth R, Kariyat R. 2023. Morphological characterization of intraspecific variation for trichome traits in tomato (*Solanum lycopersicum*). Bot Stud 64: 7. https://doi.org/10.1186/s40529-023-00370-3.
Koul M, Thomas L, Karmakar K. 2021. Functional aspects of Solanaceae trichomes in heavy metal detoxification. Nordic J Bot 39 (5): e03171. https://doi.org/10.1111/njb.03171.
Lester RN, and Seck A. 2004. *Solanum aethiopicum* L. [Internet] Record from PROTA4U. Grubben GJH, Denton OA (eds). PROTA (Plant Resources of Tropical Africa/Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands. http://www.prota4u.org/search.asp. [22 February 2026]
Lester RN.1986. Taxonomy of scarlet eggplant, *Solanum aethiopicum* L. Acta Hortic 182: 125-132. https://doi.org/10.17660/ActaHortic.1986.182.15.
Lin LJ, Hsiao YY, Kuo CG. 2009. Discovering indigenous treasures: Promising Indigenous vegetables from around the world. AVRDC - The World Vegetable Center Publication no. 09-720. AVRDC. AVRDC-The World Vegetable Center, Shanhua.
Metcalfe CR, Chalk L. 1957. Anatomy of the Dicotyledons. Clarendon Press, Oxford.
Oksanen E. 2018. Trichomes form an important first line of defence against adverse environment-New evidence for ozone stress mitigation. Plant Cell Environ 41 (7): 1497-1499. https://doi.org/10.1111/pce.13187.
Pan ZL, Guo W, Zhang YJ, Schreel JDM, Gao JY, Li YP, Yang SJ. 2021. Leaf trichomes of *Dendrobium* species (epiphytic orchids) in relation to foliar water uptake, leaf surface wettability, and water balance. Environ Exp Bot 190: 104568. https://doi.org/10.1016/j.envexpbot.2021.104568.
Payne WW. 1978. A glossary of plant hair terminology. Brittonia 30: 239-255. https://doi.org/10.2307/2806659.
Prohens TJ, Whitaker BD, Plazas Ávila MDLO, Vilanova Navarro S, Hurtado Ricart M, Blasco Villarroya M, Gramazio, P. 2013. Genetic diversity in morphological characters and phenolic acids content resulting from an interspecific cross between eggplant (*Solanum melongena*) and its wild ancestor (*S. incanum*). Ann Appl Biol 162 (2): 242-257. https://doi.org/10.1111/aab.12017.
Putra FP, Kusmiyati F, Anwar S, Widaryati, Sas MGA. 2022. Variation in leaf characters and agronomical traits of Yard-long bean genotypes between *Dimocarpus longan* and *Psidium guajava* stand. Biodiversitas 23 (11): 5752-5758. https://doi.org/10.13057/biodiv/d231127.
Shimira F, Boyacı HF, Taşkın H. 2024. Investigating phenotypic diversity in a germplasm collection of scarlet eggplant under Mediterranean conditions. Hortic Stud 41 (1): 6-21. https://doi.org/10.16882/hortis.1413023.
Song B, Song Y, Fu Y, Kizito EB, Kamenya SN, Kabod PN, Liu H, Muthemba S, Kariba R, Njuguna J, Maina S, Stomeo F, Djikeng A, et al. 2019. Draft genome sequence of *Solanum aethiopicum* provides insights into disease resistance, drought tolerance, and the evolution of the genome. GigaScience 8 (10): giz115. https://doi.org/10.1093/gigascience/giz115.
Stace CA. 1984. The Taxonomic Importance of the Leaf Surface. In: Heywood VH, Moore DM (eds). Current Concepts in Plant Taxonomy. Academy Press, London.
Taher D, Rakha M, Ramasamy S, Solberg S, Schafleitner R. 2019. Sources of resistance for two-spotted spider mite (*Tetranychus urticae*) in scarlet (*Solanum aethiopicum* L.) and gboma (*S. macrocarpon* L.) eggplant germplasms. HortScience 54 (2): 240-245. https://doi.org/10.21273/HORTSCI13669-18.
Tian D, Tooker J, Peiffer M, Chung SH, Felton GW. 2012. Role of trichomes in defense against herbivores: Comparison of herbivore response to woolly and hairless trichome mutants in tomato (*Solanum lycopersicum*). Planta 236 (4): 1053-1066. https://doi.org/10.1007/s00425-012-1651-9.
Wagner GJ, Wang E, Shepherd RW. 2004. New approaches for studying and exploiting an old protuberance, the plant trichome. Ann Bot 93 (1): 3-11. https://doi.org/10.1093/aob/mch011.
Watts S, Kariyat R. 2021a. Morphological characterization of trichomes shows enormous variation in shape, density, and dimensions across the leaves of 14 *Solanum* species. AoB Plants 13 (6): plab071. https://doi.org/10.1093/aobpla/plab071.
Watts S, Kariyat R. 2021b. Picking sides: Feeding on the abaxial leaf surface is costly for caterpillars. Planta 253 (4): 77. https://doi.org/10.1007/s00425-02- 03592-6.
Watts S, Kariyat R. 2023. An attempt at fixing the oversimplification of Nightshades' (genus *Solanum*) epidermal hair complexity. Front Plant Sci 14: 1176674. https://doi.org/10.3389/fpls.2023.1176674.
Werker E. 2000. Trichome diversity and development. Adv Bot Res 31: 1-35. https://doi.org/10.1016/S0065-2296(00)31005-9.