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Inventory and Characterization of Leaf and Rhizome Morphology of Zingiberaceae Family Plants in the Kediri Region

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ABSTRACT

The Zingiberaceae family is a group of monocot plants widely distributed in tropical regions with high morphological diversity. This study aimed to describe in detail the leaf and rhizome morphological characters of 12 Zingiberaceae species found in the Kediri region, East Java, namely C. zanthorrhiza, C. longa, C. zedoaria, C. caesia, C. soloensis, Z. officinale, Z. officinale var. amarum, Z. zerumbet, A. galanga, A. zerumbet, K. galanga, and B. rotunda. The study was conducted using a descriptive exploratory method with a snowball sampling technique. Characters observed included leaf length and width, leaf apex and base shape, leaf venation patterns, as well as rhizome color, texture, aroma, shape, and branching pattern. The results showed that all species share pinnate leaf venation and entire leaf margins as characteristic features of the Zingiberaceae family. Morphological variation was found primarily in leaf dimensions, rhizome flesh color, and rhizome aroma. Rhizomes of all species exhibited a sympodial branching pattern. Striking differences were found between genera, particularly in rhizome flesh color: Turmeric spp. are generally orange to purple, Zingiber spp. are creamy yellow, and Kaempferia galanga is white. This morphological data can serve as a reference for field identification, conservation efforts, and the development of biology teaching materials based on local biological potential.

INTRODUCTION

The Zingiberaceae family is a monocot family with high diversity and is widespread in the tropics. Globally, the family includes about 50–55 genera with more than 1,300 species, distributed across Southeast Asia, South Asia, and the Pacific region (Kress et al., 2002; Saha et al., 2020). Indonesia is known as one of the centers of Zingiberaceae diversity, with hundreds of species that grow wild or are cultivated by local communities (Mahendrawati et al., 2021). This diversity is evident in the variation in the shapes of rhizomes, leaves, and flowers, which are distinctive and zymomorphic.

The Kediri region in East Java has fairly high potential for Zingiberaceae diversity. Various genera, such as *Zingiber, Curcuma, Alpinia, Kaempferia,* and *Boesenbergia,* are found growing in yards, on farmland, and in residential areas. However, scientific documentation on variation in the morphological characteristics of Zingiberaceae in the Kediri region remains very limited. Most of the available information is general and descriptive, lacking detailed morphological measurements. The limitations of such data often lead to erroneous species identification or reliance on local names (Trisianna et al., 2025).

The morphological approach has long been the primary method for the identification and classification of plants, including those in the Zingiberaceae family. A previous study in Serang Regency, Banten, identified 12 species of Zingiberaceae and showed that vegetative characters are sufficient to distinguish species despite significant variation (Windarsih et al., 2021). Zahara (2020) also proved that the identification of Zingiberaceae species can be effectively carried out through vegetative morphological descriptions. Although molecular approaches are constantly evolving, morphology-based identification remains an important first step, especially in the inventory of local plant diversity (Sattler & Rutishauser, 2022).

The selection of the Kediri area as the research location is based on a combination of scientific and complementary empirical evidence. Scientifically, the Kediri region is located in an active volcanic zone on the slopes of Mount Kelud, which produces andosol soil with nutrient content and drainage that support the optimal growth of rhizome plants. Hence, this area has the potential to be an agroecological habitat suitable for Zingiberaceae diversity.

Empirically, the results of preliminary observations in the field show that various genera such as *Zingiber, Curcuma, Alpinia, Kaempferia,* and *Boesenbergia* are found growing both wild and cultivated in the yards, spice gardens, and traditional agricultural lands of the Kediri people, which indicates a high diversity of species that have the potential to be inventoried. Another empirical fact is strengthened by the tradition of using rhizome plants that has long been embedded in traditional medicine practices, the herbal medicine industry, and agrarian culture of the people of East Java, including in the Kediri region, which makes rhizomes a commodity with high economic and cultural value (Wahyuni et al., 2024). The combination of agroecological potential and the intensity of local utilization forms the basis for consideration and is a strategic advantage in choosing Kediri as the location

for research, inventory, and morphological characterization of Zingiberaceae.

Although various studies on the morphological character of Zingiberaceae have been conducted in several regions of Indonesia, studies documenting variation in the vegetative morphology of Zingiberaceae species in the Kediri region remain very limited. In fact, Kediri is one of the areas with high utilization of rhizome plants as ingredients in traditional medicine, spices, and as yard plants. The limited data mean that species identification in the field still relies heavily on local names, which can lead to misidentification.

Based on this background, this study aims to inventory and describe the morphological characteristics of leaves and rhizomes of species of the family Zingiberaceae found in the Kediri area. The research is expected to produce information on diagnostic characteristics for practical species identification, support the conservation of local germplasm, and serve as a data source for the development of teaching materials on local potential biodiversity.

RESEARCH METHODS

Study Design

This study employed a field exploration approach. The research was conducted over six months, from January to June 2026. Field exploration and sampling were carried out at various locations in the Kediri area, East Java, including the eastern region of Wates on the slopes of Mount Kelud, the western region around Mount Klotok, the southern region in residential yards of Kras Village, and the northern region in residential yards of Plemahan Village.

