



More than one taioba: morpho-anatomical differentiation of araceae species sold under a single vernacular name and their relevance for food quality and identification

Cassia Mônica Sakuragui¹ · Thandy Yudhi Grijó Kato² · Daniel Luiz da Silva Dutra Junior¹ · Juliana Villela Paulino^{1,2}

Received: 4 June 2025 / Revised: 5 December 2025 / Accepted: 18 December 2025
© The Author(s) 2026

Abstract

In Brazil, the vernacular name *taioba* refers to several unconventional food plants of the Araceae family, which complicates accurate identification and may pose risks to consumer safety. This study investigated the morphological and anatomical characteristics of species sold under this name in the metropolitan region of Rio de Janeiro. We identified *Xanthosoma taioba*, *Leucocasia gigantea*, *Colocasia esculenta*, and *Alocasia macrorrhizos* in different horticultural sites, with *X. taioba* being the culturally recognized edible reference (true *taioba*) in Brazil, and the first two species being more frequently sold as edible leafy vegetables. Therefore, *X. taioba* and *L. gigantea* were selected for detailed anatomical analysis including transverse sections of the petiole, leaf blade, and midvein using light and scanning electron microscopy. *Xanthosoma taioba* has a higher abundance of idioblasts containing raphides and druses, and a palisade-like mesophyll arrangement, whereas *L. gigantea* has fewer idioblasts. These morphoanatomical characters provide effective, low-cost tools for species differentiation, especially when reproductive structures are absent. Accurate identification is essential to ensure food safety and preserve the nutritional quality of *X. taioba*.

Keywords Calcium oxalate · Ethnobotany · Food safety · Misidentification · UFP · *Xanthosoma taioba*

1 Introduction

The consumption of unconventional food plants (UFP – sensu Kinupp 2007) has significantly increased in recent years in Brazil, influenced by both media and government initiatives (Silveira et al. 2010; Pereira and Yshida 2024). This growth is attributed to the remarkable diversity of UFPs in the Brazilian flora, the increasing cultivation of these species by smallholder farmers, and the rising emphasis on food sovereignty defined as the right of people to access healthy and sustainably produced food, in accordance with their cultural traditions, agricultural practices, and local production

systems (Silveira et al. 2010; ONU 2015; Pereira and Yshida 2024). Despite its high urban density, Rio de Janeiro has many localities that support small-scale family farming businesses (IBGE Demographic Census 2010; Tenchini and Freitas 2024). Much of the agroecological production from these small farmers is sold at local markets, improving access to healthy foods and reviving the tradition of consuming UFP throughout the state (Alimentos Saudáveis nos Mercados Locais 2015).

Tuberous Araceae species with edible value are frequently misidentified due to their morphological similarities, such as the shape and color of their leaves and petioles, as well as spadix-type inflorescences and cordiform or sagittate leaf blades, increasing the risk of accidents from improper consumption (Lana and Tavares 2010). Several plants in this family, particularly ornamental ones, have been associated with poisoning incidents due to accidental ingestion. For example, species of the genera *Dieffenbachia* (dumb cane), *Monstera*, and *Caladium* can cause throat swelling and suffocation (Oliveira et al. 2003). A key factor in the toxicity of these plants is the presence of calcium oxalate crystals,

✉ Cassia Mônica Sakuragui
cassia.sakuragui@jbrj.gov.br

¹ Escola Nacional de Botânica Tropical, Instituto de Pesquisa Jardim Botânico Do Rio de Janeiro, Jardim Botânico St., 1008, Rio de Janeiro, RJ 22460-000, Brazil

² Department of Natural Products and Food, School of Pharmacy, Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, RJ 21941-902, Brazil

which is a general characteristic of Araceae species (Mayo et al. 1997). However, these toxic effects are not caused just by the calcium oxalate raphides themselves, which are not inherently toxic, but rather result from a combined mechanical and chemical action. Raphides, organized into large idoblasts known as biferines, penetrate the mucous membranes of the mouth, facilitating the transfer of unstable chemical toxins presumably originating in the biferine mucilage (Mayo et al. 1997). This dual action causes inflammation and pain, especially if the plant material is not properly processed. While the raphides remain intact after cooking, the toxicity is effectively removed due to the instability of the active toxic compounds (Silveira et al. 2010). Some species also contain latex, which may contribute to their toxicity. These risks highlight the need for accurate botanical identification, especially for food plants marketed and consumed by the public.

Taioba is part of this context as a traditional leafy vegetable propagated exclusively vegetatively with high nutritional value, widely cultivated in home gardens and urban and peri-urban plots. Beyond Rio de Janeiro, this vegetable is also widely cultivated in other Brazilian states, such as Bahia, Minas Gerais, and Espírito Santo (Souza and Finger 2014). Historically, rural, quilombola, and low-income urban communities have consumed *taioba* primarily in cooked form (Carvalho and Cordeiro 1990; Kinupp 2007). The leaves are rich in vitamins A and C, and mineral salts calcium, iron, potassium, and manganese, making it an important ally in combating food insecurity and micronutrient deficiencies (Pinto et al. 1999; Lara et al. 2019). Despite its nutritional relevance, its production chain remains incipient and poorly structured (Guedes et al. 2021).

However, the indiscriminate use of the common name *taioba* for multiple Araceae species has caused confusion, with serious implications for food safety and the nutritional quality of marketed foods (Benevides et al. 2022; Sepúlveda-Nieto et al. 2017). The popular name *taioba* has been attributed to the following species: *Alocasia macrorrhizos* (L.) G. Don, *Leucocasia gigantea* (Blume) Schott, *Xanthosoma robustum* Schott, *Xanthosoma sagittifolium* (L.) Schott, and *Xanthosoma taioba* E. G. Gonçalves (Flora e Funga do Brasil 2025). Flora e Funga do Brasil (2025) also includes additional names, such as *taioba-de-são-tomé* (*Colocasia esculenta* (L.) Schott) and *taioba-de-tracajá* (*Echinodorus horizontalis* Rataj, Alismataceae).

In the literature, studies focusing on *taioba* as a potential Brazilian UFP cite *Xanthosoma taioba* (Padilha et al. 2017) and *Xanthosoma sagittifolium* (Campos et al. 2019; Silva et al. 2022). Despite the multiple species listed under the vernacular name *taioba* in Flora e Funga do Brasil (2025), studies involving chemical composition (Pinto et al. 2001; Benevides et al. 2022) and genetic characterization (Sepúlveda-Nieto et al. 2017) have predominantly used the

name *X. sagittifolium*. Here, we adopt the name *X. taioba* following the conclusions of Gonçalves (2011), who clarified the application of these names based on morphological and geographical distinctions. According to that work, *X. sagittifolium* refers to a species originally described from Jamaica, while *X. taioba* corresponds to the species cultivated and consumed in Brazil. The two taxa differ in traits such as basal denudation (present in *X. sagittifolium*, absent in *X. taioba*) and the color of staminodes (cream in *X. sagittifolium*, pinkish in *X. taioba*) (Gonçalves 2011).

