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The variation of the Solanaceae family trichomes found in the Cendana Hill, Sedan District, Rembang Regency

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Abstract: This study aimed to identify the variation of trichomes in the Solanaceae family found in the Cendana Hill of Sedan District, Rembang Regency. This study used the trichome printing method and the results were observed under a microscope. This study found trichomes glandular and non-glandular from the six Solanaceae species with various types. Different variations were found from the six species of the Solanaceae family, i.e: stellata, acicular, uncinate, hydathode, simplex and curved. The variations of trichomes from the Solanaceae family have different characteristics and shapes. This study identified six species from the Solanaceae family that have variations in the shape and type of trichomes on the epidermal layer of leaves, i.e: *Solanum melongena var. melongena, var. serpentinum, Solanum lycopersicum, Solanum nigrum, Physalis angulata, Nicotiana tabacum,* and *Capsicum frutescens*. Non-glandular trichomes act as a mechanical defense against pathogens and herbivores, while glandular trichomes have the function of secreting secondary metabolites, such as alkaloids and flavonoids, which play a role in chemical defense.

Keywords: Glandular trichomes, non-glandular trichomes, Solanaceae, trichome variation

Abstrak: Penelitian ini bertujuan untuk mengidentifikasi variasi trikoma pada famili Solanaceae yang ditemukan di bukit Cendana Kecamatan Sedan, Kabupaten Rembang. Penelitian ini menggunakan metode *trikomatal printing* dan hasilnya diamati dibawah mikroskop. Hasil dari penelitian ini ditemukan trikoma glandular dan juga non grandular dari ke tujuh spesies Solanaceae dengan tipe yang bermacam-macam. Ditemukan variasi yang berbeda dari ketujuh spesies famili Solanaceae yaitu bentuk stellata, acicular, uncinate, hydathode, simplex and curved. Variasi trikoma dari famili Solanaceae yang ditemukan memiliki ciri dan bentuk yang berbeda. Penelitian ini mengidentifikasi enam spesies dari famili Solanaceae yang memiliki variasi bentuk dan jenis trikoma pada lapisan epidermis daun, yaitu *Solanum melongena var. melongena, var. serpentinum, Solanum lycopersicum, Solanum nigrum, Physalis angulata, Nicotiana tabacum,* dan *Capsicum frutescens*. Trikoma non-glandular berperan sebagai pertahanan mekanis terhadap patogen dan herbivora, sedangkan trikoma glandular memiliki fungsi sekresi metabolit sekunder, seperti alkaloid dan flavonoid, yang berperan dalam pertahanan kimiawi.

Kata kunci: Trikoma glandular, trikoma non-glandular, Solanaceae, variasi trikoma

INTRODUCTION

Cendana Hill is a natural tourism area managed by the Rembang Regency government as a conservation area. This hill is at a height of 560 meters above the surface sea. In the Cendana Hill area, there are many types of plants. One of the plants in the area of Cendana Hill is the Solanaceae family. The family Solanaceae or eggplant tribe is one of the tribes of shrubs, herbs, and flowering plants that consists of 80 genera with 1,7000 species (Anggraeni et al., 2023; Shobari et al., 2023). Most plants in this family are helpful in various fields life humans (Romero et al., 2021; Wang et al., 2021; Wu et al., 2021). Plants of the family Solanaceae can be utilized by the public as sources of food and medicine (Chang et al., 2022; El-Sappah et al., 2021; Wang et al., 2020). The high species diversity in the Solanaceae family makes it difficult to identify individual species within this family (Teixeira et al., 2023). One of the methods used for recognizing member family Solanaceae are the identification of morphology leaves, fruit, and stems (Saputri & Putri, 2023). The characteristics that appear can used to recognize or identify type member families by observing the type, structure, or form of visible trichomes. The diversity of the genus and species from the family Solanaceae indicates the existence of diverse types and forms from trichomes in the family mentioned. Plants that are included in the family Solanaceae own diverse types of trichome based on the existence of glandular and non-glandular trichomes (Feng et al., 2021; Li et al., 2021; Livingston et al., 2020; Tanney et al., 2021; Wang et al., 2021).

