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Morphological Character and Trichomes of *Daun Gatal* (*Laportea decumana* (Roxb.) Wedd) in Different Natural Shades in Manokwari, West Papua

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ABSTRACT

Daun gatal (Laportea decumana (Roxb.) Wedd.) is a medicinal plant traditionally used by local Papuan communities as a physical therapy to relieve fatigue, muscle pain, and body aches. However, the ecological aspects of its cultivation remain poorly understood. This study aimed to compare the leaf morphological variables of daun gatal cultivated under shaded and unshaded conditions. Field observations were conducted alongside leaf morphometric analysis and examination of leaf trichome characteristics to strengthen the analytical results. The findings indicated that air temperature, air humidity, and sunlight intensity were positively correlated (~0.80) with plant height, leaf area, trichome length, and trichome density in plants grown under shaded conditions. Meanwhile, plant height and stem diameter did not differ significantly (P>0.05) between shaded and unshaded treatments. In contrast, leaf length, leaf width, and leaf area showed significant differences (P<0.05) between the two treatments. Trichomes of plants grown in shaded habitats were significantly longer than those in unshaded habitats (P<0.05). Trichome density exhibited a similar pattern, being higher in shaded areas than in unshaded areas, although the difference was not statistically significant (P>0.05). Overall, this study demonstrates that the daun gatal exhibits morphological adaptations to variations in light intensity within its habitat, providing an important scientific basis for the effective management and optimal cultivation of Laportea decumana in Manokwari Regency.

INTRODUCTION

West Papua is one of the regions in Indonesia with high biodiversity, including various medicinal plants. One medicinal plant used by the indigenous people of Papua is the *daun gatal* plant. In the Papua region, there are three types of *daun gatal* plants, namely *Laportea decumana* (Roxb)

Wedd., *Laportea interrupta* (L.) Chew., and *Dendrocnide peltata* (Blume.) Miq. (Holdsworth, 1978; Irnawati et al., 2023). The *L. decumana* type is locally known as the *daun gatal*. The *daun gatal* of *L. decumana* is more in demand among the public than the other two types due to its abundant availability and its itching sensation, which is considered the most natural physical therapy for relieving fatigue, muscle pain, and sciatica (Paisey et al., 2017).

People cultivate *daun gatal* in house yards and gardens for sale (Simaremare et al., 2019). The active compounds found in *daun gatal* are alkaloids, glycosides, steroids/triterpenoids, flavonoids, tannins, and saponins, which exhibit antioxidant, antibacterial, analgesic, and cytotoxic activity (Thalib et al., 2021). According to Prabawati et al. (2021), daun gatal trichomes contain formic acid and methyl silicic acid.

The use of *daun gatal* is traditionally done by rubbing the leaves on the skin or sore parts of the body. Tripoli leaves will attach to the skin's epidermis to release formic acid and methyl silicic acid, which cause the pores of blood vessels to dilate, allowing blood circulation to flow smoothly and relieving pain (Susanti et al., 2025). Although it has become an integral part of the public health culture in Papua, understanding of the environmental factors affecting the physical and physiological qualities of *daun gatal* plants remains very limited.

Environmental factors have a very dominant influence on the morphological and physiological profile of *daun gatal* plants. Based on field observations, plants growing in highland areas show striking differences in characteristics compared to lowland populations. *Daun gatal* on the plateau tend to have darker green pigmentation and stem sizes that can reach heights of up to 180 cm. In contrast, plants that grow in lowlands with direct sunlight exposure and drier air conditions generally have yellowish-green leaves and a shorter habitus (Sadsoeitoeboen & Moeljono, 1992). This phenomenon indicates the specific adaptation of plants to the intensity of light and humidity of the environment in which they grow.

Several previous studies on *daun gatal* in Papua have included ethnobotanical aspects, testing the physical quality of ointment formulations, and exploring trichome forms in the Urticaceae family (Irnawati et al., 2023; Wenda et al., 2023; Demena et al., 2024). However, information on the relationship between specific environmental factors, such as light intensity (shade vs. no shade), and plant morphological and trichome characteristics in *L. decumana* has not been reported. The limitations of this information need to be investigated immediately, as the local

Papuan community cultivates *daun gatal* under various environmental conditions. These variations in shade and the absence of shade can affect trichome quality and the concentration of formic acid produced, so they are thought to impact treatment efficacy, as reported by La Basy et al. (2022).