Although *taioba* is a promising leafy vegetable with high nutritional value and ease of cultivation, it is often confused with other species that may not be safe for consumption. This identification challenge is even greater because commercialized vegetative parts (leaves and petioles) lack reproductive structures, making morpho-anatomical tools essential (Keating 2000). Among the species commonly referred to as *taioba*, only *Xanthosoma taioba* has been formally described in the literature as a safe and traditionally consumed leafy vegetable (Gonçalves 2011; Kinupp and Lorenzi 2014). *Leucocasia gigantea*, popularly known as *taioba-manteiga*, is also cultivated and commercialized as an edible plant in several Brazilian states, but no specific toxicological or food safety studies have been conducted so far. This lack of data highlights the importance of anatomical and morphological analyses to support reliable identification and contribute to the safe consumption of these plants. In this context, this study aimed to characterize morphological features of four Araceae species sold under the vernacular name *taioba* in the metropolitan region of Rio de Janeiro, to identify diagnostic traits and clarify species boundaries. Additionally, a detailed anatomical comparison was conducted to better understand the two most frequent commercialized species, *Xanthosoma taioba* (sold as *taioba*) and *L. gigantea* (sold as *taioba-manteiga*). This aims seek to promote the safe consumption of UFP within agroecological systems and local food cultures.

2 Material and methods

Plant material was collected between June and July 2017 from five horticultural sites from natural occurrence: three in the municipality of Magé and two in the city of Rio de Janeiro. In each location, plants locally referred to as *taioba* were selected based on their commercial use and morphological similarity. Four specimens were collected and processed using standard herbarium procedures. Vouchers were deposited at Herbarium RFA (Thiers 2025) (accession numbers: RFA 43584, RFA 43586, RFA 43587, and RFA 43588), and later identified as *X. taioba*, *L. gigantea*, *A. macrorrhizos*, and *C. esculenta*, respectively.

Morphological trait dimensions were recorded using a measuring tape. The evaluated features included petiole (color, length, and diameter), sheath (length and diameter), leaf blade (length, overall shape, width, and number of primary lateral veins) following Mayo (1991), and rhizome (length and diameter). Data were analyzed qualitatively and used for comparative descriptions of the collected specimens.

Xanthosoma taioba (sold as *taioba*) and *L. gigantea* (sold as *taioba-manteiga*) were selected for detailed anatomical analyses due to their frequent commercialization under the same vernacular name. Samples of the petiole, leaf blade, and midvein were fixed in FAA 70 (formaldehyde, acetic acid, and ethanol; Johansen 1940), dehydrated in an ethanol series, and preserved in 70% ethanol. Samples were embedded in Leica historesin (Gerrits and Horobin 1991) and sectioned using a Leica RM 2245 rotary microtome. Sections (2–5 µm thickness) were stained with 0.05% toluidine blue in phosphate buffer (pH 4.4) (O'Brien et al. 1964) and examined under a Bioptika B50 light microscope. Images were captured using a CMOS digital camera (BP 5.0), and scale bars were calibrated under the same optical conditions.

For scanning electron microscopy (SEM), additional samples of the leaf blade and petiole were sectioned transversally and longitudinally with the aid of a Leica SAPO stereomicroscope. Samples were dehydrated using critical point drying (Bal-Tec CPD 030), mounted on metal stubs using carbon tape, coated with gold in an Emitech K550X sputter coater, and examined under a JEOL JSM-6490LV microscope (CBPF, Rio de Janeiro) at 15–30 kV. Images were processed using Adobe Photoshop CS5 for contrast adjustment, labeling, and background extraction.

3 Results

3.1 Morphological characteristics of *taioba* species

The morphological characteristics of *C. esculenta*, *L. gigantea*, *A. macrorrhizos* and *X. taioba* show clear differences among the species, particularly in size and leaf structure (Table 1, Figs. 1 and 2).

Xanthosoma taioba stands out for its sagittate blade and a petiole that attaches at the apex of the main vein, not peltately, distinguishing it from the *Leucocasia* species, which have peltate blades. It also exhibits the greatest number of basal lobe veins among the species (4–5 acroscopic and 5–7 basiscopic veins). In addition, *X. taioba* shows the smallest values for stem diameter, petiole length, petiole diameter, blade dimensions, and basal lobe dimensions.

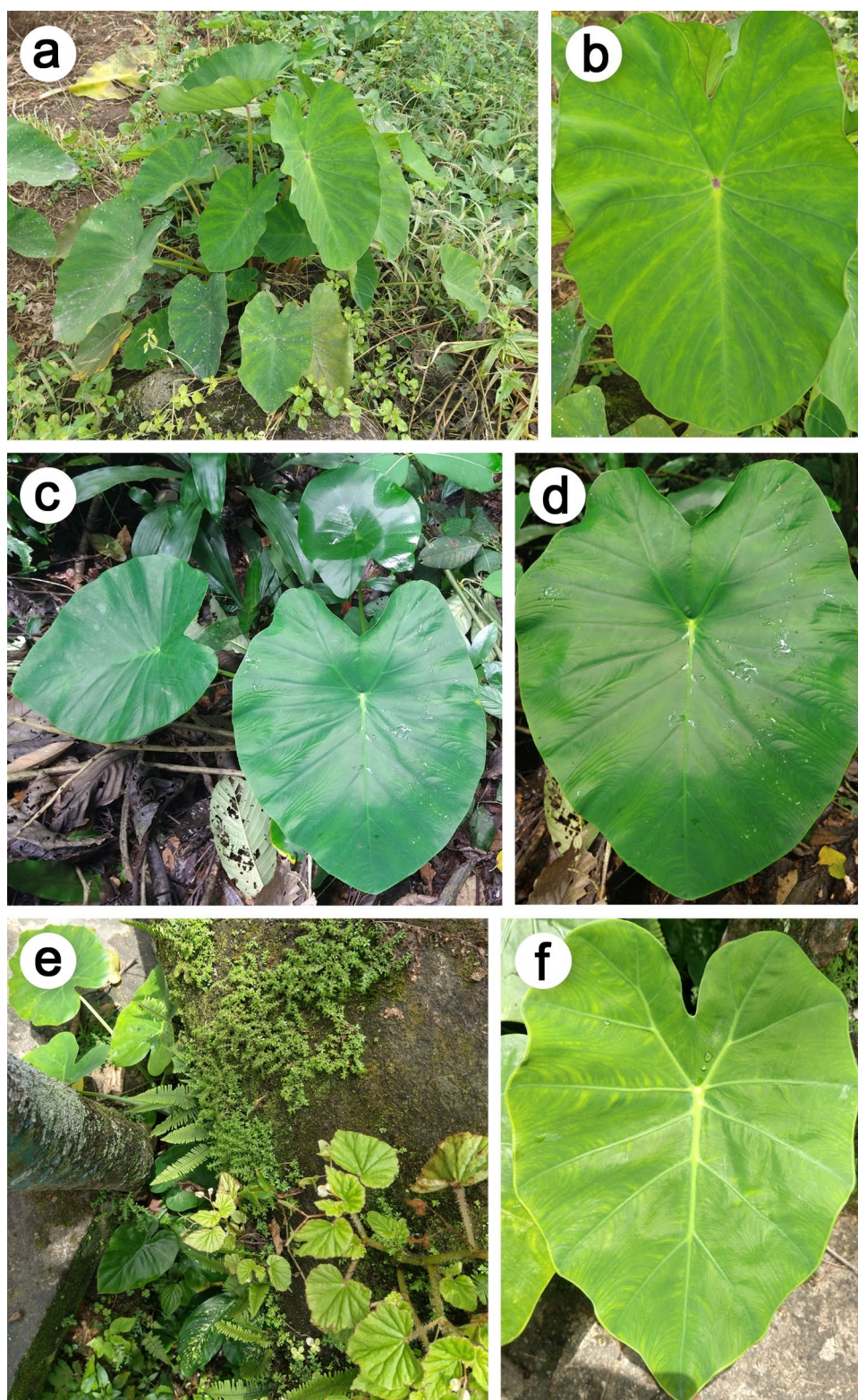
3.2 Morphological key to *taioba* species