Trichomes are classified into two i.e: glandular trichomes and non-glandular trichomes. Non-glandular trichomes serve as a physical barrier against herbivores and environmental stresses. These trichomes can be simple (unicellular or multicellular) or branched, such as biramous (bifurcated), stellate (star-shaped), and dendroid (tree-like branched). Some plants also have special shapes such as long, twisted ribbon trichomes (Hu et al., 2012; Ma et al., 2016). Meanwhile, glandular trichomes play a role in the production and secretion of chemical compounds as a defense mechanism. The capitular glandular trichomes have stalks and heads, and function in the secretion of terpenes and flavonoids, while the peltate glandular trichomes are shaped like shields and produce essential oils (Mustofa et al., 2025). In addition, there are specialized forms such as capitate biseriate and uniseriate linear glandular trichomes found in certain species (Bhatt et al., 2010; Uzelacss et al., 2019).

The essential of trichoma including plant defense, metabolic production, and potential bioinspired applications (Dhankhar et al., 2023). Trichomes serve as the first defense against various biotic and abiotic stress (Hidayat et al., 2024; Hauser, 2014). Trichomes protect plants from herbivores, pathogens, and environmental stresses such as UV radiation, drought, and extreme temperatures (Han et al., 2023; Hauser, 2014; Kaur & Kariyat, 2020). Their structural diversity and density can significantly influence a plant's ability to survive these challenges (Mustofa et al., 2021). The unique structure and function of trichomes have inspired biomimetic applications. For example, their ability to create complex three-dimensional networks can be mimicked in materials science to develop novel materials with enhanced protective properties (He et al., 2022; Suvindran et al., 2018). Additionally, the role of trichomes in water uptake and metal detoxification has implications for ecological and agricultural innovation (Li et al., 2023; Liu et al., 2017).

Although trichomes have long been used as characters in plant identification and classification, information on trichome variation in the Solanaceae family found in certain regions is still limited. More detailed identification can help clarify phylogenetic relationships and species adaptation to the local environment. In addition, Rembang Regency has a distinctive ecosystem, including hilly areas such as Cendana Hill. This research is important to document the morphological diversity of trichomes in the Solanaceae family growing in the area as a first step in local species conservation efforts.

The study of trichomes can provide insight into the various types and forms of trichomes. The benefits of this trichome research are to discover new things related to its type and contribute to various fields of science, such as phytopathology. Based on the description above, this study to identify trichome variations in the Solanaceae family found in Cendana Hill, Sedan District, Rembang Regency.

METHOD

This type of research was an exploratory, descriptive study describing some variations of trichomes in cendana Hill Sedan District, Rembang Regency conservation areas.

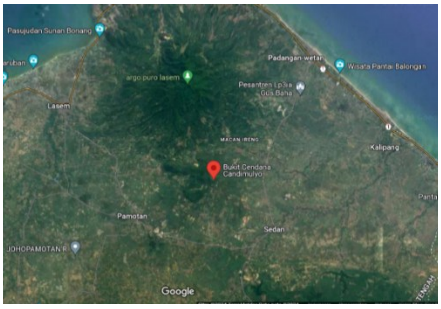

Figure 1. Location of leaf sampling family Solanaceae

The tools used in this research were, microscope, glass object, tweezers, scalpel, and camera and the materials are nail polish, solvent and leaves. The data collection process in this research was carried out through several stages, starting with leaf sampling from various species of the Solanaceae family using purposive sampling method. The samples collected included *Solanum melongena var. melongena, var. serpentinum, Solanum lycopersicum, Solanum nigrum, Physalis angulata, Nicotiana tabacum,* and *Capsicum frutescens* found in Cendana Hill. The leaves were then prepared by cutting them into small pieces and observing their structure before microscopic observation. Observations were made using a light microscope, followed by documentation through microscopic photography to record trichome variations in each species. Data analysis was conducted by identifying and classifying trichomes based on their shape and type, both glandular and non-glandular, such as stellate, simple, and acicular. Observations were compared with literature references and previous studies to ensure classification accuracy.

This research went through several stages, namely making preparations. Make preparations using the trichromatic technique printing by applying nail polish above the lower surface of the leaf because morphologically, the presence or absence of trichomes is usually identified with fine hairs found on the surface of plant organs. After applying nail polish to the surface of the leaf, please wait for 10 minutes until the nail polish dries, attach the adhesive tape on top of the nail polish layer, remove the adhesive tape from the leaf surface, then place it on a glass object and observe under a microscope and document using a smartphone camera (Huebbers et al., 2022). Documenting research results using a smartphone camera.