Efforts to map the different shade variations of *daun gatal* growing areas in West Papua can serve as a basis for determining the biological quality of *daun gatal* plants. In addition, environmental parameters, especially the effects of shade and lack of shade, affect the morphological characteristics and trichomes of the leaves, which are further suspected to influence the formic acid content of *daun gatal*. Shade variations can also affect changes in plant morphology, anatomy, and phytochemical content, as reported by Marcelline et al. (2025) in *Bidens pilosa* and by Handayani et al. (2025) in *Commelina diffusa*. No information has been reported on changes in the morphology and character of the *daun gatal* trichomes. Therefore, understanding the influence of shade on the morphology and character of *daun gatal* trichomes is a means of determining the quality of the growing environment and the development of the use of germplasm based on ecological and land ecotypes. Based on this background, this study aims to analyze the morphological and trichomy characteristics of *daun gatal* in different natural shades in Manokwari, West Papua.

RESEARCH METHODS

Study Design

This study uses quantitative and qualitative descriptive approaches, field survey methods, and laboratory analyses. The research activities were carried out from February to November 2025, located in Manokwari Regency, West Papua Province (Figure 1).

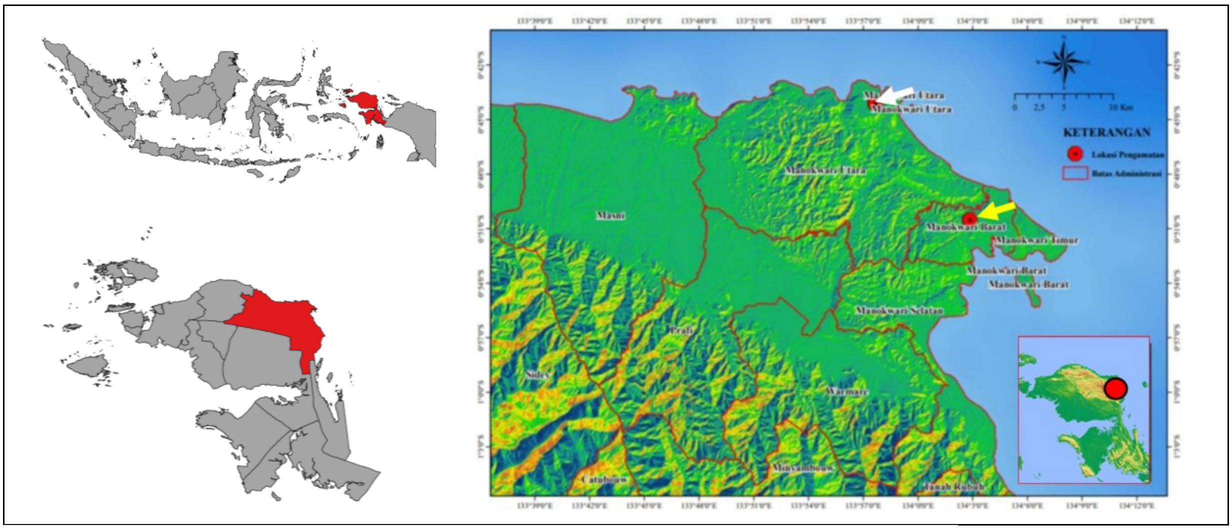

Figure 1. The research location points are in Manokwari Regency, West Papua Province.
The yellow arrow is the West Manokwari District; the white arrow is the North Manokwari District.

Procedure

The research design focused on comparative studies of the habitats of shaded and unshaded *daun gatal*, examining morphological and trichome characters. The observed variables included environmental parameters (air temperature, soil moisture, soil pH, and light intensity), leaf morphology (leaf length, width, and area), and microscopic characteristics of trichomes in leaves (type, number, and density).

Plant sampling was carried out in two main areas, namely West Manokwari District (0º 49′ 32.7" LS; 134º 3′ 45.8" E) and North Manokwari District (0º 43′ 58" LS; 133º 57′ 32.8" E), which includes one location in North Manokwari District including Mandopi Gunung Village and five locations covering West Manokwari District, namely: University of Papua Campus Dormitory, Amban Village, Jalan Angkasa Mulyono (Amban Village), Jalan Manunggal (Amban Village), and Reremi Manokwari Village. The trichome identification process and subsequent laboratory analysis were conducted at the Biology Laboratory of the Faculty of Mathematics and Natural Sciences, University of Papua.