- (1) Leaf peltate 2
- (2) Stem diameter 8–9 cm; lamina green to pale green; margin sinuate; petiole green *Leucocasia gigantea* 2'. Stem diameter up to 5 cm; lamina dark to pale green, sometimes cinereous; margin entire; petiole green or sometimes with vinaceous apex or entirely vinaceous *Colocasia esculenta* 1'. Leaf not peltate 3
- (3) Adaxially obtuse central vein; collecting vein present *Xanthosoma taioba* 3'. Adaxially acute central vein; collecting vein absent *Alocasia macrorrhizos*

Table 1 Morphological measurements and leaf characteristics of four Araceae species commonly sold as *taioba* in Brazil. Values shown are based on representative individuals

Species	<i>C. esculenta</i>	<i>L. gigantea</i>	<i>A. macrorrhizos</i>	<i>X. taioba</i>
Stem Diameter (cm)	4–5	8–9	4–5	4–5
Petiole Length (cm)	75–77	64.5–66.5	73–74	30–32
Petiole Diameter (cm)	5.1–5.5	4–4.5	6–6.5	3.5–4
Petiole Color	Green or sometimes the apex vinaceous or entirely vinaceous	Green	Green	Green
Blade Dimensions (cm)	37–37.5×27–27.5	37–38×26–28	52–55×35–36	28–30×18–19
Blade Color (adaxial surface)	Dark to pale green, sometimes cinereous	Green to Pale green	Green to Pale green	Dark green
Posterior Lobes (cm)	10.5–11×13–15	11.5–12×12–13.5	15.5–16×17–17.5	10–11×9.5–10
Number of Basal Veins	Acroscopic:3 Basiscopic: 1	Acroscopic:2–3 Basiscopic: 2–3	Acroscopic:3–4 Basiscopic: 2	Acroscopic:4–5 Basiscopic: 5–7
Blade Shape	Cordate, broadly ovate	Cordate, broadly ovate	Ovate	Triangular-ovate
Blade base	Cordate	Cordate	Cordate	Sagittate
Blade margin	Entire	Sinuate	Sinuate	Entire
Leaf	Peltate	Peltate	Not peltate	Not peltate

Fig. 1 Leaf morphology of *Colocasia* and *Leucocasia* individuals. a–d. *Colocasia esculenta*. e–f. *Leucocasia gigantea*

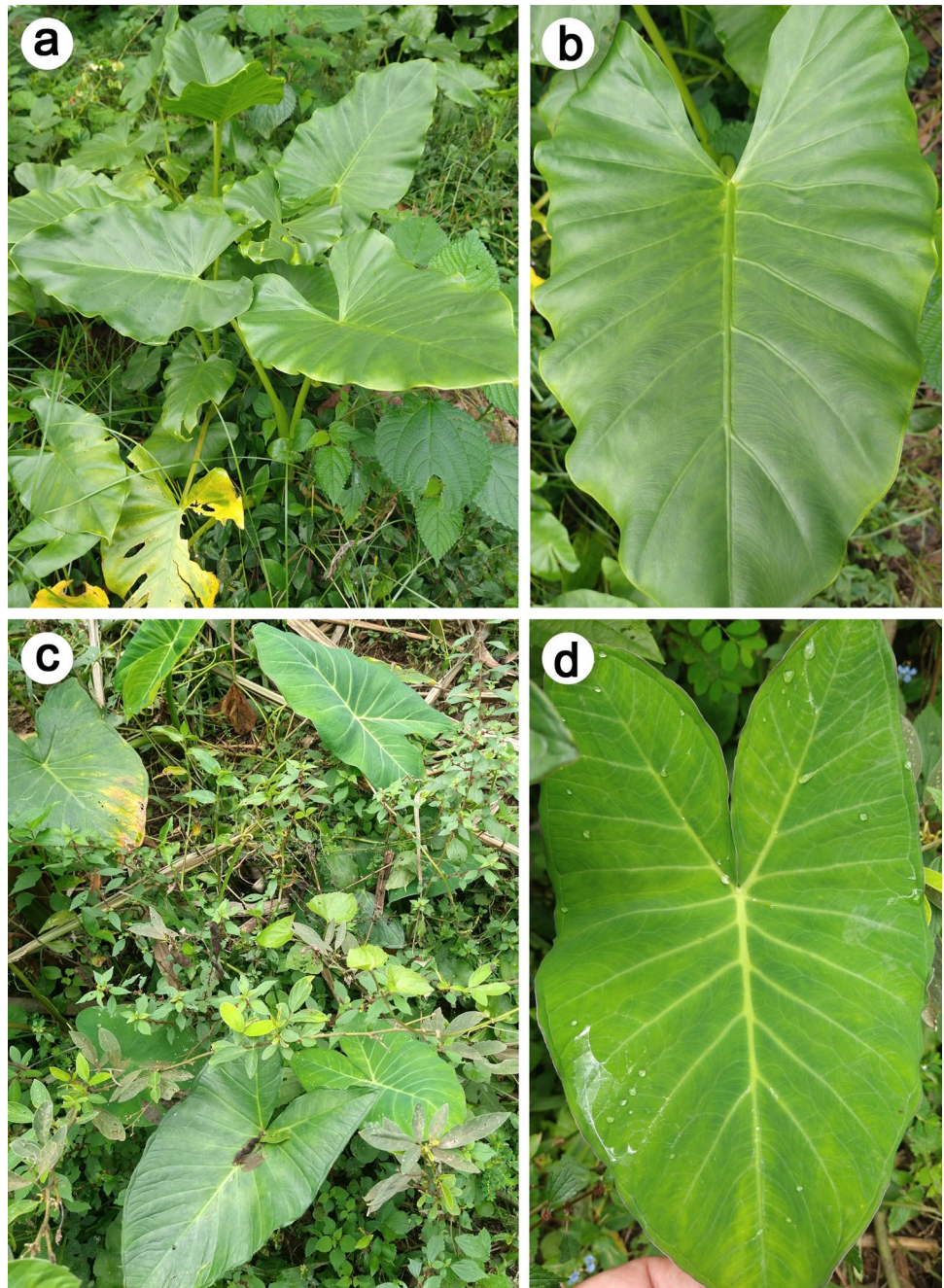


3.3 Anatomical description of *L. gigantea* and *X. taioba*

Leucocasia gigantea (*Taioba-manteiga*) – In the petiole, the

epidermis is uniseriate, covered by a cuticle, and composed of periclinally slightly elongated cells (Fig. 3a). Beneath it, annular collenchyma bundles encircle the structure (Fig. 3b). The central region is filled with parenchyma containing large