Sampling sites comprised residents' home gardens, spice gardens, traditional agricultural areas, and forests surrounding the villages. The study locations were selected based on preliminary interviews with spice farmers, traditional herbal medicine practitioners, and local biology teachers, who identified areas where spice plants are commonly cultivated and traditionally utilized.

Procedure

The sample search began with semi-structured interviews with key informants, namely spice farmers, traditional herbal medicine artisans, and local biology teachers, to obtain information on the whereabouts of Zingiberaceae plants. Each sample found was photographed against a black background for uniformity of documentation, and its scientific name was identified using the PlantNet application and verified using POWO, with the key to the determination of the Flora of Java (Backer & Bakhuizen van den Brink, 1968), as well as the current taxonomic literature.

Observations of leaf morphological characteristics were carried out on: (1) leaf dimensions including leaf length and width were measured using a ruler on 5 adult leaves per individual; (2) leaf shape of the leaves; (3) leaf edges; (4) leaf tips; (5) base of leaves; and (6) leaf grafting patterns, referring to the terminology and standard vegetative morphology characterization procedures used by Rifai (1976) and Windarsih et al. (2021). The observed rhizome morphological characteristics include: (1) rhizome skin color; (2) the color of the rhizome flesh; (3) rhizome aroma; (4) the shape and branching of the rhizome; and (5) the position of flower growth relative to the vegetative structure, referring to the diagnostic character of the rhizome and the position of the flower used by the Boer et al. (2018). Each character is described based on a minimum of 3 individuals per species to minimize individual variation.

Data Collection

This study uses an exploratory descriptive method with snowball sampling. The technique begins by identifying key informants with knowledge of Zingiberaceae plants in the Kediri area, then gradually expanding the scope of information based on the recommendations of previous informants until data saturation is reached (Sugiyono, 2019). This approach is effectively used to systematically track the distribution and diversity of species in an area.

Data Analysis

The data from morphological observations were analyzed descriptively, qualitatively, and quantitatively. Quantitative characters (leaf length, leaf width, rhizome diameter, and rhizome length) are presented in the measurement range. Qualitative characters are described using standard morphological terminology referring to Rifai (1976) and are compared between species in the form of a morphological character comparison table. Species determination was verified using the Plants of the World Online (POWO) and PlantNet taxonomic databases.

RESULTS AND DISCUSSION

Based on the results of exploration carried out in the Kediri area during the research period, 12 species of Zingiberaceae were found, classified into 5 genera, namely Curcuma (5 species), Zingiber (3 species), Alpinia (2 species), Kaempferia (1 species), and Boesenbergia (1 species). Empirically, field observations and interviews with key informants show that Curcuma species are most commonly found because they are actively cultivated in residents' yards and spice gardens as raw materials for herbal medicine, kitchen spices, and traditional medicines, and that the local community deliberately maintains their presence.

This abundance is also supported by the scientific fact that Curcuma is one of the genus with the largest number of species in the Zingiberaceae family and has a wide ecological tolerance, including the ability to survive the dry season through the rhizome dormancy mechanism, so that this genus can adapt to various microhabitat conditions in the Kediri area, ranging from open yards to semi-shaded land (Saha et al., 2020). The abundance of the genus Curcuma in this study area is consistent with reports from other tropical regions in Indonesia (Mahendrawati et al., 2021). Details of the taxonomic classification are presented in Table 1.

The number of species found in this study (12 species from 5 genera) is comparable to the inventory conducted in other regions in Indonesia with similar agroecosystem characteristics. Windarsih (2021) reported 12 species of Zingiberaceae in Serang Regency, Banten, while Octariyanti & Yulianty (2022) found 10 species in the urban area of Bandar Lampung. Kress (2002), in a global phylogenetic study, noted that Indonesia, especially Java and Kalimantan, is the center of secondary diversification for several major genera, such as *Curcuma* and *Zingiber*.

This strengthens the position of the Kediri region and its surroundings as a significant pocket of Zingiberaceae diversity on the island of Java. In contrast to primary forest areas that are rich in endemic species, the diversity in the Kediri area is more supported by long-cultivated or semi-wild species around settlements, which have very high economic and cultural value for the local community (Wahyuni et al., 2024). It should also be noted that this study documented the presence of *Alpinia zerumbet* in the Kediri region, representing a new distribution not previously documented in southern East Java.