Data Collection

The research stage began with semi-structured interviews with selected respondents, guided by the questionnaires. The selection of respondents in this study was carried out using a purposive sampling technique involving the community of *daun gatal* cultivators and sellers in Manokwari City.

The total number of participants was 16, comprising 4 sellers and 12 who played a dual role as cultivators and sellers. After the interview, location observations were conducted to assess the sample area's representation in terms of accessibility and habitat conditions (shaded and unshaded). At each location, five individual plants from different clumps were selected for morphological measurements.

The plant's height is measured with a measuring tape, while the stem diameter is measured with a caliper. Samples of healthy adult leaves are collected and stored on plastic labels for laboratory analysis. In the laboratory, the length and width of the leaves were measured with a ruler, and their area was estimated by tracing on millimeter paper (Masilewi et al., 2022). Trichomes were observed on the underside of the leaf using the Dino-Lite Edge Digital Microscope AM7915 Series, connected to software on a laptop, to digitally document the type and length of trichomes (Surianto, 2022).

All data are collected through direct field measurements and laboratory observations. Environmental parameters were measured in situ using a thermohygrometer for air temperature and humidity, a soil tester for pH and soil moisture, and a lux meter for light intensity. Leaf morphology data includes leaf length (cm), leaf width (cm), and leaf area (cm^2). The collected trichome microscopic data included trichome type, number of trichomes per field of view (trichomes/mm^2), and trichome length (mm).

Data Analysis

Leaf area data were analyzed by summing the boxes on the block millimeter paper and converting the sum to square centimeters (Masilewi et al., 2022). Trichome density is calculated using a modified formula from Nyandwi et al. (2025), expressed in units/mm^2. The area of view was obtained from the multiplication of length (6,989 mm) and width (5,053 mm). All quantitative data were statistically tested using multivariate fingerprint analysis (ANOVA) to compare shaded and unshaded habitats. In addition, a correlation analysis between environmental factors and the morphological characteristics and trichomes of *daun gatal* was also carried out using Pearson's r. All data analysis is performed using SPSS version 27.00 for Windows.

RESULTS AND DISCUSSION

Characteristics of Local Communities Cultivating *Daun Gatal*

Respondents interviewed: 68.75% were female and 31.25% were male. Most of the respondents came from the Sough tribe (31.25%), and there were also other respondents from the Ayamaru tribe (26.6%), Mee (13.3%), Wamena (13.3%), Serui (6.6%), Keerom (6.6%), and the Moi tribe (6.6%). The *Daun gatal* by each tribe interviewed has different regional names, namely Kafa' (Sough tribe), Kafa' (Ayamaru/Maybrat), and Bouma (Mee), Kafa (Wamena), Fia/Fiar' (Serui), Kue (Keerom), and Kafa (Moi tribe).

Respondents interviewed said that they often use *daun gatal* to treat various complaints, namely fatigue, headache, rheumatism, malaria, aches, gout, and stomach pain. The results of the interview also identified other benefits of *daun gatal*, namely, stimulating children to walk after their feet are rubbed with *daun gatal* and expelling evil spirits (suanggi). The way the respondents used *daun gatal* consists of several ways, namely; (1) the *daun gatal* are rubbed or applied to the affected part of the body; (2) the *daun gatal* are placed on the mat and then the sick part of the body is laid on the leaves; (3) the *daun gatal* are repeatedly struck on the sore part of the body; (4) *daun gatal* are boiled and then the decoction is drunk; and (5) fresh *daun gatal* chewed and swallowed.

The *daun gatal* used in ways 1-4 is the underside of the adult *daun gatal*'s leaves (abaxial), which are green. At the same time, *daun gatal* that are consumed directly are young leaves. According to respondents, *daun gatal* planted without shade, when applied to the body, causes an itchy sensation for a longer duration than *daun gatal* grown in the shade.

The respondents propagated *daun gatal* plants using vegetative propagation methods, including crouching and stem cuttings. Propagation by ducking uses stones to bend the parent plant's stem until it touches the ground; the buried part will form roots and produce new shoots. According to respondents, propagation by crouching can produce about two to three new shoots from a single parent plant. Propagation through stem cuttings involves cutting young stems from the plant and then planting them in a growing medium. Each piece of the stem can form roots that develop into new plants independently.