Fig. 2 Leaf morphology of *Alocasia* and *Xanthosoma* individuals. a-b. *Alocasia macrorrhizos*. c-d. *Xanthosoma taioba*



schizogenous aerenchyma spaces originating near the xylem (Fig. 3c). These air spaces are lined by a uniseriate layer of cells with projections of crystalliferous idioblasts containing raphides and druses (Fig. 3d). Some parenchyma cells also contain calcium oxalate crystal sand. Collateral vascular bundles are scattered throughout the parenchyma and are associated with laticifers near the phloem (Fig. 3b, g). Idioblasts are less abundant in this species compared to *X. taioba*. In the leaf blade, the epidermis is uniseriate and cutinized, with abaxial cells exhibiting papillae ornamentation and adaxial cells being smaller and elongated without

ornamentation (Fig. 3E). The mesophyll is dorsiventral, composed of two to three layers of cuboidal parenchyma toward the adaxial surface, some with idioblasts. Beneath these, aeriferous parenchyma layers form aerenchyma lined by juxtaposed uniseriate cells, some also bearing idioblast projections (Fig. 3d–e). In the midvein, the epidermis has flattened adaxial and elongated abaxial cells, both covered by cuticle (Fig. 3f). Below the adaxial epidermis are two to three layers of cuboidal parenchyma. Collenchyma around the periphery is angular to mainly annular (Fig. 3a, g), and the central region contains schizogenous aerenchyma, with

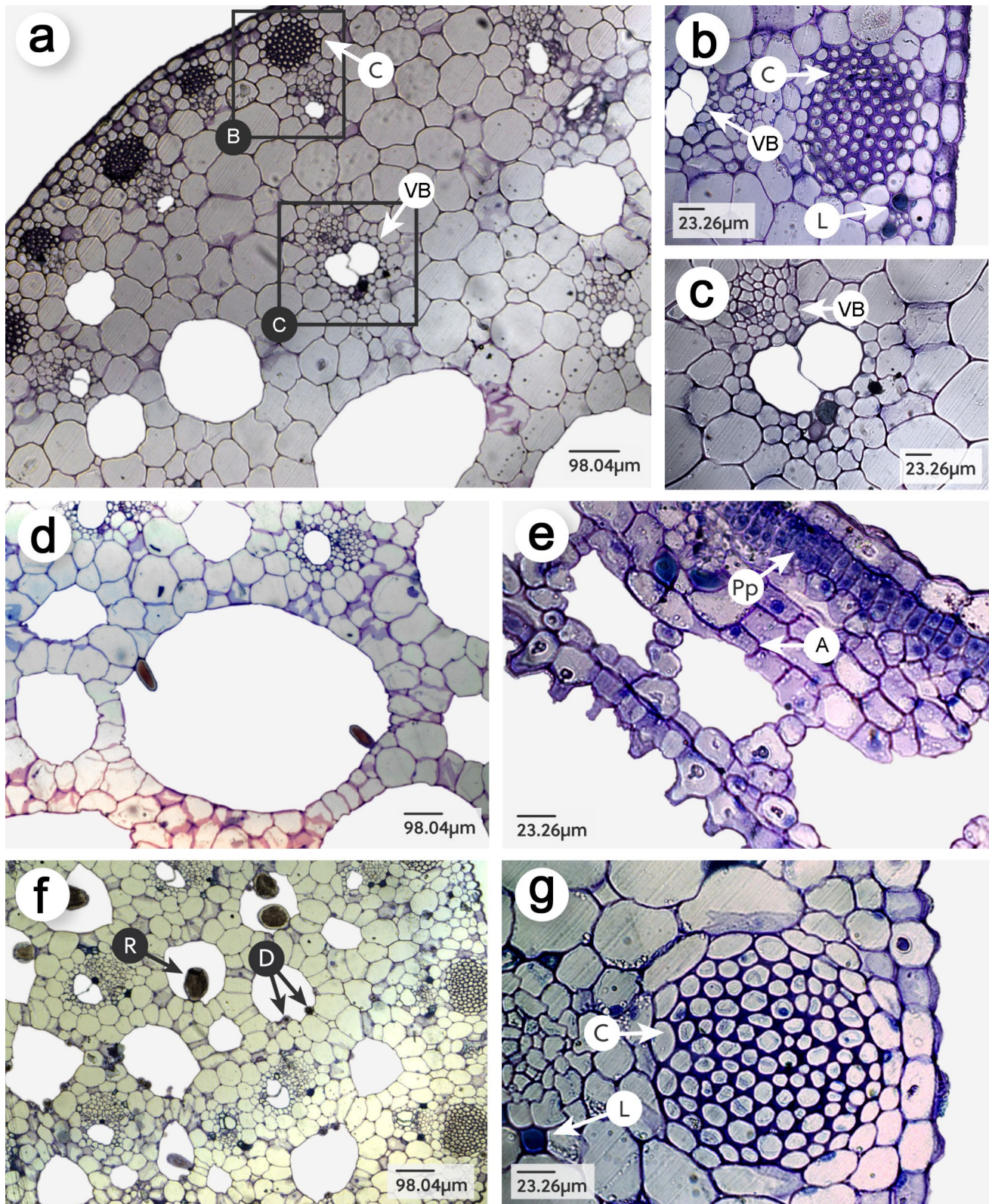


Fig. 3 Leaf anatomy of *Leucocasia gigantea*. a. petiole region. b. annular collenchyma of the petiole. c. aerenchyma in the vascular bundle. Note the two air spaces forming adjacent to the vascular bundle in a, b, and c. d. aerenchyma with projections of crystalliferous idioblasts. e. leaf mesophyll, showing the epidermis on both sides. Note the papillae ornamentation on the abaxial surface, visible in the lower-left region of the image. f. midrib region. g. angular collenchyma of the midrib. Symbols: A=aerenchyma, C=Collenchyma, D=druse, L=laticifers, Pp=palisade parenchyma, Vb=vascular bundle. Scales: A, D, F=98.4 μm; B-C, E, G=23.26 μm

isodiametric cells with idioblasts projecting into the spaces (Fig. 3d, g). Crystal sand and laticifers near the phloem are also present.

