Botanical identity of a medicinal root commercialized under the name "Santa Lucía Morotí" and anatomical, micrographic, and histochemical characterization

Nadia A. Gaeta, Ignacio J. Agudelo, Leonardo M. Anconatani and Rafael A. Ricco

Correspondence

Nadia A. Gaeta[1,2,*], Ignacio J. Agudelo[1,2], Leonardo M. Anconatani[1,2] and Rafael A. Ricco[1,2]

[1]Universidad de Buenos Aires, Facultad de Farmacia y Bioquímica, Departamento de Farmacología, Cátedra de Farmacobotánica, Buenos Aires, Argentina
[2]Universidad de Buenos Aires, Facultad de Farmacia y Bioquímica, Instituto de Tecnología Farmacéutica y Biofarmacia (InTecFyB), Buenos Aires, Argentina

*Corresponding Author: nadia.gaeta.doctorado@gmail.com

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Research

Abstract

Background: Traditional medicine in Paraguay relies on various medicinal plants referred to as **santa lucía morotí** in the vernacular. These plants have many uses, from treating ophthalmic conditions to serving as a refreshing remedy. This study aims to identify the botanical species associated with the plant material sold under the name **santa lucía morotí** in informal markets within the Ciudad Autónoma de Buenos Aires, República Argentina. This investigation aims to determine if there has been a substitution of this plant material with a local species and to establish anatomical, micrographic, and histochemical parameters.

Methods: Fresh roots were procured from street vendors within the Paraguayan community residing in the Ciudad Autónoma de Buenos Aires, República Argentina, labeled as **santa lucía morotí**. These roots were cultivated until the plants reached the flowering stage, at which point they were identified using taxonomic keys. Transverse sections were prepared and stained with safranin and fast green. Additionally, histochemical reactions were conducted to localize and characterize families of metabolites, with a known variety of biological and pharmacological activities.

Results: The plant was identified as *Commelina platyphylla* Klotzsch ex Seub. (Commelinaceae). This suggests that there has been no substitution of this plant material. Terpenoids, saponins, alkaloids, and flavonoids were successfully histochemical localized.

Conclusions: The species under investigation has not been replaced as it transitioned from traditional Paraguayan medicine to the urban environment of Buenos Aires City. The characterization of metabolites provides valuable guidance for phytochemical and pharmacological research to validate ethnomedical uses.

Keywords: Santa Lucía Morotí, *Commelina platyphylla*, urban ethnomedicine, migrant ethnomedicine

Background

Argentina is a host country for migrants from numerous parts of the world, especially from neighboring countries (Modolo 2016), with the Paraguayan community being the majority (30.5%) followed by the Bolivian community (19.1%). As of the 2010 census, 550713 Paraguayan citizens were residing in the country. This migration is boosted by the presence of social networks that serve to facilitate the integration of migrants and act as a bridge between countries (Bruno *et al*. 2013).

Medeiros de Muniz *et al*. (2012) assert that migrant groups can modify their ethnomedical systems. One of these modifications involves adapting their *"materia médica"* to the local flora of their destination by replacing or substituting plant species, as well as incorporating new species and new uses for already known species. On the other hand, this may also lead to the abandonment of certain plants due to their low availability. Another strategy they can employ is the incorporation of new species that are present in both their place of origin and their place of residence, or even the import of species from their places of origin.

Species belonging to the Commelinaceae family have been reported in Paraguay under the name **santa lucía morotí**. This name likely refers to the patron saint who protects the sight of practicing Catholics. Under this vernacular name, *Tradescantia fluminensis* Vell. (Martinez Crovetto 1981) and *Commelina erecta* L. (Benitez *et al.* 2009) have been cited. The mucilage trapped in their floral bracts has been reported for treating conjunctivitis, and their roots have been used as a refreshing remedy (Basualdo *et al.* 2004). *Commelina platyphylla* Klotzsch ex Seub. is also called **santa lucía morotí**, but the entire plant treats diarrhea and digestive disorders (Pavetti *et al*. 1988). On the other hand, the root of *Commelina virginica* L. has been reported for its antipyretic properties, and the mucilage from its bracts is used as an ocular refresher, although it is known under the name **santa lucía joví** (Pavetti *et al*. 1988).

The name **santa lucía morotí** is also used for *Commelina diffusa* Burm. f., which roots are used in infusion as a tonic and stomachic (Michalowski 1955). Other authors mention under this same vernacular name both *C.diffusa* and *C. platyphylla*, with various uses, including diuretic and refreshing effects (decoction of the whole plant) and for vaginal and urethral washes (boiling) (Gonzalez Torres 1981). The use of aqueous extracts such as infusions, decoctions and mixes with **yerba mate** (*Ilex paraguariensis* St. Hil., Aquifoliaceae) is frequent in the Paraguayan folk medicine (Kujawska 2018, Soria *et al*. 2020).