Biophysical Information of the Research Site

The local Papuan community grows *daun gatal* in shaded and unshaded habitats. The *daun gatal* plant grows on riverbanks, in yards near wells, and in gardens. *Daun gatal* plants are grown in beds and without beds. Some respondents put leaf litter or coconut coir under the plant. To be a water reserve and moisten the soil. In general, respondents do not use chemical fertilizers in the maintenance of *daun gatal* plants. There are two methods for maintaining *daun gatal* plants: watering *daun gatal* plants and pulling out weeds that grow under them. The conditions of the research location are adjusted to the conditions of the gardens of the local Papuan community, namely, in the habitat with or without shade. Information on the condition of the research location is shown in Table 1.

In general, the temperature and intensity of sunlight are higher in unshaded habitats than in shaded habitats (Table 1). The presence of shade causes sunlight to be retained, thereby lowering the temperature around the shaded habitat (Grunicke et al., 2020). A temperature drop triggers an increase in humidity around the shaded area. The presence of shade for a long time can also create a microclimate around the habitat, affecting its vegetation components, including *daun gatal*. We conducted a further analysis of three factors with quite diverse values, namely air temperature, air humidity, and sunlight intensity. These factors affect the growth pattern of *daun gatal*, particularly plant height, stem diameter, leaf area, trichome length, and trichome density (Figure 2).

Table 1. Environmental parameter information of the habitat of *daun gatal* with and without shade

Parameters	Habitat	
	With shade	**No shade**
Air temperature (ºC)	29.6 ± 0.95	31.4 ± 0.70
Air humidity (%)	85.0 ± 2.0	79.3 ± 2.30
Soil moisture (%)	87.6 ± 7.64	62.3 ± 4.04
Sunlight intensity (lux)	3818 ± 5096	6012 ± 4386
Soil pH	5.8 ± 1.26	4.7 ± 1.66

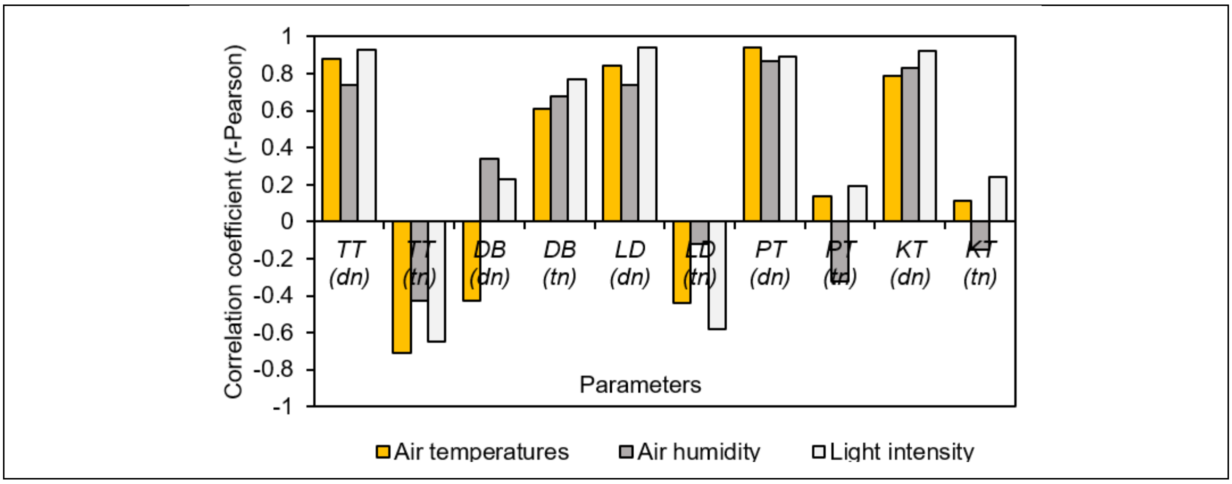

Figure 2. The correlation coefficient (*r-Pearson*) of morphological variables with environmental factors.
Description: TT = plant height (cm), DB = stem diameter (cm), LD = leaf area (cm^2), PT = trichome length (mm) and KT = trichome density per mm^2, dn = shaded, tn = without shade.

The trend in this study shows that plant height, leaf width, trichome length, and trichome density in shaded habitats are positively correlated with temperature, humidity, and sunlight intensity (Figure 2). Meanwhile, plant height and leaf area in unshaded habitats tend to be negatively correlated with temperature, humidity, and sunlight intensity. In unshaded habitats, stem diameter tends to be positively correlated with temperature, humidity, and sunlight intensity.