Table 1. Classification of Zingiberaceae species found in the Kediri Region

Local Name	Scientific Name	Species	Genus
Temulawak	*Turmeric zanthorrhiza*	*C. zanthorrhiza*	*Curcuma*
Kunyit	*Turmeric longa*	*C. longa*	*Curcuma*
Kunyit putih	*Turmeric zedoaria*	*C. zedoaria*	*Curcuma*
Kunyit hitam	*Turmeric caesia*	*C. caesia*	*Curcuma*
Temu poh	*Turmeric soloensis*	*C. soloensis*	*Curcuma*
Jahe	*Zingiber officinale*	*Z. officinale*	*Zingiber*
Jahe emprit	*Zingiber officinale Roscoe*	*Z. officinale var. Amarum*	*Zingiber*
Lempuyang	*Zingiber zerumbet*	*Z. zerumbet*	*Zingiber*
Lengkuas	*Alpinia galanga*	*A. galanga*	*Alpinia*
Lengkuas merah	*Alpinia Zerumbet*	*A. zerumbet*	*Alpinia*
Kencur	*Kaempferia galanga*	*K. galanga*	*Kaempferia*
Kunci	*Boesenbergia rotunda*	*B. rotunda*	*Boesenbergia*

Source: Results of field observations (2026), verified based on POWO (2024)

Table 2. Leaf morphological character of 12 species of Zingiberaceae in the Kediri Region

Species	Morphological character of the leaves						
	Shape of the leaves	**Base of the leaf**	**Leaf edges**	**Leaf tips**	**Leaf bones**	**Leaf length (cm)**	**Leaf width (cm)**
C. zanthorrhiza	Lance-oval	Pointed	Physician	Squirt	Pinnate	20–40	5–10
C. longa	Lance-elliptical	Rounded	Physician	Squirt	Pinnate	30–60	15–20
C. zedoaria	Elongated lance	Rounded	Physician	Squirt	Pinnate	30–60	15–20
C. caesia	Lancer	Rounded	Physician	Squirt	Pinnate	20–30	5–10
C. soloensis	Lance-elliptical	Pointed	Physician	Squirt	Pinnate	30–60	10–20
Z. officinale	Linear Lantern	Pointed	Physician	Squirt	Pinnate	20–30	2–4
Z. officinale var. Amarum	Linear Lantern	Pointed	Physician	Squirt	Pinnate	10–20	1–3
Z. zerumbet	Lancer	Rounded	Physician	Squirt	Pinnate	20–40	5–10
A. galanga	Elongated lance	Rounded	Physician	Squirt	Pinnate	25–60	5–15
A. zerumbet	Lance-oval	Pointed	Physician	Squirt	Pinnate	23–30	3–8
K. galanga	Wide elliptical	Rounded	Physician	Squirt	Pinnate	15–20	3–12
B. rotunda	Lance-oval	Rounded	Physician	Squirt	Pinnate	10–25	5–10

Remarks: Measurements were made on ≥3 individuals per species; Values in the Minimum – Maximum (cm) range

The presence of this species is likely related to the introduction by the community as an ornamental plant, given its beautiful flowers and distinctive rhizome aroma. This new distribution documentation is very important for updating Indonesia's flora database, especially in the context of Plants of the World Online (POWO, 2024) and sustainable biodiversity monitoring efforts. Sattler & Rutishauser (2022) affirm that region-based morphological inventories remain the most efficient method for detecting new distributions and data gaps in under-documented taxa.

Characterization of Leaf Morphology

Observations of leaf morphology in 12 species of Zingiberaceae from the Kediri region reveal both uniformity and diversity of characters. All observed species have pinnate venation with prominent main leaf veins and parallel lateral leaf veins, which is a diagnostic feature of the Zingiberaceae family (Windarsih et al., 2021). The leaf margins of all species are flat (integer), consistent with their general characteristics. The tips of the leaves of all species are tapered (acuminate). At the same time, the base varies between rounded in most species and pointed (acute) in *C. zanthorrhiza, Z. officinale,* and *C. soloensis.* Complete data on leaf morphological characters are presented in Table 2.

The most significant morphological variation is found in the leaf dimensions. *Z. officinale* var. *amarum* has the smallest leaves (10 – 20 cm long, 1 – 3 cm wide) that

grow horizontally at the soil surface, corresponding to its distinctive rosette habitus (Boer et al., 2018). In contrast, *C. longa* and *C. zedoaria* have the widest leaves (15 – 20 cm), while *Alpinia galanga* has the longest leaves that can reach 60 cm. The large leaf size of the genus *Curcuma* and *Alpinia* correlates with its ability to capture sunlight optimally in habitats under a somewhat shaded canopy (Endress et al., 2000).

Boesenbergia rotunda has medium-sized leaves (10 – 25 cm long, 5 – 10 cm wide) with rounded bases, in contrast to the species *Zingiber*, which has narrower leaves with a higher length-width ratio. This character is consistent with the findings of Octariyanti & Yulianty (2022), who reported that narrow leaves in *Zingiber* are associated with greater transpiration efficiency in more open habitats. Observations of 12 species of Zingiberaceae found in the Kediri region show that all species have pinnate leaf growths (*Pinnate Venation*) with lateral leaf bones arranged in parallel, leaf edges flat (*integer*), and the tips of the leaves are tapered (*Acuminate*) as a conservative diagnostic characteristic of this family (Windarsih et al., 2021).

