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VEGETATIVE MACROMORPHOLOGICAL CHARACTERIZATION OF SIX *Syzygium* spp. SPECIES

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ABSTRACT

This study aimed to investigate the external morphological characteristics of the roots, stems, and leaves of six Syzygium species through direct visual observations in South Sumatra, Indonesia. The study was conducted in May 2026 across various residential areas and natural habitats using a qualitative descriptive approach. Fresh specimens of Syzygium jambos (L.) Alston, Syzygium cumini (L.) Skeels, Syzygium malaccense (L.) Merr. & L.M.Perry, Syzygium aqueum (Burm.f.) Alston, Syzygium polyanthum (Wight) Walp., and Syzygium aromaticum (L.) Merr. & L.M.Perry were documented and measured directly in their natural habitats. The results showed that all six species shared several general morphological characteristics, including a taproot system; woody, cylindrical, and erect stems; and green, petiolate, simple leaves with entire margins, pinnate venation, opposite phyllotaxis, and smooth surfaces. Despite these shared vegetative characteristics, the species can be distinguished by diagnostic morphological variations, particularly stem surface characteristics and branching patterns, as well as leaf length-to-width ratios, shape, apex, and base. Distinctive macromorphological variations in stems and leaves can serve as preliminary diagnostic characters for distinguishing closely related species, particularly when reproductive organs are unavailable.

INTRODUCTION

Syzygium is a genus within the family Myrtaceae and the order Myrtales that is widely distributed in Sumatra (Widodo & Chikmawati, 2016; Widodo & Lucas, 2018; Mustaqim et al., 2023). Species identification within this genus remains challenging in the field because many species exhibit similar vegetative characteristics. When trees are not fruiting, local people and novice researchers often have difficulty distinguishing among species because of striking similarities in leaf morphology and external stem appearance (Widodo et al., 2012). In addition to reproductive characters, recent studies have shown that vegetative traits, including leaf shape, leaf venation patterns, leaf surface texture, and stem characteristics, can serve as important taxonomic markers for identifying members of the genus *Syzygium* (Aprillia et al., 2021).

Morphological analyses of various *Syzygium* species have revealed relatively consistent variation in vegetative characters, which can be used to distinguish species, even in the absence of flowers and fruits (Aprillia et al., 2021). Examining vegetative organs is particularly important because most species have relatively restricted flowering and fruiting periods, whereas leaves and stems can be observed year-round (Ulfa et al., 2023). Therefore, studies of vegetative morphology can provide an alternative identification approach that is more practical and readily applicable to field research and biodiversity inventories (Nasution & Hadiati, 2014; Priadi et al., 2016; Rachmah et al., 2023; Ma'rifah et al., 2024).

Previous studies have often used anatomical or micromorphological approaches that require specialised laboratory equipment. Existing studies on external morphology have also been limited to specific protected forest areas or botanical gardens (Mudiana, 2016), or have relied on leaf sections for direct microscopic observation, which is less practical for field-based applications (Chatri et al., 2020). Consequently, available plant identification resources often use technical terminology that may be difficult to understand and provide limited visual illustrations, highlighting the need for identification media that facilitate side-by-side comparisons of the characteristics of different tree species (Hidayah et al., 2023). The present study's innovative contribution lies primarily in its focus on readily observable external diagnostic characteristics of the roots, stems, and leaves (Saragih et al., 2018). Observations were conducted directly across several regions of South Sumatra to obtain accurate data on morphological

differences, particularly those related to leaf surfaces, root systems, and stem characteristics.

The difficulties of field identification and the limited information available from previous studies are the primary rationale for this study. This research provides a simpler, more practical approach to identifying and grouping plants. Identifying species within the genus *Syzygium* is often challenging because many species exhibit substantial morphological similarities. Moreover, distinguishing characteristics among species are not always readily observable by researchers or the general public. Therefore, research focusing on easily recognisable morphological traits under field conditions is needed. This study aims to examine the root, stem, and leaf characteristics of several members of the genus *Syzygium* through direct observations conducted in South Sumatra, Indonesia. The findings are expected to provide a useful reference for facilitating simpler and more effective identification and grouping of species within the genus *Syzygium*.