The length and density of trichomes are negatively correlated with air humidity in unshaded habitats. On the other hand, the length and density of trichomes are positively correlated with higher temperatures and sunlight intensity in shaded habitats. Previous reports on *Wigandia urens* plants have shown that trichome density is significantly correlated with temperature and photosynthetically active radiation (PAR), indicating microclimatic influences (Pérez-Estrada et al., 2000).

The temperature and intensity of sunlight appear to have a significant influence on plant height, leaf area, and trichome length (*Pearson* r> 0.8) in shaded habitats (Figure 2). Therefore, these two factors can be the best predictors to determine changes in the morphology of *daun gatal* due to differences in shade. Research by Valladares et al. (2016) states that canopy and shade significantly affect the growth of plants below by changing temperature conditions and reducing the intensity of sunlight entering the soil surface. Meanwhile, in a broader context, Rahmawati et al. (2024) showed that shade intensity can affect the diversity and abundance of underplant species.

Morphological Description of *Daun Gatal* Plants

Daun gatal plants that grow in shaded habitats tend to be taller, have dark green leaves, and have larger leaf sizes. Meanwhile, plants exposed to direct sunlight are shorter, with yellowish-green leaves and relatively small leaf size. Even though they are different, *daun gatal* plants, whether shaded or exposed to sunlight, still show a herbaceous habitus and grow in clusters. The observation results showed that one unshaded clump of plants consisted of four to nine individuals. Meanwhile, one family of shaded *daun gatal* plants consists of two to eight individuals. *Daun gatal* plants that are shaded or exposed to sunlight are shown directly in Figure 3.

The characteristics of the stem of the *daun gatal* plant show that the young stems are green and the adult stems are light brown with a woody structure (Figure 3). The stem of the *daun gatal* is round. The entire surface of the stem has trichomes; visually, young stems have more trichomes than mature stems. The average height of *daun gatal* plants growing in both shaded and unshaded habitats is shown in Table 2. Although plant height differed between the two shade systems, the analysis showed that stem height and diameter did not differ significantly between the two growing sites (*P>0.05)*.

Figure 3. Habitus of *daun gatal* plants. A. unshaded habitats and B. with shade

Table 2. The average height and stem diameter of the *daun gatal* plant in different habitat conditions

Habitat	Observed variables		*P-value*	
	Plant height ± SD (cm)	**Stem diameter ± SD (cm)**	**Plant height**	**Stem diameter**
With shade	96.4 ± 4.30	1.69 ± 0.72	0.12 (not significantly different)	0.09 (not significantly different)
No shade	88.2 ± 0.76	2.60 ± 1.12		

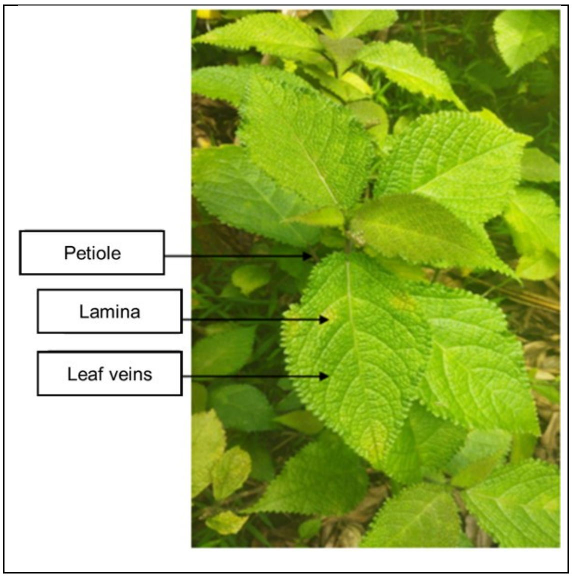

Figure 4. Leaf morphology of *daun gatal* plants and their leaf arrangement

Shaded, *daun gatal* plants tend to be taller, but there is considerable variation in plant height, as reflected in the standard deviation (Table 2). Meanwhile, plants grown without shade tend to have a uniform height because the standard deviation value is smaller. However, the stem diameter variable shows the opposite pattern: without shade, it tends to increase variation in stem diameter compared to under shade. Variations in shade cause plants to compete for light, leading to increased plant height. On the other hand, a lack of shade causes plants to increase water absorption from the soil, so the stem diameter becomes larger and varies. Similar adaptations have also been widely reported in tropical forest ecosystems and other herbaceous and shrub habitats (Jiang et al., 2023; Luo et al., 2023).