RESULTS AND DISCUSSION

Based on the research results conducted in the PGRI Ronggolawe University Tuban laboratory, five species were found from six species of the family Solanaceae. The results of research that has been done can seen in Table 1.

Table 1. Observation results shape and type trichomes Solanaceae

Local Name	Scientific Name	Form Trichoma	Type Trichoma
Terong ungu	*Solanum melongena var. melongena*	Stellata	Non glandular
Terong hijau	*Solanum melongena var. serpentinum*	Acicular	Non glandular
Tomat	*Solanum lycopersicum*	Stellate	Non glandular
Ranti	*Solanum nigrum*	Uncinate	Non glandular
Ciplukan	*Physalis angulata*	Hydathode	Glandular
Tembakau	*Nicotiana tabacum*	Simplex	Glandular
Cabai rawit	*Capsicum frustescens*	Curved	Non glandular

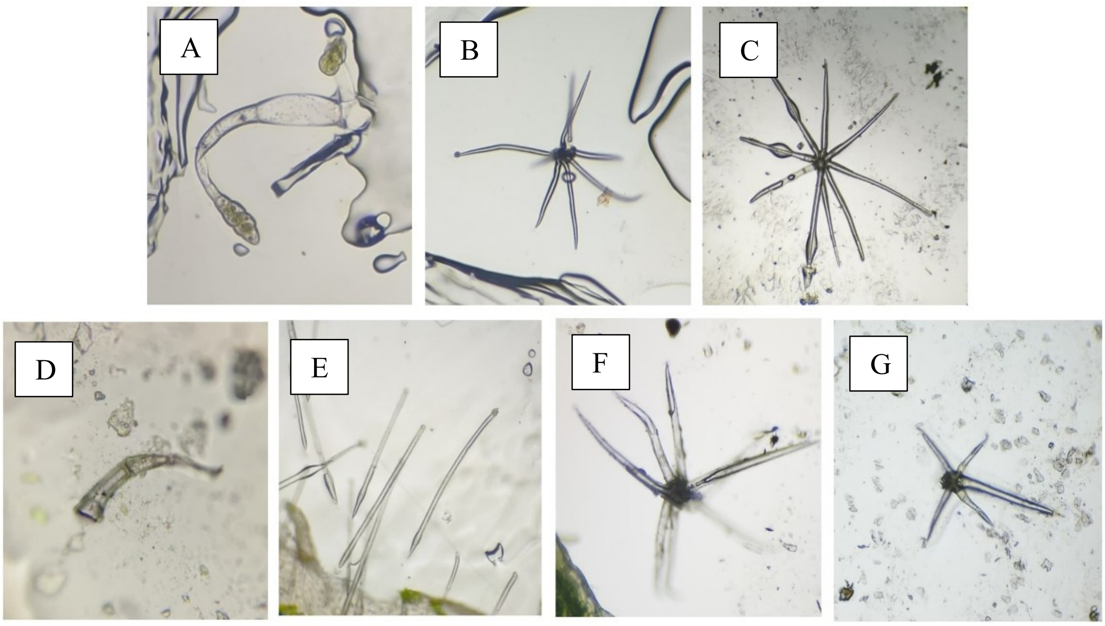

Figure 2. Types and shapes of trichomes (a*) Nicotiana tabacum,* (b) *Solanum lycopersicum,* (c) *Solanum melongena var. melongena,* (d) *Physalis angulata*, (e) *Solanum melongena var. serpentinum,* (f) *Capsicum frustescens, (g) Solanum nigrum*

Based on Table 1, it is known that there are 6 species of Solanaceae, but specifically in *Solanum melongena* there are 2 varieties i.e: *Solanum melongena var. melongena* and *Solanum melongena var. serpentinum*. The other five plants are *Solanum lycopersicum, Solanum nigrum, Physalis* *angulata, Nicotiana tabacum,* and *Capsicum frutescent* were found from different trichomes on the epidermis layer of the leaf family Solanaceae. The image of trichome variation is presented in Figure 2.