The base of the leaf varies between rounded (*rounded*) in most species and pointed (*Acute*) on *C. zanthorrhiza, Z. officinale,* and *C. soloensis. Leaf shape (leaf shape*) shows a noticeable diversity between genera. Genus *Turmeric* generally has an elliptical to elongated lance (*C. longa, C. zedoaria*) and lance-oval (*C. zanthorrhiza*), with exceptions *C. caesia* the built lances narrower, the genus *Zingiber* characterized by a narrow linear-lance wake (*Z. officinale, Z. officinale* var. *Amarum*) and lancet (*Z. zerumbet*), while *Alpinia galanga* building an elongated lance, *A. zerumbet* lance-oval, and *K. galanga* It has the most distinctive shape, which is a wide elliptical shape that distinguishes it markedly from other species.

The diversity of leaf shapes among genera is not only diagnostic but also reflects ecological adaptation to habitat conditions. Wide leaves on *Turmeric* and *Alpinia* adapt to partial shade to optimize light interception (Nurfadilah et al., 2022), while the leaves are narrowly linear-lanceolate on *Zingiber*, an adaptation to open habitats that suppresses water loss while maintaining photosynthetic efficiency at high light intensity (Poulsen et al., 2018). The typical wide-elliptical shape of *K. galanga* makes it easily recognizable in the field, even without generative organs. Thus, the integration of leaf shape, dimensions, and rhizome characters provides a reliable field identification tool for distinguishing Zingiberaceae species practically and measurably (Rifai, 1976; Windarsih et al., 2021).The leaves of Zingiberaceae species recorded in the Kediri region are presented in Figure 1.

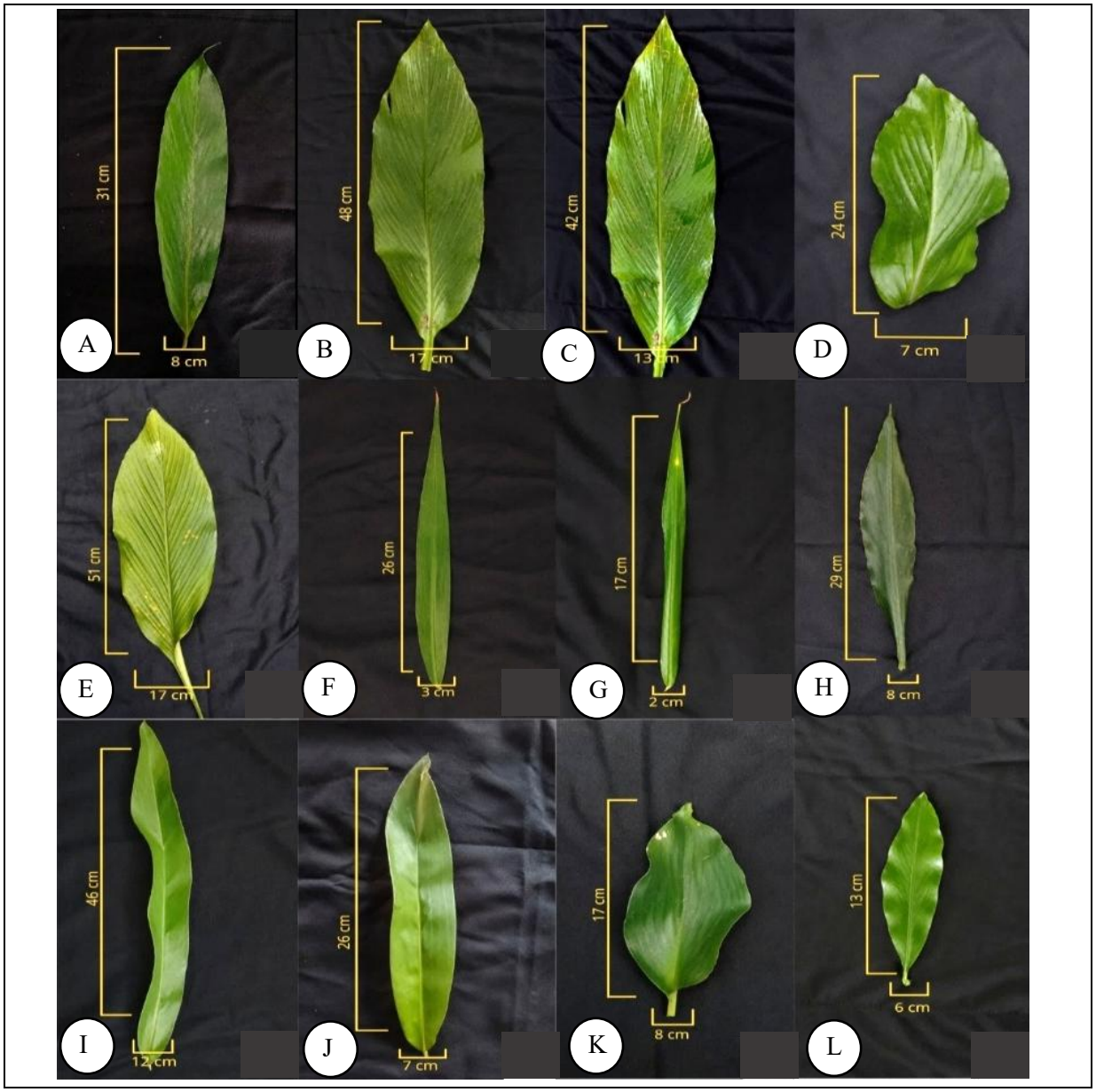

Figure 1. Leaves of members of the Zingiberaceae family found in Kediri. (A) *C. zanthorrhiza*; (B) *C. longa*; (C) *C. zedoaria*; (D) *C. caesia*; (E) *C. soloensis*; (F) *Z. officinale*; (G) *Z. officinale* var. *Amarum*; (H) *Z. zerumbet*; (I) *A. galanga*; (J) *A. zerumbet*; (K) *K. galanga*; (L) *B. rotunda*
Source: Author's Documents