Morphologically, the leaves of the *daun gatal* plant consist of stalks and leaf blades. The petioles are green and purplish-green. Sits petioles are arranged opposite the main stem and alternating with each other. Oval leaves with serrated margins, acute apices, alternate pinnate arrangement, and trichomes on both surfaces (Figure 4).

There are variations in the surface color of the upper leaves, ranging from green to yellowish-green (Figure 5). The dark green color is found on *daun gatal* plants in shade. This color is consistent with the research by La Basy et al. (2022), which states that the upper surface of the leaves of *Laportea decumana* is green. The yellowish-green color is found in *daun gatal* plants that grow in full sun (Figure 5). This yellowish-green color is found with variations: light yellow in the form of dots; light yellow with black spots and leaf edges; light yellow dominant throughout the leaf strands; and dark yellow on the leaf edges and brown leaf edges. The difference in leaf color is influenced by the intensity of light received by the plant.

Excessive light can damage the chlorophyll pigment, resulting in leaves turning yellowish and showing symptoms of necrosis in certain parts, such as blackened leaf edges (Mathur et al., 2018). In contrast, shaded conditions allow the leaves to retain their dark green color due to the high chlorophyll content produced to optimize light absorption under limited light (Umesh et al., 2023).

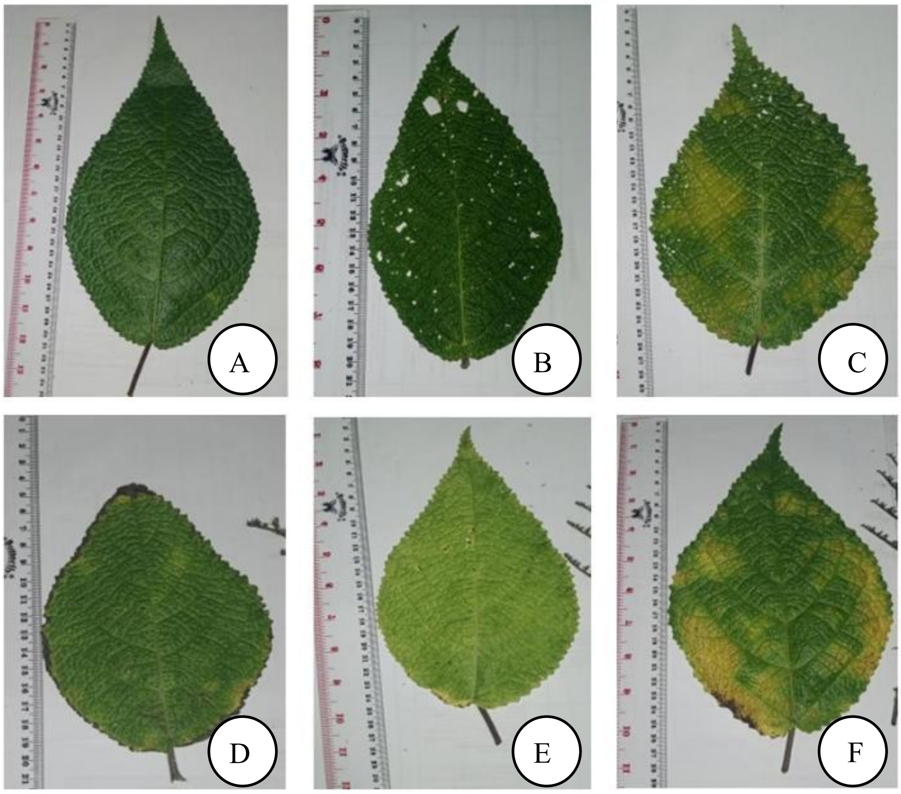

Figure 5. The characteristics of *daun gatal* grown in different shades. Description A-B: *Daun gatal* that grows in shade, has a greener color; C-F: *Daun gatal* that grows without shade, yellowish in color.

Some leaves show damage with small holes (Figure 5.A, B), brown edges of the leaves appear burned (Figure 5.C, D, and F), and the surface of the leaves appears to have yellow spots (Figure 5.E). In shaded conditions, there are many pest attacks, such as by insects and caterpillars, resulting in small holes. Meanwhile, in the absence of shade, it is suspected that chlorophyll is damaged, causing the leaves to change color and intensifying pathogen attacks.