Solanum melongena

Species *Solanum melongena* is regularly called plant eggplant purple and eggplant green. This is its stellate and acicular non-glandular trichomes. The characteristics of stellate and acicular trichomes are that they have many arms shaped like stars on their leaves. Exact results of the study Ilahi et al. (2018) reported that in the genus *Solanum*, stellate trichomes are the non-glandular type with stellate form or can resemble stars on the leaf organs. Only part of the leaf abaxial was studied because the study trichome found trichomes on the leaf's surface. Trichome stellate trichomes, which are a type of non-glandular trichome, function as a barrier to the entry of pathogens through the stomata, while stellate trichomes glandular functions to secrete secondary metabolites (Saputri & Putri, 2023). Trichomes grandular can produce secondary metabolites by producing secret (Astuti, 2021).

Stellate and acicular trichomes differ primarily in their shape and structure, with stellate trichomes being star-shaped and needle-like trichomes being elongated and pointed. Stellate trichomes can serve as biophysical barriers, helping plants adapt to severe environments by creating a complex three-dimensional network (Gonzalez & Arbo, 2004; Hua et al., 2021; Liu et al., 2017).

Solanum lycopersicum

This species has non-glandular trichomes on the leaf epidermis. The leaf trichomes of the tomato plant are acicular. In line with the study by Appidi et al. (2008) in the section adaxial and abaxial leaf plant tomato *(Solanum lycopersicum*) obtained Trichome non-glandular type with form hair multicellular resemble Needles and types glandular trichomes with short capitate unicellular form. Non-glandular trichomes on the leaves of tomatoes can act as protectors against herbivores. Structure rough and stiff trichomes can make it difficult for insects and animals to eat leaves (Sanjayanti et al., 2024).

Trichome is hair that grows and originates from epidermal cells with form, structure as well and various functions (Agustin & Susanti, 2022; Cold et al., 2020; Malik & Sanadhya, 2018; Matsumura et al., 2022). Trichomes can range in size from a few micrometers to several centimeters, and their shapes can vary (Konrad et al., 2021; Schuurink & Tissier, 2020). Trichomes are found throughout the plant kingdom and have a variety of shapes (Zheng et al., 2022). Trichome characters are instrumental in identifying species of a genus (Parmar & Zaman, 2022). Trichomes in the epidermis tissue have unique properties as a defense against insects, which are determined by the presence of glands (glandular) or not (non-glandular) (Camoirano et al., 2020).

Nicotiana tabacum

Trichomes found in *Nicotiana tabacum* are glandular trichomes or simple trichome glands with stalks with head unicellular or multicellular. According to a study by Swandari, (2018) the trichome *Nicotiana tabacum* were shaped like a stalk and cell one. Generally, glandular trichomes can produce terpenoid exudate, oil essential, and lip lipids for pheromones, insects, neurotoxins, cytotoxins, anti-inflammatory, and anti-mitotic. Exudates play a role in trapping predators or releasing toxic compounds as polyphenols (Cahyono et al., 2022).

Solanum nigrum

The trichomes in this species are stellate. This was done by research Kariyat et al., (2019) it is known that the epidermis derivative is in the form of trichomes found based on results observations made on species *Solanum melongena* and *Solanum nigrum* that are non-glandular trichomes and stellate in shape. Species other than *Solanum tuberosum* found existence in trichome multicellular, non-glandular-shaped simple that simply resembles a needle.

Capsicum frustescens

In the abaxial part of the leaves of *Capsicum frustescens*, non-glandular type trichomes are obtained as blunt-tip multicellular hairs. The shape of the trichomes was in the form of simple hairs whose tops bend like they have hooks. In contrast to the findings of Ayub et al. (2021) in the results of their research, it was written that the genus *Capsicum* in the species *C. frutescent* and *C. chinense* had found two types of glandular and non-glandular trichomes on the adaxial and abaxial parts of the leaf. However, only non-glandular trichomes were found in this study because it was conducted on the abaxial part of the leaf. After all, morphologically, trichomes are identical to fine hairs usually found on plant organs' surfaces (Wardhani, 2019). There are several differences between glandular and non-glandular trichomes seen from their secretion function: non-glandular trichomes with no secretion and glandular trichomes with secretion results. Each plant has a different type of trichome; this causes the structure and morphology of trichomes to have diversity and can be used to identify genus, species, subspecies, and varieties of the various families studied (Huabber, 2022). Therefore, the differences in each plant can be seen from the type of trichomes with glandular and non-glandular types that characterize each plant.