Characterization of Rhizome Morphology

Rhizomes are modified stems and are characteristic and important taxonomic features of the family Zingiberaceae. From the observations, all 12 species found had a sympodial rhizome branching pattern, in which lateral shoots grow alternately and become dominant shoots after the previous shoots stop growing. This sympodial branching pattern is a conservative character in the Zingiberaceae. It is consistent with the report by Uma & Muthukumar (2014) on the anatomy of Zingiberaceae roots from various tropical regions. Complete data on the morphological character of the rhizome are presented in Table 3.

Table 3. Morphological Character of Rhizomes of 12 Species of Zingiberaceae in the Kediri Region

Species	Morphological character of the rhizome					
	Rhizome color (outer)	**Rhizome meat**	**Rhizome aroma**	**Shape of the rhizome**	**Rhizome branching**	**Flower growth**
C. zanthorrhiza	Yellowish brown	Bright yellow	Typical, powerful	Large oval	Simpodial	Rhizoma
C. longa	Yellowish brown	Orange/deep yellow	Aromatic, bitter	Branched cylindrical	Simpodial	Rhizoma
C. zedoaria	Light brown	Beige white	Camphor, strong	Branched cylindrical	Simpodial	Rhizoma
C. caesia	Dark brown	Purple/ gray	Sharp, strong	Cylindrical-short	Simpodial	Rhizoma
C. soloensis	Light brown	Beige white	Lightweight, fresh	Cylindrical-rounded	Simpodial	Rhizoma
Z. officinale	Light brown	Beige white slightly yellow/pale yellow	Spicy, tangy	Branched cylindrical	Simpodial	Rhizoma
Z. officinale var. Amarum	Light brown	Beige white	Spicy, tangy	Branched cylindrical	Simpodial	Rhizoma
Z. zerumbet	Light brown	Pale yellow	Fragrant, fragrant	Slim cylindrical	Simpodial	Rhizoma
A. galanga	Light brown scaly	Beige white	Fresh, typical	Thick/large cylindrical	Simpodial	Pseudostem
A. zerumbet	Scaly pink	Pink	Fresh, typical	Thick/large cylindrical	Simpodial	Pseudostem
K. galanga	Yellowish brown	White	Distinctive, fragrant	Cylindrical short-blunt	Simpodial	Rhizoma
B. rotunda	Yellowish white	Pale white	Lightweight, distinctive	Small cylindrical /radius-like	Simpodial	Rhizoma

Remarks: Data based on observations of ≥3 individuals per species

Rhizomes are stem modifications that are a main characteristic of the Zingiberaceae family and serve as storage centers for secondary metabolites of high economic value. All species found have a sympodial rhizome branching pattern, where growth occurs through lateral shoots that develop into new rhizome units. This sympodial growth pattern is a conservative character in the Zingiberaceae family and plays an important role in vegetative reproduction and clonal distribution of plants (Uma & Muthukumar, 2014).

The shape of the rhizome also shows clear variation among species and serves as a complementary character in identification. *C. zanthorrhiza* has large, round-oval rhizomes, while most Curcuma and Zingiber species, such as *C. longa, C. zedoaria*, and *Z. officinale*, exhibit a distinctive branched cylindrical shape due to repeated lateral shooting growth. The genus Alpinia exhibits a thick, large cylindrical rhizome shape associated with the larger size of its parent plant, while B. rotunda has the most distinctive shape, resembling a small cylindrical rhizome with a radius extending from the central point, very different from all other species found (Sirirugsa et al., 2007). These differences in rhizome shape reflect

growth strategies and branching patterns specific to each genus, although the rhizomes are entirely sympodial (Boonma et al., 2023).

The variation in rhizome shape observed among the 12 species not only reflects differences among the genera but also shows a fairly consistent pattern at the genus level. In the genus *Curcuma*, for example, variations in rhizome shapes can be seen, ranging from large, rounded-oval types in *C. zanthorrhiza*, branched, cylindrical in *C. longa* and *C. zedoaria*, to short, cylindrical in *C. caesia* and *C. soloensis*. The pattern of variation in this genus suggests that rhizome shape is plastic. However, plasticity still has diagnostic value at the species level when combined with other characteristics such as the color of the flesh and the aroma of the rhizome (Sirirugsa et al., 2007). The rhizomes of Zingiberaceae species recorded in the Kediri region are presented in Figure 2.