MATERIALS AND METHODS

Study Period, Study Area, and Sampling

This study was conducted in May 2026 in residential areas and other open habitats across South Sumatra, Indonesia. Plant specimens were selected using a purposive sampling technique (Sugiyono, 2013; Hasmiati et al., 2024). Specimens were selected based on the presence of complete vegetative structures, including roots, stems, and leaves, and their accessibility for direct morphological observation (Mudiana, 2016; Sharma & Nirmala, 2018; Irawan et al., 2020; Sasmaini et al., 2024). The samples comprised six *Syzygium* species collected from Banyuasin Regency, Penukal Abab Lematang Ilir Regency, and Palembang City, South Sumatra, Indonesia. Table 1 and Figure 1 present the distribution of sampling locations and the species collected.

Table 1. Sampling Locations for *Syzygium* spp. in South Sumatra

No.	Species	Geographical Coordinates
1.	Jambu mawar (*Syzygium jambos* (L.) Alston)	Palembang City -2.962628°S ; 104.747659°E
2.	Jamblang (*Syzygium cumini* (L.) Skeels)	Banyuasin Regency -2.924473°S ; 104.441192°E
3.	Jambu bol (*Syzygium malaccense* (L.) Merr. & L.M.Perry)	Penukal Abab Lematang Ilir Regency 3.338099°S ; 104.000958°E

No.	Species	Geographical Coordinates
4.	Jambu air (*Syzygium aqueum* (Burm.f.) Alston)	Banyuasin Regency -2.685856°S ; 104.391231°E
5.	Salam (*Syzygium polyanthum* (Wight) Walp.)	Banyuasin Regency -2.924072°S ; 104.515567°E
6.	Cengkeh (*Syzygium aromaticum* (L.) Merr. & L.M.Perry)	Banyuasin Regency -2.486467°S ; 104.883763°E

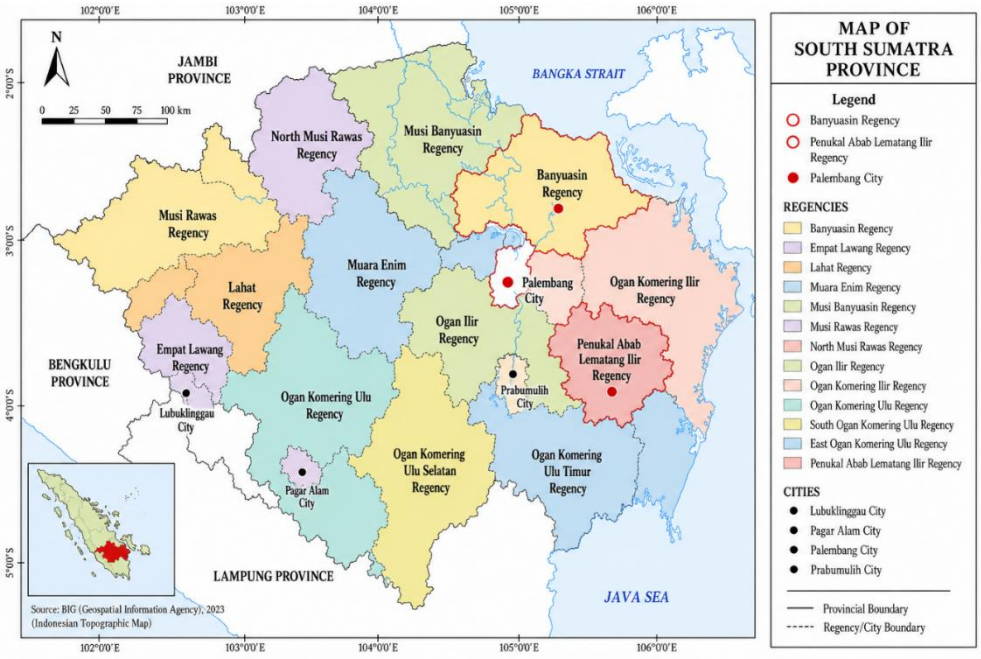


Figure 1. Map of sampling locations for *Syzygium* spp.