Xanthosoma taioba (Taioba) – In the petiole, the epidermis is uniseriate, covered by a cuticle, and composed of slightly elongated cells. The underlying region exhibits annular collenchyma bundles that surround the organ (Fig. 4c) and parenchyma with large schizogenous aerenchyma formed near the xylem (Fig. 4a, b). These aerenchyma cavities are lined by a uniseriate layer of cells containing projecting idioblasts with raphides and druses. Calcium oxalate crystal sand is also observed in some parenchyma cells (Fig. 5h). Vascular bundles are dispersed throughout the parenchyma, with laticifers associated with the phloem (Fig. 4b, 4.2). In the leaf blade, the epidermis is uniseriate and cutinized, with abaxial cells showing papillae ornamentation and adaxial cells being smaller, periclinally elongated, and lacking ornamentation. The dorsiventral mesophyll consists of two to four layers of isodiametric to tabular parenchyma cells resembling palisade parenchyma (Fig. 4d, f), often containing idioblasts. Beneath them are aeriferous parenchyma layers, with air spaces lined by a uniseriate layer of cells bearing idioblast projections (Fig. 4e). In the midvein, the epidermis has flattened adaxial and elongated abaxial cells, both covered by cuticle (Fig. 4g). Below the adaxial surface, two to four layers of tabular parenchyma are present. Angular and anellar collenchyma bundles are present at the periphery (Fig. 4h), while the central region contains schizogenous aerenchyma with idioblasts projecting raphides and druses into the air spaces (Fig. 4i). Crystal sand and laticifers are also common in this region.

3.4 Diagnostic anatomical traits of *L. gigantea* and *X. taioba*

The subepidermal parenchyma in the leaf blade and midvein differs: *L. gigantea* shows two to three layers of cuboidal cells (Fig. 3e), whereas *X. taioba* has two to four layers of isodiametric to tabular cells resembling palisade parenchyma (Fig. 4d). Beyond these distinctions, the most notable anatomical differences between these species lie in the greater abundance and more frequent presence of crystalliferous idioblasts in *X. taioba*, especially in the petiole (Fig. 5). These anatomical traits serve as reliable diagnostic characters for distinguishing these culturally and economically significant species.

4 Discussion

This study corroborates previous data that the vernacular name taioba is applied to different species of Araceae. It also confirms that this practice occurs specifically in the

municipality of Rio de Janeiro and surrounding areas, especially in reference to the species *Xanthosoma taioba* and *Leucocasia gigantea*. This situation raises important concerns, as these species differ in nutritional content and concentrations of antinutritional compounds, especially calcium oxalate crystals, which can cause irritation or health risks if not properly cooked. Thus, the mislabeling of these plants compromises both the expected nutritional quality and consumer safety. This correct diagnosis is in line with Good Manufacturing Practices, helping to prevent possible food poisoning (Genta et al. 2005). Efforts to improve species identification and standardization in local markets are essential to protect public health and increase the cultural and economic value of these underutilized food plants.

Our morpho-anatomical data contribute directly to this goal, as we reveal some differences between *X. taioba* (taioba) and *L. gigantea* (taioba-manteiga), especially in the transverse sections of the petiole, leaf blade, and midvein. Idioblasts containing druses and raphides are more abundant in *X. taioba*, especially near aerenchyma cavities, supporting previous work by Keating (2004) on the taxonomic significance of crystal types in Araceae. In the petiole region, both species have a uniseriate epidermis covered by a cuticle. In the midvein region, collenchyma varies from annular to angular. This contrasts with the findings of Arogundade and Adedeji (2019) who consider collenchyma types a useful diagnostic character in *Colocasia* and *Xanthosoma*. However, a single organ may present more than one type of collenchyma depending on its position or developmental stage (Appezatto-da-Glória and Carmello-Guerreiro 2006).

In the leaf blade, both species displayed a uniseriate epidermis covered by a cuticle, with papillae ornamentation on the abaxial surface (see Figs. 3e and 4d). However, *X. taioba* has two to four layers of isodiametric to tabular parenchyma cells resembling palisade parenchyma, while *L. gigantea* has two to three layers of cuboidal cells. This difference corroborates the findings of Adedeji and Illoh (2004), who highlighted the diagnostic value of subepidermal cell shape and arrangement in monocot systematics. In the midvein, both species have aerenchyma with schizogenous origin, but their internal organization differed. *X. taioba* shows a greater number of idioblasts, with projections of druses and raphides into the air spaces. Crystal sand was also observed more frequently in this species. These features are consistent with anatomical descriptions in *Xanthosoma* by Osuji and Nwala (2015). Together, the differences between *X. taioba* and *L. gigantea* support their taxonomic delimitation and align with previous studies that emphasize the value of anatomical characters in Araceae systematics (Keating 2004; Arogundade and Adedeji 2017).

In nutritional terms, *X. taioba* stands out for its high content of essential minerals such as calcium, iron, and zinc, which are important for addressing micronutrient