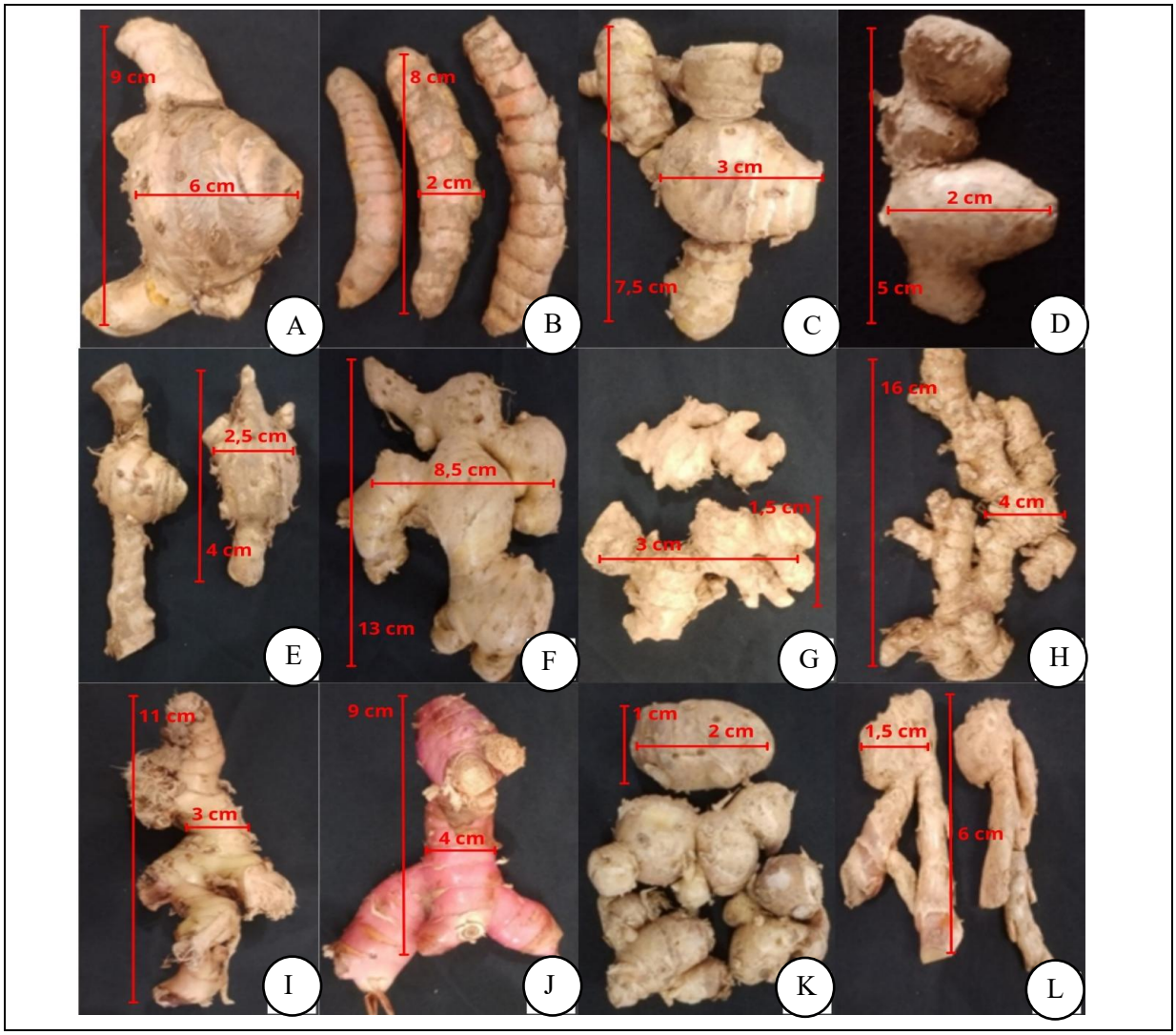

Figure 2. Rhizomes of members of the Zingiberaceae family found in Kediri. (A) *C. zanthorrhiza*; (B) *C. longa*; (C) *C. zedoaria*; (D) *C. caesia*; (E) *C. soloensis*; (F) *Z. officinal*; (G) *Z. officinale* var. *Amarum*; (H) *Z. zerumbet*; (I) *A. galanga*; (J) *A. zerumbet*; (K) *K. galanga*; (L) *B. rotunda*
Source: Author's Documents

Meanwhile, in the genus *Zingiber*, the three species observed (*Z. officinale, Z. officinale var. amarum, and Z. zerumbet*) all have branched, cylindrical rhizomes of varying degrees of thinness, which distinguish them from the rhizomes of the genus *Alpinia*, which tend to be thicker and larger. The sympodial branching pattern that characterizes all observed species, as already described, also shows variations in branch density and lateral bud growth direction, which contribute to differences in rhizome shape (Boonma et al., 2023). The flesh color of rhizomes varied among the Zingiberaceae species recorded in the Kediri region. These variations are presented in Figure 3.