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Jurnal Pro-life, 13 (2): 125-140, Juli 2026

Table 3. Morphometrics of *daun gatal* growing with shade vs. no shade

Habitat	Observed leaf modifiers		
	Leaf length ± SD (cm)	Leaf width ± SD (cm)	Leaf area ± SD (cm^2)
With shade	23.89 ± 2.30 a	13.86 ± 1.13 a	209.33 ± 23.12 a
No shade	19.80 ± 0.91 b	11.86 ± 0.96 b	141.06 ± 10.29 b

Remarks: The same letter in the same column behind the number shows no significant difference based on the Tukey P test < 0.05

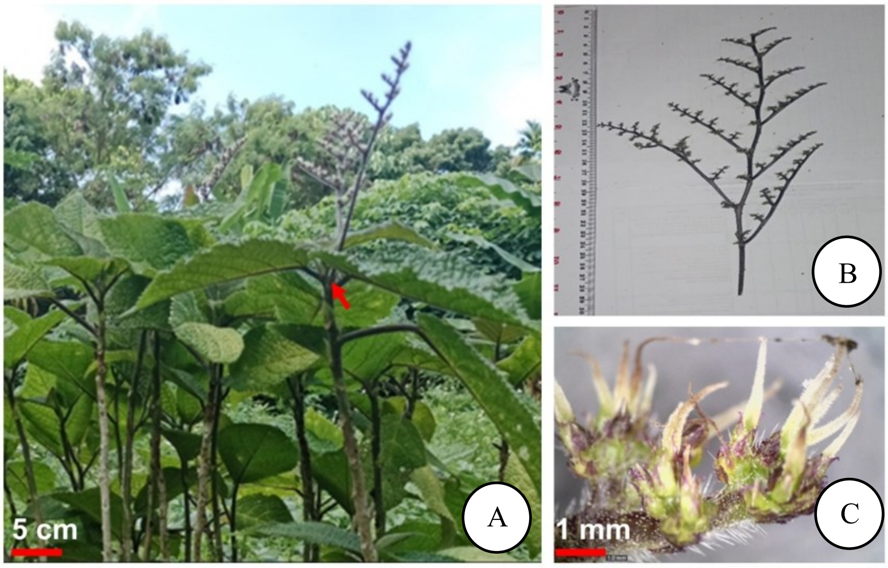

Figure 6. Characteristics of the arrangement of *daun gatal* flowers. A. Flowers are in the armpits of the leaves (red arrow in picture), B. panicle bouquets, and C. flowers with stigmas.

Shaded plants have a higher average leaf length, width, and area compared to unshaded plants (Table 3). The results of the variance analysis also showed that the average length, width, and area of leaves were significantly different between shaded and non-shaded plants. *Daun gatal* plants that grow in shade have a greater standard deviation than plants that grow without shade (Table 3). This indicates that shade causes greater variation in leaf morphology than plants growing without shade.

Meanwhile, the area of leaves in shade tends to be almost twice that of leaves without shade. This tendency differs from that of other C3 plants, such as soybeans, which experienced a decrease in leaf area of around 33.3% due to shade (Wu et al., 2022). However, the same tendency is observed in lettuce, spinach, and tea leaf plants, whose leaf size increases under specific shade conditions (Ohashi-Kaneko et al., 2007; Sano et al., 2018). Regarding the use of its leaves as pain relievers, growing *daun gatal* in a certain shade can be an option to increase leaf area.

This study successfully documented the inflorescence of *daun gatal*. *Daun gatal* have a compound flower type and are located in the leaf armpits (Figures 6.A and 6.B). Flowers are white with blackish-purple flower stalks (Figure 6.C). The study found that as many as 20 individuals were in the inflorescence phase in unshaded habitats.

Meanwhile, in the shaded habitat, there are three individuals in the inflorescence phase.

Characteristics of Trichomes of *Daun Gatal*

Trichomes are derivatives of the epidermis in the form of hairs that develop on the surface of plant organs with varying shapes, arrangements, and functions. The study found that leaf trichomes in *daun gatal* consisted of both stinging and non-stinging types. Stinging trichomes are larger in size than non-stinging trichomes. Trichomes are unicellular, needle-like (Nyandwi et al., 2025). The tip is tapered with an enlarged (basal) bottom (Figure 7). *Daun gatal* trichomes are found on the lower surface of the leaf (*abaxial*), along the leaf bone and branch bones, as well as the edges of the leaves. Based on Demena et al. (2024), the type of *daun gatal* trichomes *L. decumana* is included in the non-glandular category, namely trichomes that produce secretions. This non-glandular trichome resembles thorns or sharp protrusions on the surface of the trunk and leaves. Trichomes of the *daun gatal* of *L. decumana* have the main function of protecting plants from herbivorous disturbances. This defense mechanism works through an itchy or irritating sensation on the skin during physical contact.