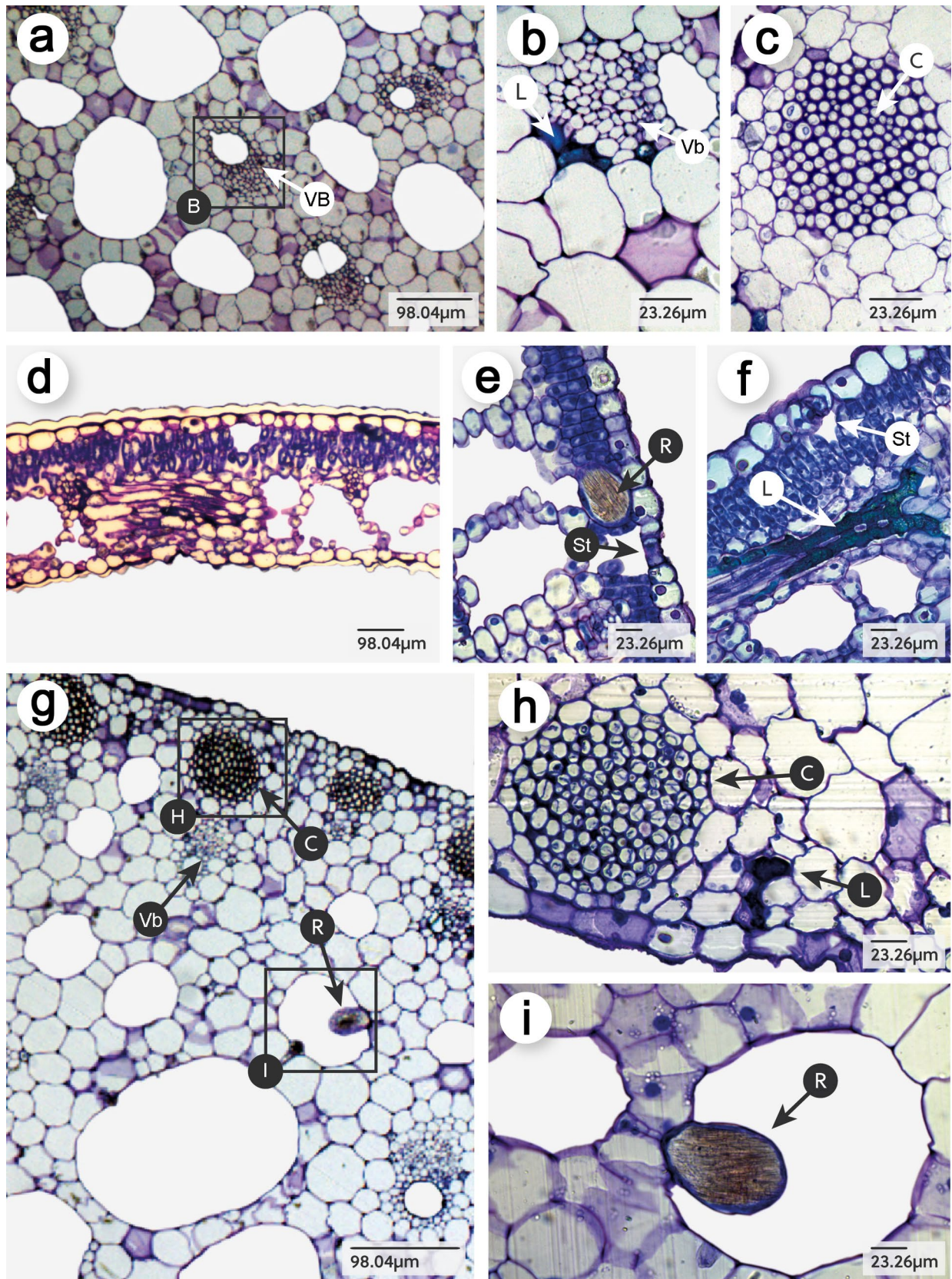


Fig. 4 Leaf anatomy of *Xanthosoma taioba* a-c. petiole region. b. vascular bundle with laticifers. c. detail of annular collenchyma. d. cross-section of the leaf mesophyll displaying the epidermis on both the abaxial (toward the bottom) and adaxial (toward the top) surfaces of the image. e. palisade parenchyma with crystalliferous idioblast. Note the stoma in the epidermis. f. section of the mesophyll showing aerenchyma, laticifers, and a stoma in the epidermis. g-h. midvein region in cross-section g. the collenchyma bundles cords distribution in the subepidermal region and the air spaces containing crystalliferous idioblasts. h. angular collenchyma. I. details of an aerenchyma space with a raphide. Symbols: A = aerenchyma, C = collenchyma, L = laticifers. Pp = palisade parenchyma, R = raphide, St = stoma, VB = vascular bundle. Scales: A, D, G = 98.4 µm; B-C, E-F, H-I = 23.26 µm

deficiencies, especially in vulnerable populations. This species also contains high concentrations of bioactive compounds like phenolics and carotenoids (Benevides et al. 2022). On the other hand, *L. gigantea* is appreciated for its culinary versatility and relatively low oxalate levels, making it easier to prepare safely. As calcium oxalate is present in all Araceae, appropriate processing is essential. Thermal methods such as steaming and boiling are effective in reducing oxalate content and enhancing both palatability and bioavailability of nutrients (Bradbury and Nixon 1998; Pinto et al. 2001; Conceição et al. 2024). While detailed compositional studies on *X. taioba* and *L. gigantea* are still limited, comparisons with related species, such as *C. esculenta*, suggest significant differences in mineral and antinutritional compound content. For example, leaves of *X. taioba* are rich in calcium and phenolic compounds (Benevides et al. 2022), which contribute to bone health and antioxidant capacity. These properties are important for dietary interventions aimed at reducing oxidative stress and controlling cholesterol levels (Pinto et al. 2001; Souza et al. 2024).

Cultural confusion between *taioba* and *taioba-manteiga* in local markets has consequences that extend beyond food safety. It undermines the transmission of traditional knowledge, weakens cultural identities associated with specific plant uses, and can distort the perceived value of each species. Distinguishing these plants is not only a matter of scientific accuracy, it also helps to preserve local agricultural traditions and culinary heritage. Initiatives that bridge botanical science and popular knowledge are therefore fundamental to ensure the sustainable and respectful use of these plants.

The implications of our findings also extend to food security and sustainable agriculture. Both *X. taioba* and *L. gigantea* are adaptable plants with great potential for cultivation in agroecological systems. Their inclusion in community gardens and urban agriculture initiatives has already contributed to dietary diversification and better access to nutritious foods. In projects developed in Bairro Esperança and Dom Helder Câmara, *X. taioba* has been cultivated with other functional plants such as *Pereskia aculeata*

(*ora-pro-nobis*), to support local strategies against malnutrition in children aged 0–5 years (Naves 2010; Medeiros et al. 2021). These initiatives also offer educational workshops on proper preparation, helping to reduce health risks from calcium oxalate consumption.

From a taxonomic perspective, our results reinforce the importance of integrating morphological and anatomical traits (e.g., leaf shape, venation, and distribution of idioblasts) to distinguish species sold under the same vernacular name. The differences observed between *X. taioba* and *L. gigantea*, especially the greater abundance and diversity of crystalliferous idioblasts in *X. taioba*, provide valuable diagnostic features for species identification. These anatomical traits also support ethnobotanical practices that recommend removing petioles and main veins before cooking (Silveira et al. 2010; Kinupp and Lorenzi 2017).