Figure 3. The color of the flesh of the rhizomes of members of the Zingiberaceae family found in Kediri. (A) *C. zanthorrhiza*; (B) *C. longa*; (C) *C. zedoaria*; (D) *C. caesia*; (E) *C. soloensis*; (F) *Z. officinale*; (G) *Z. officinale var. Amarum*; (H) *Z. zerumbet*; (I) *A. galanga*; (J) *A. zerumbet*; (K) *K. galanga*; (L) *B. rotunda*
Source: Author's Documents

The morphological diversity of Zingiberaceae rhizomes in Kediri is closely correlated with local adaptation and utilization. Large-thick rhizomes (*C. zanthorrhiza, A. galanga and A. zerumbet*) are rich in carbohydrates and secondary metabolites, are more resilient to environmental stresses, and are in demand for commercial cultivation. Conversely, small-lean rhizomes (*B. rotunda and K. galanga*) are fast-cycling and highly regenerative, suitable for intensive rotation in the yard (Boonma et al., 2023).

The color of the flesh and aroma are the traditional differentiators in medicine-culinary use, as reflected in the local name. Understanding this variation is crucial for taxonomy, as well as for the cultivation, conservation, and sustainable use of the local Zingiberaceae genetic resources. The color of the flesh of the rhizome is the most informative diagnostic character for the distinction between genera and species. The genus *Curcuma* exhibits a variety of flesh colors that are characteristic of its secondary metabolite content. *C. zanthorrhiza* is bright orange in color, which indicates high levels of curcuminoids; *C. longa* is intensely orange; *C. zedoaria* is creamy white with a strong camphoraceous odor due to the sesquiterpene content, and *C. caesia* has a unique grayish-purple rhizome flesh that is a distinctive character resulting from the accumulation of anthocyanins (Kaliyadasa & Samarasinghe, 2019).

C. soloensis exhibits creamy-white rhizome flesh with a light and fresh aroma, different from other *Curcuma* species.

The genus *Zingiber* is characterized by light yellow to yellowish-white rhizome flesh. *Zingiber officinale* has a very distinctive, pungent, spicy aroma due to the presence of gingerol and shogaol, while *Zingiber zerumbet* has a softer aroma, with the dominant presence of zerumbons. These two *species of Zingiber* can be distinguished by the shape of the rhizome: *Z. officinale* has more compact, branched rhizomes, whereas *Z. zerumbet* has slender, elongated rhizomes.

Alpinia galanga has the largest and thickest rhizome among all the observed species, with a reddish-brown outer skin and a scaly surface that is very distinctive and easily recognizable in the field (Kress et al., 2002). The rhizome flesh is light orange in color with a distinctive fresh aroma. *Kaempferia galanga* has the smallest rhizomes, with a short, blunt, cylindrical shape, pure white rhizome flesh, and a distinctive fresh fragrance that is the main distinguishing feature of this species. *Boesenbergia rotunda*: It has small cylindrical rhizomes resembling fingers with pale put-colored flesh and a light aroma.

Another important character is the flower's position relative to the vegetative structure. Most species have flowers that grow from rhizomes, namely *C. zanthorrhiza, C. longa, C. zedoaria, C. caesia, C. soloensis, Z. officinale, Z. officinale var. amarum, Z. zerumbet, K. galanga,* and *B. rotunda*. Meanwhile*, A. galanga* and *A. zerumbet* have flowers that grow directly from *pseudostems*. This difference in flower position is an important taxonomic character for identifying the genus Zingiberaceae (Boer et al*.,* 2018).

Ecological and Ethnobotanical Implications of Morphological Findings

The morphological diversity among the 12 species of Zingiberaceae in the Kediri region is not only of taxonomic value but also reflects complex ecological adaptations to local habitat conditions. Leaf size, which varies significantly among species and genera, reflects different light-capture strategies. Species with broad leaves, such as *C. longa* and *C. zedoaria*, generally grow in partial shade, where a large leaf surface area supports photosynthetic efficiency under low-light conditions (Nurfadilah et al*.,* 2022).

On the other hand, *Z. officinale* with narrow leaves and upright habitus is better adapted to direct light exposure in open ground, which is consistent with its distribution in agricultural gardens in the Kediri area. Similar adaptation patterns were also reported in various Zingiberaceae species in the tropical rainforest region of Borneo by Poulsen (2018), who showed that variation in vegetative morphology is strongly correlated with light gradients and growing-site height.

From an ethnobotanical perspective, all 12 species found in the Kediri area have a long history of use as medicinal plants, spices, and foodstuffs in the local culture of East Java. This utilization is closely related to the morphological characteristics of the rhizome, especially the color of the flesh and the aroma, which reflect the content of active secondary metabolites. Widayat's (2021) research on farming communities in East Java shows that the community's introduction of Zingiberaceae species still relies heavily on the rhizome's organoleptic characteristics rather than on scientific descriptions. This underscores the urgency of systematic morphological documentation, as carried out in this study, so that field identification can be conducted more accurately and in a standardized manner. Trisianna (2025) also emphasized that misidentification based on local names in Zingiberaceae species can pose risks in traditional medicine, given differences in bioactive content among closely related species.

The relevance of this morphological data is also very large in the context of local germplasm conservation. Some of the

species found, such as *C. caesia* and *C. soloensis*, are rare and have not been widely cultivated commercially. Comprehensive morphological characterization is a basic prerequisite for both ex situ and in situ conservation programs, as it enables access to be separated based on valid species identities (Saha et al., 2020). In addition, this morphological data can be integrated with phytochemical and molecular data to build a more complete database of local biodiversity, as recommended by Handayani et al. (2023) in their study of medicinal plant inventories on the island of Java.