Our research group has reported fusiform roots being sold under the name **santa lucía morotí** at street stalls in the Constitución neighborhood of the Ciudad Autónoma de Buenos Aires (Agudelo *et al.* 2022). The use of underground organs makes the botanical identification of these species extremely challenging, as taxonomic keys are primarily based on floral characteristics.

This study aims to identify the botanical species associated with the plant material sold under the name **santa lucía morotí** in informal markets within the Ciudad Autónoma de Buenos Aires, República Argentina in order to determine if local species have substituted this plant material. Additionally, the study aims to obtain anatomical, micrographic, and histochemical parameters that can assist in the species identification within a quality control context and provide guidance for future phytochemical and biological activity studies.

Materials and Methods

Plant Material Collection

Plant material was collected by acquiring fresh specimens from street vendors cited in Constitución, La Boca, Carlos Mugica, and Barrio Padre Rodolfo Ricciardelli neighborhoods. These samples were labeled with their respective vernacular names and preserved following the guidelines outlined in Arenas and Kamienkowski (2014).

Cultivation and Identification of Plant Material

Six fresh roots (n=6) were planted in 1L capacity pots with black soil in September 2019. The plants flowered between November and December 2019. Plant identification was carried out using taxonomic keys (Hassemer 2017, Hassemer 2018). A representative voucher specimen was prepared and deposited in the BAF herbarium with the accession number BAF20981.

Pharmacognosy Study

Anatomical studies were conducted by obtaining sections and double staining (Yeung *et al.* 2015) with safranin and fast green (Zarlavsky 2014). The presence of metabolites was qualitative detected using histochemical reactions to guide the search for active markers (Demarco 2023, El Babili *et al*. 2021, Ferreira *et al*. 2014, Yadav *et al*. 2021) (Table 1).

Table 1. Histochemical reactions.

Histochemical reaction	Family of compounds qualitative detected	References
Polarized light	Starch, collenchyma cell walls, calcium oxalate crystals	Johansen 1940, Zarlavsky 2014
Lugol	Starch	
Sudán III	Lipids	
Phloroglucinol/HCl	Lignin	
Cl_3Fe	Polyphenolic compounds	
AEDBE (366 nm)	Flavonoids	Wagner & Bladt 1996, Nguyen 2020
Draggendorff	Alkaloids	Mondolot-Cosson *et al*. 1997, Gómez *et al.* 2019
Vainillin/H_2SO_4	Terpenic compounds	Wagner & Bladt 1996
Anisaldehyde/H_2SO_4	Terpenic compounds	
$SbCl_3$	Saponins	Hardman & Sofowora 1972

Results

Plant Material Acquisition

Ten samples of brown, fusiform fresh roots were obtained from street vendors in the Constitución neighborhood, Carlos Mujica neighborhood, and Zavaleta neighborhood. These samples were stored following the guidelines outlined by Arenas and Kamienkowski (2014) (Figure 1A and B). The samples employed in the elaboration of transversal sections and histochemical reactions were processed fresh, since it is the best condition for these studies.

Cultivation and Identification of Plant Material

The three plants obtained from the planted fresh roots produced flowers between November 2019 and January 2020. These flowers exhibited inflorescences with white petals, consisting of a tripetalous corolla, three sterile stamens, three fertile stamens, and a curved style. These inflorescences were surrounded by a glabrous ovate bract (Figures 1C, D, and E). According to the taxonomic keys used (Hassemer 2017, Hassemer 2018), this species belongs to *Commelina platyphylla* Klotzsch ex Seub. (Commelinaceae).

Pharmacognosy Study

The characters used for the description of anatomical and morphological structures were taken from Hofreiter and Tillich (2002). In the transversal sections, a two-layered exodermis without a sclerenchyma ring is observed (Figure 2A and B). The outer cortex consists of multiple cell layers with intercellular spaces of approximately one cell diameter, while the inner cortex consists of four layers of regularly arranged cells surrounding the central cylinder (Figure 2C).

The endodermis has a single layer of cells with Casparian bands that were positively recognized with Sudan III as reddish-orange (Figure 2D) and with phloroglucinol/HCl as pink (Figure 2E), indicating the presence of cuticle and lignin, respectively, in a U-shape. These Casparian bands are not continuous around the perimeter of the endodermis. The vascular system is arranged in cords of phloem and xylem. Xylem vessels are arranged in a tetrarch manner, surrounded by lignified sclerenchyma cells that react positively to phloroglucinol/HCl (Figure 2E).