Species Identification

A descriptive qualitative approach was employed to characterise the morphological features of the vegetative organs, including the roots, stems, and leaves (Nurdin et al., 2022). Species identification was conducted by comparing the observed morphological characteristics with descriptions provided in relevant taxonomic references, including *Morfologi Tumbuhan* (Tjitrosoepomo, 2020; Sitepu et al., 2023), *Flora Malesiana* (Steenis, 1950), and scientific publications on *Syzygium* spp. (Mudiana, 2016; Suparman et al., 2026). Identification was further verified by comparing the specimens with digitised herbarium records and authenticated species images available from the Royal Botanic Gardens, Kew Herbarium, Global Plants JSTOR, and Wikimedia Commons.

Nomenclatural verification was subsequently performed using authoritative online taxonomic databases, including iNaturalist, Plants of the World Online (POWO), and

the Global Biodiversity Information Facility (GBIF), to confirm the currently accepted scientific names and taxonomic status of the identified species. The roots, stems, and leaves of each sampled tree were examined systematically, with particular attention to their colour, shape, surface characteristics, and texture. Photographs were taken to document these diagnostic morphological features in detail (Liunokas & Billik, 2021). The resulting observations were systematically recorded and synthesised to provide a comprehensive description of each *Syzygium* species' morphological characteristics (Irawan et al., 2020).

RESULTS AND DISCUSSION

Syzygium is a diverse genus within the family Myrtaceae and the order Myrtales, comprising numerous species that are widely distributed throughout tropical and subtropical regions (Widodo & Chikmawati, 2016). Table 2 presents the taxonomic classification identified in this study, including the division, class, order, family, species, and corresponding local names. This classification provides a systematic overview of the taxonomic position of each *Syzygium* species examined in the study.

Table 2. Taxonomic Classification of Six *Syzygium* spp. Species

Division	Class	Order	Family	Species	Local Name
Tracheophyta	Magnoliopsida	Myrtales	Myrtaceae	*Syzygium jambos* (L.) Alston	Jambu mawar
Tracheophyta	Magnoliopsida	Myrtales	Myrtaceae	*Syzygium cumini* (L.) Skeels	Jamblang
Tracheophyta	Magnoliopsida	Myrtales	Myrtaceae	*Syzygium malaccense* (L.) Merr. & L.M. Perry	Jambu bol
Tracheophyta	Magnoliopsida	Myrtales	Myrtaceae	*Syzygium aqueum* (Burm fil.) Alston	Jambu air
Tracheophyta	Magnoliopsida	Myrtales	Myrtaceae	*Syzygium polyanthum* (Wight) Walp.	Salam
Tracheophyta	Magnoliopsida	Myrtales	Myrtaceae	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Cengkeh

Members of this genus exhibit distinctive leaf and stem morphology, which can serve as important diagnostic features for species identification and classification (Aprillia et al., 2021). In general, species within the genus share several morphological traits, including stem morphology, leaf colouration, and root system characteristics.

Nevertheless, each species exhibits specific morphological features that distinguish it from other congeners despite belonging to the same genus (Figure 2).



Figure 2. Growth habit. a. *Syzygium jambos* (L.) Alston; b. *Syzygium cumini* (L.) Skeels; c. *Syzygium malaccense* (L.) Merr. & L.M.Perry; d. *Syzygium aqueum* (Burm.f.) Alston; e. *Syzygium polyanthum* (Wight) Walp.; f. *Syzygium aromaticum* (L.) Merr. & L.M.Perry

The research findings indicate that all observed species possess a taproot system (*radix primaria*) (Figure 3). According to Zahro et al. (2024), *Syzygium* species possess a taproot system. This finding is consistent with the characteristic root morphology of plants in the class Magnoliopsida, which are generally characterised by a well-developed taproot system. Ma'rifah et al. (2024) reported that the taproot system represents a distinctive morphological characteristic of Magnoliopsida, supporting the vegetative growth and long-term survival of perennial woody plants, particularly under tropical environmental conditions. In general, the roots of this plant group function as robust mechanical supports that firmly anchor woody stems in the soil while also providing an extensive surface area for the efficient uptake of water and essential nutrients (Yasin et al., 2022; Mudiana & Ariyanti, 2020; Abdulrahman et al., 2018; Launuru et al., 2019).