Physalis angulata

Trichomes found on *Physalis angulata* leaves showed secretory structures in trichomes glandular embedded between the epidermis. Glandular trichomes are trichomes with cells that have a secretory function. These trichomes consist of basal, stalk, and tip cells. The tip cells of the trichome is a secretion substance consisting of one or many cells with a special liquid (Muravnik, 2020). Trichomes can be found in all plant organs, vegetative organs such as leaves and stems, and generative organs such as petals, corollas, stamens, seeds, and fruit. Such as it is trichomes non-glandular, trichomes glands can form unicellular, multicellular, uniseriate, and multiseriate (Esmaeili et al., 2019).

Trichomes found on the *Physalis angulata* leaves was multicellular trichomes consisting of one basal cell, one stalk cell, and four simple hair-like cells with hooked and warty ends (Muliyah & Ratna Djuita, 2022). The morphology of the trichome gland multicellular usually has a distinctive structure: cell head, cell stalk with amount one or several cells, basal cells, and sometimes found in the neck, which is located between the cell head and cell stalk (Naidoo et al., 2012). Trichomes on *Physalis angulata* their own texture and extensive base, almost resembling the spearhead, but the end is bent, as in Figure 2D. In addition, the trichomes on *Physalis angulata* the surface, and its spots arise like warts. Glandular trichomes produce metabolic secondary such as alkaloids, flavonoids, and terpenoids, which are toxic to herbivores. This substances can chase away or poison insects and animals, a little one who wants to eat leaf (Hua et al., 2021).

Research on trichomes in the Solanaceae family offers various potential benefits across fields such as environmental management, agriculture, health, and education. A deeper understanding of trichome structure and function can support the development of sustainable solutions, enhance plant resilience, facilitate the discovery of new pharmaceuticals, and enrich educational content. In environmental contexts, trichomes play a role in plant-insect interactions, where certain types help plants defend against herbivores and pests. This knowledge can be applied to develop more environmentally friendly pest control methods. Additionally, some trichomes can absorb air pollutants, making them useful indicators of air quality (Chang et al., 2019). In agriculture, trichomes contribute to protecting plants from environmental stresses such as drought, extreme temperatures, and pathogens. Understanding their protective functions can aid in developing more stress-resistant plant varieties. Trichomes also enhance the absorption of water and nutrients, ultimately contributing to increased crop yields (Jayanthi et al., 2018).

Research on trichomes has a significant positive impact on human life, both in the fields of health and education. In the health sector, trichomes in several species of the Solanaceae family are known to produce metabolites with specific pharmacological properties; therefore, trichome research has the potential to support the discovery of new drugs for various diseases. Additionally, oils extracted from the trichomes of certain Solanaceae species possess moisturizing and anti-inflammatory properties, contributing to the development of natural, safe, and high-quality cosmetic raw materials (Dhankhar et al., 2023). Meanwhile, in the field of education, trichome research is beneficial in enhancing students' understanding of biodiversity. This is because trichomes exhibit great diversity in form, structure, and function across different Solanaceae species, and studying them can help students comprehend the diversity of living organisms through microscopic observation skills. Furthermore, the study of trichomes has the potential to produce engaging, informative, and relevant teaching materials for various educational levels (Hall et al., 2018; Nurtjahyani et al., 2021)

CONCLUSION

Based on the results of research that has been carried out on the variation of trichomes from the Solanaceae family, the results obtained include the following: *Solanum melongena*, *Solanum melongena*, *Solanum lycopersicum, Solanum nigrum, Physalis angulata, Nicotiana tabacum, Capsicum frutescent.* Different variations were found from the six species of the Solanaceae family i.e: stellata, acicular, uncinate, hydathode, simplex and curved. Therefore, the six variations of trichomes from the Solanaceae family have different characteristics and shapes. This research in trichome variations in the Solanaceae family found in the Cendana Hill of Sedan District, Rembang Regency, contributes to the learning of exciting plant anatomy and can improve the understanding of anatomical concepts, especially trichomes.

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