Dormancy and Evergreen Status of Zingiberaceae Species in Kediri Region

One important aspect that differentiates the life strategies of Zingiberaceae species is the phenological pattern of vegetative growth, specifically whether the species is evergreen (all year round) or experiences seasonal dormancy. In the context of a wet tropical climate such as that of the Kediri region, the difference between these two patterns is less clear than in subtropical areas or in extreme seasonal climates. However, it can still be identified through observations of plant morphology and behavior in the field (Larcher et al., 2003).

Based on field observations during the research period, the species in the Kediri area can be grouped into two phenological categories. First, species that are evergreen or always retain green leaves throughout the year without a noticeable abortion phase, namely *Alpinia galanga, A. zerumbet,* and *Boesenbergia rotunda*. The genus *Alpinia* is generally known as a tropical evergreen plant with a persistent pseudostem and a year-round active rhizome system, enabling it to maintain vegetative growth even during mild dry seasons (Yusuf et al., 2021). This is closely related to the capacity of rhizomes to store water and carbohydrate reserves, ensuring the continuity of plant metabolism outside the rainy season.

Second, species that exhibit a rhizome dormancy pattern, which is a physiological resting phase in which the entire aerial part (leaves and pseudo-stems) dries and sheds periodically. In contrast, the rhizome remains alive in the soil as an organ of perennation. This dormancy pattern is found mainly in the genus *Curcuma* and *Kaempferia*. Species such as *C. zanthorrhiza, C. longa, C. zedoaria, C. caesia, C. soloensis,* and *K. galanga* regularly undergo a dormancy phase that coincides with the dry season in East Java, generally between July and September.

During this phase, the entire aerial tissue dries out and falls off, while the rhizomes enter a state of low metabolism to conserve energy and avoid excessive water loss (Prakash et al., 2020). A combination of environmental factors controls rhizome dormancy in the Zingiberaceae family,

especially decreased nocturnal temperatures, reduced day length (photoperiod), and reduced groundwater availability (Shrivastava & Kumar et al., 2019).

The genus *Zingiber* occupies a phenological position that varies between the two categories. *Zingiber officinale* and *Z. officinale var. amarum*, which are widely cultivated on agricultural land in the Kediri area, tend to exhibit partial dormancy, with plants experiencing leaf aging and reduced vegetative vigor during the dry season but do not completely dry out when irrigation is available. In contrast, *Z. zerumbet* that grows in more humid and sheltered habitats, such as riverbanks and mixed gardens, exhibits a character more closely resembling semideciduous, with more pronounced leaf shedding under drought conditions (Kress et al., 2002). This difference in dormancy response has direct implications for optimal rhizome harvest timing; dormant species should be harvested before or at the onset of dormancy, when accumulation of secondary metabolites in the rhizome reaches its peak (Kaliyadasa & Samarasinghe et al., 2019).

From a morphological point of view, this difference in phenological status is also reflected in the physical character of the rhizome. Dormant species generally have rhizomes with thicker, harder skin, contain more starch as energy reserves to pass the resting phase, and have budding eyes (nodes) that are more prominent as vegetative regeneration points after dormancy ends. In contrast, evergreen species tend to have more fibrous rhizomes with higher water content and meristematic activity that lasts year-round (Shrivastava & Kumar et al., 2019). This difference also impacts the vegetative propagation ability of evergreen species such as *A. galanga*, which can be propagated from rhizome cuttings at any time of the year. In contrast, dormant species such as *C. longa* have much higher planting success when planted at the beginning of the rainy season, when buds begin to become active again (Prakash et al., 2020).

Understanding the dormancy and evergreen status of each species has important practical implications for cultivation, conservation, and scientific inventory. In biodiversity survey activities, dormant species can go undetected if sampling is conducted only at a single time outside the growing season, leading to an underestimation of species diversity in an area (Windarsih et al., 2021). Therefore, the snowball sampling approach used in this study, involving in-depth interviews with local farmers and herbal medicine artisans, proved very effective in identifying dormant species that were not visually apparent at the time of observation. This phenological information then needs to be explicitly documented in local biodiversity databases

as a complement to morphological data, so that it can support the management and conservation of Zingiberaceae germplasm more comprehensively and with greater target specificity in the Kediri area.

CONCLUSION

This study successfully described the morphological characters of the leaves and rhizomes of 12 species of Zingiberaceae from 5 genera found in the Kediri area. Uniform conservative characters across species include pinnate leaf stalk, flat leaf edges, tapered leaf tips, and sympodial rhizome branching patterns, while the most informative characters for distinguishing genus and species are the color of the rhizome flesh, rhizome scent, leaf dimensions, and flower position. These characters have high diagnostic value and can serve as a key for practical identification in the field without laboratory equipment, while supporting the conservation of local Zingiberaceae. Further exploration of the forest and mountainside areas around Kediri is recommended to uncover wild species that have not yet been identified.

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