Figure 3. Root. a. *Syzygium jambos* (L.) Alston; b. *Syzygium cumini* (L.) Skeels; c. *Syzygium malaccense* (L.) Merr. & L.M.Perry; d. *Syzygium aqueum* (Burm.f.) Alston; e. *Syzygium polyanthum* (Wight) Walp.; f. *Syzygium aromaticum* (L.) Merr. & L.M.Perry

Regarding stem morphology, all six observed *Syzygium* spp. exhibited a woody, tree-like growth habit (Figure 4). According to Aprillia et al. (2021) and Mudiana & Ariyanti (2020), *Syzygium* exhibits a tree growth habit, with considerable variation in tree height among species. Each species showed well-developed secondary growth, characterised by a robust woody stem structure (Ma'rifah et al., 2024). The morphological identification of the stems focused on several diagnostic characteristics, including stem length, type, colour, shape, surface characteristics, growth orientation, and branching pattern (Table 3).

Tabel 3. Morphological characteristics of the stems of six *Syzygium* spp. species.

Stem Morphological Characteristics	Species					
	***Syzygium jambos* (L.) Alston**	***Syzygium cumini* (L.) Skeels**	***Syzygium malaccense* (L.) Merr. & L.M.Perry**	***Syzygium aqueum* (Burm.f.) Alston**	***Syzygium polyanthum* (Wight) Walp.**	***Syzygium aromaticum* (L.) Merr. & L.M.Perry**
Length	2 m	0,35 m	1,03 m	5,2 m	2,7 m	6,2 m
Type	Woody	Woody	Woody	Woody	Woody	Woody
Color	Light brown	Yellowish brown	Grayish brown	Grayish brown	Light brown	Grayish brown
Shape	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical
Surface	Rough, with shallow longitudinal grooves	Rough	Rough, slightly furrowed, and slightly peeling	Rough	Rough, with fine cracks	Coarsely textured with thin scales
Growth direction	Erect	Erect	Erect	Erect	Erect	Erect
Branching pattern	Sympodial with low branching and a spreading crown	Dichotomously branched with a dense crown	Monopodial and sparsely branched	Sympodial with low and densely arranged branches	Monopodial with relatively slender branches	Monopodial with regular branching and a distinct main stem

Based on stem morphology, the six *Syzygium* species exhibited both shared and distinct traits. This finding is consistent with Aprillia et al. (2021), who reported that each species within the genus *Syzygium* possesses distinctive morphological characteristics that differentiate it from other species. The shared characteristics among the six species included stem type, shape, and growth habit. All six *Syzygium* species had woody, cylindrical stems and an erect growth habit. Aprillia et al. (2021) further reported that species of *Syzygium* generally exhibit an erect (*erectus*) growth direction. In addition, Rahmania et al. (2025) stated that the genus is characterised by woody trees with cylindrical stems, broad and complex crowns, and a robust branching system.

Although these species share several vegetative characteristics, they can be distinguished based on diagnostic morphological variations, particularly stem surface characteristics and branching patterns. *Syzygium jambos* (L.) A rough stem surface with shallow grooves characterises Alston. The species exhibits a sympodial branching pattern, with relatively low branching that forms a spreading crown. Rahmania et al. (2025) reported that *S. jambos* has a hard stem surface and a sympodial branching pattern, in which the main stem cannot be clearly distinguished from the branches. Similarly, Ochieng et al. (2022) described the species as having a dense crown with widely spreading branches.

Syzygium cumini (L.) Skeels is characterised by a rough stem surface and a dichotomous branching pattern that forms a dense crown. Mudiana & Ariyanti (2020)

reported that *S. cumini* is a tree characterised by a short trunk with low, densely arranged branches, while the bark of the trunk and branches is dark grey to brownish grey. Similarly, Rahmania et al. (2025) described the branching pattern of *S. cumini* as dichotomous, in which the main stem divides into two approximately equal sections. Furthermore, Saini et al. (2026) reported that the growth architecture of *S. cumini* is relatively evenly distributed among spreading, semi-spreading, and upright growth forms.