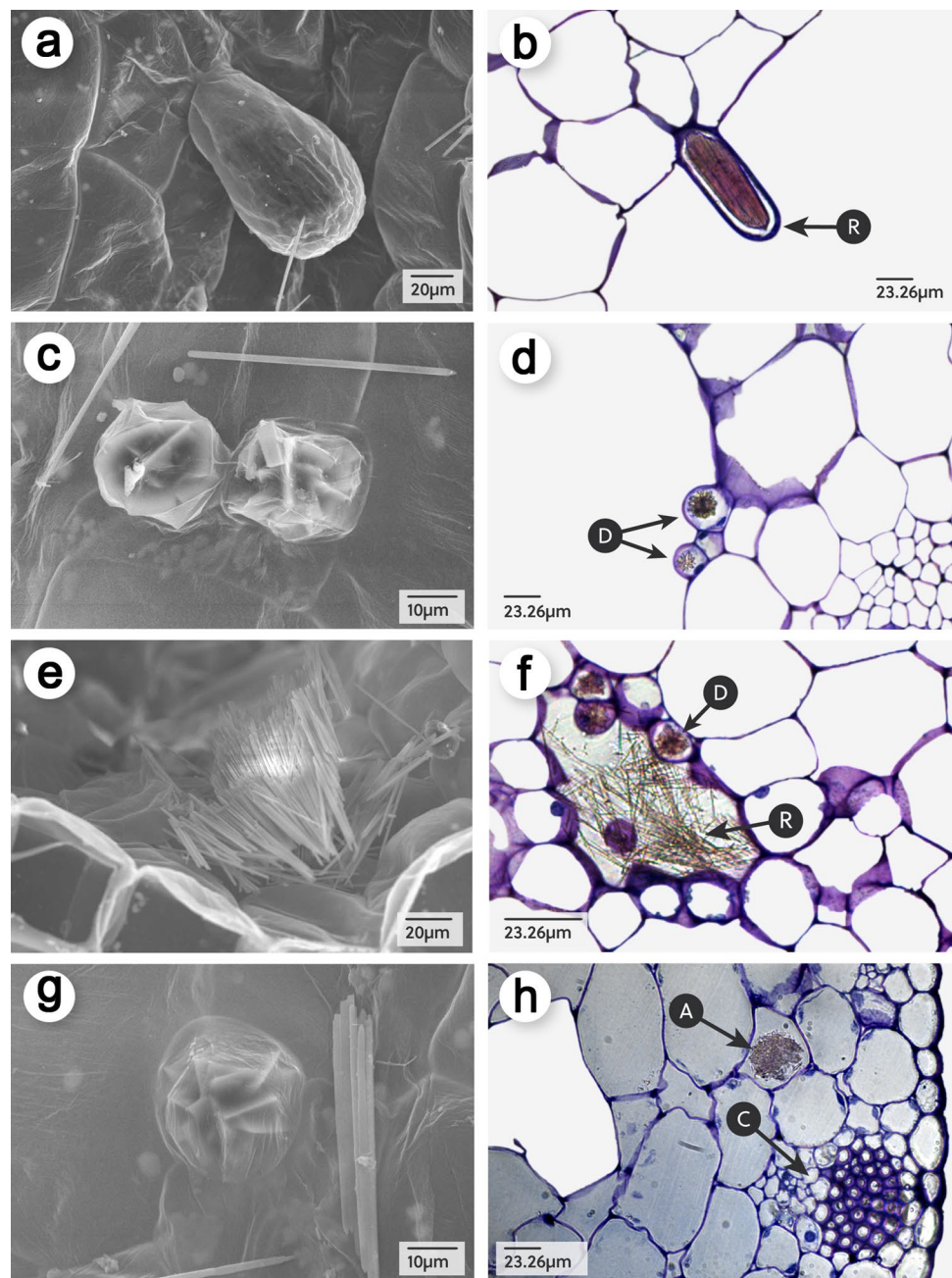
Finally, *X. sagittifolium* is the most studied species in its genus and plays an increasingly prominent role in local food systems due to its nutritional value and adaptability to diverse growing conditions. The genus *Xanthosoma* includes the largest number of edible species among Araceae, offering great potential for sustainable agriculture and dietary diversification. Efforts to valorize this diversity through community education and market differentiation can enhance food security and promote the conservation of agrobiodiversity, establishing food sovereignty, as proposed by the ONU (2015). By integrating morphological, anatomical, and nutritional data, this study sets a foundation for future research and practical strategies to optimize the safe and sustainable use of these valuable crops.

The morphological and anatomical comparisons carried out among the edible Araceae species sold as *taioba* in the Metropolitan Region of Rio de Janeiro revealed consistent differences in leaf shape, petiole dimensions, venation patterns, and in the distribution and abundance of crystalliferous idioblasts between *Xanthosoma taioba* and *Leucocasia gigantea*. These structural traits represent reliable and cost-effective tools for species identification, with direct implications for food safety and nutritional quality, particularly in relation to the variable concentrations of calcium oxalate crystals observed among the species.

In addition to their taxonomic relevance, these results reinforce the cultural and agroecological importance of *taioba*. Its inclusion in community gardens and local food systems contributes to dietary diversification, the preservation of traditional knowledge, and the strengthening of sustainable agricultural practices. In this context, educational initiatives play a key role in linking traditional uses with scientific evidence, promoting safe consumption and informed use of these plants.

From this perspective, further studies addressing the genetic diversity of these species, the refinement of species boundaries, and the development of strategies for the

Fig. 5 Details of crystalliferous idioblasts in *Leucocasia gigantea* and *Xanthosoma taioaba* under scanning electron microscopy (SEM—a, c, e, g) and light microscopy (LM—b, d, f, h). a–b. Raphides. c–d. Druses. e–f. Raphides. g. Druses and raphides. h. Crystal sand. Symbols: A = Crystal sand, C = Collenchyma, D = Druses, R = Raphides



broader use of underutilized crops are necessary. By integrating scientific advances with community-based applications, research on taioba contributes not only to taxonomic knowledge, but also to food security, public health, and the conservation of agrobiodiversity in Brazil.

Authors contributions Cassia Mônica Sakuragui: Conceptualization; Data curation; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Roles/Writing—original draft; and Writing—review & editing. Thandy Yudhi Grijó Kato: Formal analysis; Investigation; Methodology; Validation; Visualization; Roles/Writing—original draft Daniel Luiz da

Silva Dutra Junior: Software; Validation; Visualization; Roles/Writing—original draft; and Writing—review & editing. Juliana Villela Paulino: Conceptualization; Data curation; Formal analysis; Resources; Software; Supervision; Validation; Visualization; Roles/Writing—original draft; and Writing—review & editing.

Funding The Article Processing Charge (APC) for the publication of this research was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) (ROR identifier: 00x0ma614).

Data availability No new datasets were generated or analyzed during the current study. All information supporting the findings of this work is included in the article and its references.