Phytochemically, *daun gatal* trichomes contain chemical compounds such as formic acid that can stimulate sensory receptors in the skin, causing a burning or itching sensation followed by increased blood flow to the affected area (Ariastuti et al., 2018). This shows that trichomes play an important role not only morphologically but also physiologically in plants' self-defense mechanisms. The analysis of average trichome length showed a significant difference ($P < 0.05$) between plants growing in unshaded and shaded habitats (Table 4).

Table 4. Average trichome length and trichome density of *daun gatal*

Habitat	Trichome length (mm)	Trichome density (units/mm^2)
With shade	1.44 ± 0.11 a	0.032 ± 0.012 a
No shade	0.77 ± 0.09 b	0.030 ± 0.008 b

Remarks: The same letter in the same column after the number does not show a significant difference based on the Tukey P test < 0.05

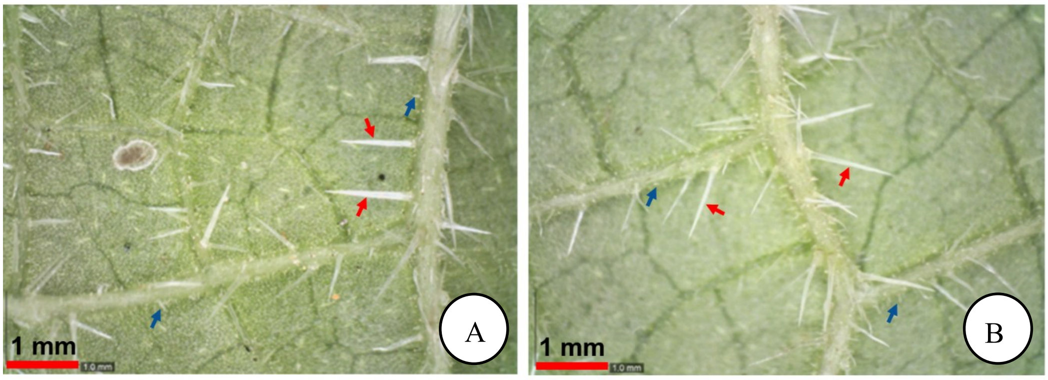

Figure 7. The morphology of *daun gatal* trichomes. A. unshaded habitat samples. B. with shade.
Description: red arrow: trichomes sting; Blue arrow: Trichomes do not sting

The tendency to elongate trichomes in response to shade is also observed in the plant species *Lippia graveolens* (Martínez-Natarén et al., 2011). The plant type *L. graveolens* has trichomes on its leaves and is morphologically similar to *daun gatal*, so it is thought that the physiological response is the same. On the other hand, we also suspect that the two plants are shade plants, so the absence of shade can lead to shorter trichomes.

The results showed that the average trichome density did not differ significantly (P < 0.05) between shaded and unshaded *daun gatal* plants. This is not in line with the results of Muhuria et al. (2006), which show that trichome density in soybean leaves decreases at low light intensity. However, the density of trichomes in *Lippia graveolens* decreases when exposed to direct sunlight (Martínez-Natarén et al., 2011). Lower trichome density can improve light capture.

The results of the study by Wati et al. (2024) indicate that trichomes on the leaves of corn plants not affected by shade exhibit consistent physical adaptations across various light conditions. Physiologically, trichomes in the *daun gatal* of *L. decumana* play a role in increasing leaf surface area, thereby enhancing photosynthesis and the plant's adaptation to dry environmental conditions (Demena et al., 2024). The presence of trichomes helps reduce water loss by slowing transpiration.

CONCLUSION

The *daun gatal* of *Laportea decumana* that grow in both shaded and unshaded conditions show significant morphological differences. Specifically, the variables of plant height, leaf length, leaf width, leaf area, and trichome length have larger units in shaded habitats than in unshaded habitats. Trichomes are longer in shaded habitats; the density of trichomes in unshaded and shaded habitats tends to be the same. This indicates that a decrease in light intensity can increase the length of the trichomes of the *daun gatal*. In contrast, the relatively similar density of trichomes suggests that the *daun gatal* has a stable number of trichomes under various environmental conditions. In general, the results of this study indicate that *daun gatal* can morphologically adapt to differences in light intensity in their growing habitat, providing an important scientific basis for the optimal management and development of *L. decumana* cultivation in Manokwari Regency.

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