Syzygium malaccense (L.) Merr. & L.M.Perry exhibits a rough, slightly furrowed, and finely exfoliating bark surface. The species displays a monopodial branching pattern with relatively sparse branching. According to Rahmania et al. (2025), *S. malaccense* exhibits a monopodial branching pattern, in which the main axis continues to grow from a single point. Orwa et al. (2009) reported that *S. malaccense* is a tree that can reach up to 20 m in height, with a straight trunk measuring 20–45 cm in diameter. The trunk often branches near the base and develops a broad, spreading crown.

Syzygium aqueum (Burm.f.) Alston has a rough stem surface. The species exhibits a sympodial branching pattern, characterised by low and closely spaced branches. Ma'rifah et al. (2024) and Aprillia et al. (2021) reported that *S. aqueum* is generally a tree reaching 3–10 m in height, with an erect growth habit and a sympodial branching pattern. The stem is brown, bears numerous spots, and has a rough texture.

Syzygium polyanthum (Wight) Walp. exhibits a rough stem surface characterised by fine fissures. The species displays a monopodial branching pattern with relatively slender twigs. Mudiana (2016) and Abdulrahman (2021) reported that *S. polyanthum* can reach heights of up to 30 m. The plant has thick, dark-brown bark with a rough, furrowed surface. Its stem is cylindrical, with a monopodial branching pattern and dense foliage.

Syzygium aromaticum (L.) Merr. & L.M. Perry has a rough stem surface characterised by thin scales. The species exhibits a monopodial branching pattern, with regular branching and a clearly defined main stem. Orwa et al. (2009a) and Alfian et al. (2019) reported that *S. aromaticum* is a tree species reaching 8–30 m in height. The crown is medium-sized, with a low crown base and a pyramidal shape, consisting of numerous upright branches. The branches tend to extend downward at an angle of approximately 45°. Overall, this robust stem structure provides primary mechanical

support for the tree crown and serves as a vascular pathway for transporting water and minerals from the roots to the leaves (Triastinurmiatiningsih et al., 2021).



Figure 4. Stem. a. *Syzygium jambos* (L.) Alston; b. *Syzygium cumini* (L.) Skeels; c. *Syzygium malaccense* (L.) Merr. & L.M.Perry; d. *Syzygium aqueum* (Burm.f.) Alston; e. *Syzygium polyanthum* (Wight) Walp.; f. *Syzygium aromaticum* (L.) Merr. & L.M.Perry

Leaf morphological identification was conducted to characterise the vegetative traits that serve as diagnostic features for each species (Figure 5). The leaf characters examined included leaf colour, leaf completeness, leaf type, length and width measurements and their ratios, blade shape, leaf apex and base, leaf margin, leaf surface, venation pattern, and phyllotaxy along the stem (Table 4). These observations illustrate variation in leaf morphology and support the identification of the species encountered.

Table 4. Morphological Characteristics of Leaves in Six *Syzygium* spp. Species

Leaf Morphological Characteristics	**Species**					
	***Syzygium jambos* (L.) Alston**	***Syzygium cumini* (L.) Skeels**	***Syzygium malaccense* (L.) Merr. & L.M.Perry**	***Syzygium aqueum* (Burm.f.) Alston**	***Syzygium polyanthum* (Wight) Walp.**	***Syzygium aromaticum* (L.) Merr. & L.M.Perry**
Color	Green	Green	Green	Green	Green	Green
Completeness	Petiolate	Petiolate	Petiolate	Petiolate	Petiolate	Petiolate
Type	Simple	Simple	Simple	Simple	Simple	Simple
Length-to-Width Ratio (cm)	15:3	6,3:2,7	18,6:6,2	16,3:9,5	12:5,2	10:3,9
Shape	Elongate	Obovate	Elongate	Oblong	Obovate	Oblong
Apex	Acuminate	Acuminate	Acute	Acuminate	Acuminate	Acuminate
Base	Acuminate	Acuminate	Obtuse	Rounded	Acuminate	Acuminate
Margin	Entire	Entire	Entire	Entire	Entire	Entire
Surface	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
Venation	Pinnate	Pinnate	Pinnate	Pinnate	Pinnate	Pinnate
Leaf Arrangement	Opposite	Opposite	Opposite	Opposite	Opposite	Opposite