Declarations

Conflict of interest There are no conflicts of interest (personal, scientific, commercial, political or financial) related to the manuscript.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Adedeji O, Illoh HC (2004) Comparative foliar anatomy of ten species in the genus *Hibiscus* L. in Nigeria. *New Bot* 31:147–180
- Appezato-da-Glória B, Carmello-Guerreiro SM (2006) Anatomia vegetal, 3ª edn. Editora UFV, Viçosa.
- Arogundade OO, Adedeji O (2017) Comparative foliar and petiole anatomy of some members of the genus *Dieffenbachia* Schott (Araceae). *Not Sci Biol* 9:94–103
- Arogundade OO, Adedeji O (2019) Taxonomic significance of the vegetative anatomy of members of *Colocasia* (L.) Schott and *Xanthosoma* (L.) Schott (Araceae). *Afr J Plant Sci* 13:92–106. <https://doi.org/10.5897/AJPS2019.1776>
- Benevides CMJ, Silva HBM, Lopes MV, Montes SDS, Silva ASL, Matos RA, Almeida-Bezerra M (2022) Multivariate analysis for the quantitative characterization of bioactive compounds in “taioba” (*Xanthosoma sagittifolium*) from Brazil. *J Food Meas Charact* 16:1901–1910
- Bradbury JH, Nixon RW (1998) The acidity of raphides from the edible aroids. *J Sci Food Agric* 76:608–616. [https://doi.org/10.1002/\(SICI\)1097-0010\(199804\)76:4<3c608::AID-JSFA996>3E3.0.CO;2-2](https://doi.org/10.1002/(SICI)1097-0010(199804)76:4<3c608::AID-JSFA996>3E3.0.CO;2-2)
- Campos FP, Beis AT, Rocha AV, et al. (2019) Palitos integrais com farinha de taioba e espinafre. *FAG J Health* p 10–11.
- Carvalho EF, Cordeiro JAD (1990) Um método alternativo e eficiente de propagação vegetativa de inhame (*Colocasia esculenta*) e de taioba (*Xanthosoma sagittifolium*). *Acta Amaz*. <https://doi.org/10.1590/1809-43921990201018>
- Conceição LS, Coqueiro JM, Costa LD, Cardoso PS, Zimmer TBR, Costa IHL, Otero DM (2024) Unconventional food plants in Brazil: knowledge and consumption analysis. *Rev Agroalimentaria* 29:179–197
- Flora e Função do Brasil (2025) Araceae. Jardim Botânico do Rio de Janeiro. <https://floradobrasil.jbrj.gov.br/FB631376>
- Genta TMS, Maurício AA, Matioli G (2005) Avaliação das boas práticas através de check-list aplicado em restaurantes self-service da região central de Maringá, Estado do Paraná. *Acta Sci Health Sci* 27:151–156
- Gerrits PO, Horobin RW (1991) The application of glycol methacrylate in histotechnology: some fundamental principles. Rijksuniversiteit Groningen, Groningen
- Gonçalves EG (2011) The commonly cultivated species of *Xanthosoma* Schott (Araceae), including four new species. *Aroideana* 34:3–23
- Guedes PTP, Cândido HT, Fernandes AM, Souza APS (2021) Tuberosas amiláceas no Estado de São Paulo: canais de comercialização e importância econômica. *Research, Society and Development* 10(4):e48610414201-e48610414201. <https://doi.org/10.33448/rsd-v10i4.14201>
- IBGE (2010) Censo brasileiro de 2010. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro
- Johansen DA (1940) Plant microtechnique. McGraw-Hill, New York
- Keating R (2000) Collenchyma in Araceae: trends and relation to classification. *Bot J Linn Soc* 134:203–214
- Keating R (2004) Vegetative anatomical data and its relationship to a revised classification of the genera of Araceae. *Ann Mo Bot Gard* 91:485–494
- Kinupp VF (2007) Plantas alimentícias não convencionais da região metropolitana de Porto Alegre. Tese, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS
- Kinupp VF, Lorenzi H (2017) Plantas alimentícias não convencionais (PANC) no Brasil. Instituto Plantarum, Nova Odessa.
- Lana MM, Tavares SA (eds) (2010) 50 hortaliças: como comprar, conservar e consumir, 2ª edn. Embrapa Informação Tecnológica, Brasília.
- Lara MCB, Maynard DC, Vilela JS, Silva MC, Moura e Lima CMA (2019) Elaboração, aceitabilidade e avaliação da composição nutricional de bolinho de taioba. *Braz J Dev* 5:24099–24109. <https://doi.org/10.34117/bjdv5n11-100>
- Mayo SJ (1991) A revision of *Philodendron* subgenus *Meconostigma* (Araceae). *Kew Bull* 46:601–681
- Mayo SJ, Bogner J, Boyce PC (1997) The genera of Araceae. Royal Botanic Gardens, Kew.
- Medeiros PM, Santos GMC, Barbosa DM, Gomes LCA, Santos ÉMDC, Silva RRV (2021) Local knowledge as a tool for prospecting wild food plants. *Sci Rep* 11:594. <https://doi.org/10.1038/s41598-020-79835-5>
- Naves AR (2010) Segurança alimentar e desenvolvimento infantil no bairro Esperança. Dissertação, Universidade Federal de Uberlândia, Uberlândia-MG
- O'Brien TP, Feder N, McCully ME (1964) Polychromatic staining of plant cell walls by Toluidine Blue O. *Protoplasma* 59:364–373. <https://doi.org/10.1007/BF01248568>
- Oliveira RB, Godoy SAP, Costa FB (2003) Plantas tóxicas: conhecimento e prevenção de acidentes. Holos, Ribeirão Preto.
- ONU (2015) Goal 2: Zero hunger. United Nations. <https://www.un.org/sustainabledevelopment/hunger/>
- Osuji JO, Nwala PC (2015) Epidermal and cytological studies on cultivars of *Xanthosoma* and *Colocasia*. *Int J Plant Soil Sci* 4:149–155
- Padilha MRF, Shinohara NKS, Shinohara GM, Cabral JVB, Oliveira FHPC (2017) Plantas alimentícias não convencionais (PANC). *An Acad Pernamb Ci Agron* 13:266–278
- Pereira HP, Yshida K (2024) A ascensão das PANC na gastronomia brasileira. *Rev IDEAS* 18.
- Pinto NAVD, Boas BMV, Carvalho VD (1999) Caracterização mineral das folhas de taioba. *Cienc Agrotecnol* 23:57–61
- Pinto NAVD, Carvalho VD, Corrêa AD, Rios AO (2001) Avaliação de fatores antinutricionais das folhas da taioba. *Cienc Agrotecnol* 25:601–604
- Sepúlveda-Nieto MDP, Bonifacio-Anacleto F, Figueiredo CF, Moraes-Filho RM, Alzate-Marin AL (2017) Accessible morphological and genetic markers for identification of taioba and taro. *Horticulturae* 3:49. <https://doi.org/10.3390/horticulturae3040049>
- Silva GM, Rocha NC, Souza BKM, Amaral MPC, Cunha NSR, Moraes LVS, Gemaque EM, Dutra CDT, Moura JS, Mendes PM (2022) O potencial das PANC: uma revisão. *Braz J Dev* 8:14838–14853. <https://doi.org/10.34117/bjdv8n2-416>
- Silveira GSR, Madeira NR, Mascarenhas MHT, et al. (2010) Manual de hortaliças não-convencionais. MAPA, Brasília.
- Souza CS, Finger FL (2014) Avaliação do armazenamento refrigerado na brotação de taioba. *Magistra* 26:147–155
- Souza BJ, Duarte LSF, Lima CLS et al (2024) Potencial hipocolesterolêmico da folha de taioba. *Nutrivisa* 11:e12562

- Tenchini FP, Freitas CO (2024) Agricultura familiar no estado do Rio de Janeiro. *Rev Econ Sociol Rural* 62:e266755. <https://doi.org/10.1590/1806-9479.2022.266755>
- Thiers B (2025 onwards) Index Herbariorum. New York Botanical Garden. <http://sweetgum.nybg.org/ih/>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.