Morphological observations of the leaves revealed both shared and distinctive characteristics among the six *Syzygium* spp. Shared characteristics included leaf colour, completeness, type, margin, surface texture, venation, and arrangement. All six *Syzygium* spp. exhibited green, petiolate, simple leaves with entire margins, smooth surfaces, pinnate venation, and opposite phyllotaxis. According to Aprillia et al. (2021) and Ma'rifah et al. (2024), *Syzygium* species generally have simple leaves arranged oppositely. Despite sharing several vegetative characteristics, the species can be distinguished by diagnostic variations in leaf morphology, particularly the length-to-width ratio, leaf shape, apex, and base. This finding is consistent with Aprillia et al. (2021), who reported that diagnostic leaf characters distinguishing species within the genus *Syzygium* include leaf length and width, as well as the shape of the leaf base and apex.

Syzygium jambos (L.) Alston possesses elongated leaves measuring approximately 15 cm in length and 3 cm in width, with acute apices and bases. According to Ochieng et al. (2022), the leaves of this species have a smooth surface and range from 10 to 22 cm in length and 2.5 to 6.25 cm in width. The mature leaves are glossy and dark green. In addition, Mohamed et al. (2014) reported that *S. jambos* has oppositely arranged leaves, measuring 7.5–20 cm in length and 3.4–7.8 cm in width.

Syzygium cumini (L.) Skeels possesses obovate leaves measuring approximately 6.3 cm in length and 2.7 cm in width. The leaves have acute apices and bases. Mudiana

& Ariyanti (2020) reported that *S. cumini* has simple, opposite leaves that are obovate, green to dark green, with entire margins and acute apices. According to Yadav & Kapoor (2025), *S. cumini* leaves range from 5 to 20 cm in length and have entire margins, a glossy surface, dark green colouration, and pinnate venation.

Syzygium malaccense (L.) Merr. & L.M.Perry has elongated leaves measuring approximately 18.6 cm in length and 6.2 cm in width. The leaves have an acute apex and an obtuse base. This observation is consistent with Aprillia et al. (2021), who reported that *S. malaccense* has leaves with an obtuse base and an acute apex. Orwa et al. (2009b) likewise described the leaves of *S. malaccense* as opposite, measuring 15–38 cm in length and 7–20 cm in width, with a thick, leathery texture and a green colouration.

Syzygium aqueum (Burm.f.) Alston has elliptic leaves measuring 16.3 cm long and 9.5 cm wide. The leaves have an acute apex and a rounded base. According to Aprillia et al. (2021), the leaf blades of *S. aqueum* are elliptic in shape, with pinnate venation, ranging from 5–25 cm in length and 5–12 cm in width. The leaf blades are papery, with a rounded base and an acute apex. Similarly, Viacrucis & Buot (2021) reported that *S. aqueum* has simple, opposite leaves with pinnate venation and a rounded leaf base.

Syzygium polyanthum (Wight) Walp. has obovate leaves measuring approximately 12 cm in length and 5.2 cm in width. The leaves possess acute apices and bases. Mudiana (2016) reported that *S. polyanthum* has obovate leaves with acute apices, with leaf dimensions ranging from 5–15 × 3.5–6.5 cm. Similarly, the leaves of *S. polyanthum* have been described as elliptic to oblong or lanceolate, with a firm texture, measuring 6–12 cm in length, with acute apices and bases, entire margins, and glossy green surfaces (Silalahi, 2017; Abdulrahman et al., 2018; Abdulrahman, 2021).

Syzygium aromaticum (L.) Merr. & L.M.Perry has elliptic leaves measuring approximately 10 cm in length and 3.9 cm in width. The leaves possess acute apices and bases. Novichasari & Sipayung (2018) reported that the leaves of *S. aromaticum* have acute apices and bases, entire margins, pinnate venation, and a smooth, glossy surface attributed to oil glands.

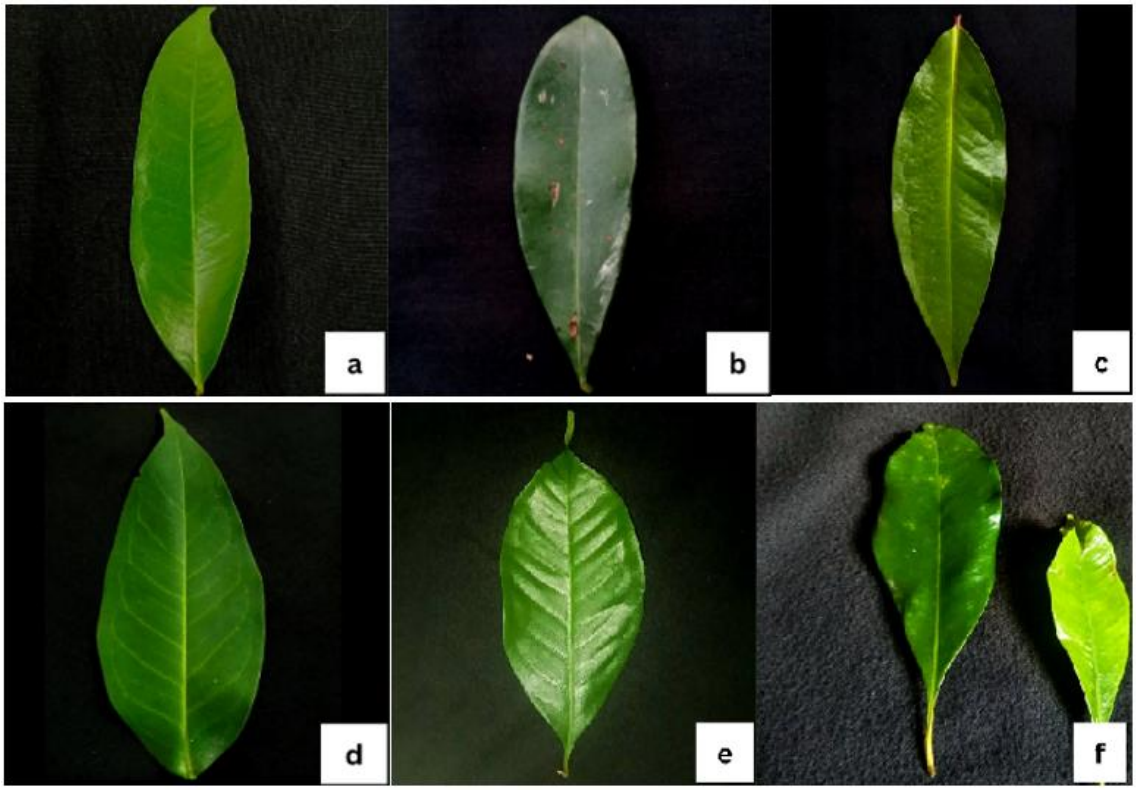


Figure 5. Leaf. a. *Syzygium jambos* (L.) Alston; b. *Syzygium cumini* (L.) Skeels; c. *Syzygium malaccense* (L.) Merr. & L.M.Perry; d. *Syzygium aqueum* (Burm.f.) Alston; e. *Syzygium polyanthum* (Wight) Walp.; f. *Syzygium aromaticum* (L.) Merr. & L.M.Perry

CONCLUSION

The observed morphological characteristics of the stems and leaves can serve as preliminary diagnostic traits for distinguishing the six *Syzygium* species. Diagnostic morphological variations include stem surface characteristics and branching patterns, as well as the leaf length-to-width ratio, shape, apex, and base. These findings indicate that visual characterisation of the vegetative organs (stems and leaves) of *Syzygium* spp. can provide a practical, rapid, and relatively cost-effective approach to species identification.

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