The root contains abundant starch (Figure 3A), which is ovoid or irregularly ellipsoidal in shape with an eccentric hilum, located from the central cylinder to approximately half of the total organ diameter. With the Dragendorff's reaction, alkaloids were positively recognized as reddish-brown in the outer cortex adjacent to the exodermis, (Figure 3B). The outer layer of the exodermis reacts to $FeCl_3$, indicating the presence of polyphenols recognized as dark brown. (Figure 3C). Fluorescence microscopy tests (AEDBE at 366 nm) reveal the presence of flavonoids (yellow) in the central cylinder and in the cell walls of the cortex (Figure 3D: Reagent Blank; Figure 3E: Flavonoid Reaction). Furthermore, the anisaldehyde sulfuric acid reaction for terpenoid presence is positive (orange) in the cortex (Figure 4A and B), while the vanillin sulfuric acid reaction for terpenoids is positive (reddish- brown) in idioblasts adjacent to the central cylinder (Figure 4C). With the $SbCl_3$ reaction, Saponins were positively recognized as reddish-orange in the primary cortex adjacent to the endodermis (Figure 4D).

Figure 1A and B: Detail of the acquired roots; Figure 1C, D, and E: Detail of the flowering plants.

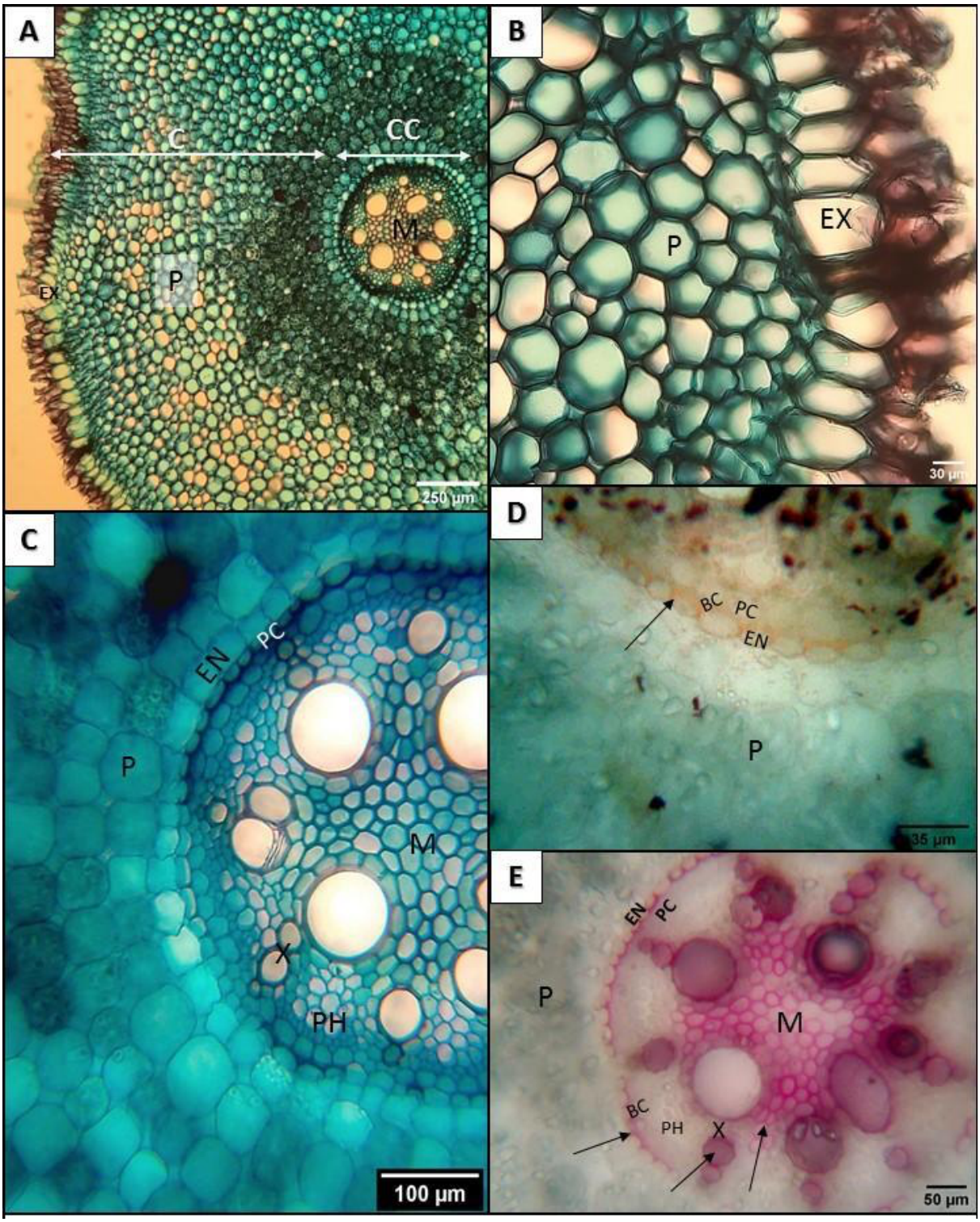

Figure 2A: Cross-section of the root; Figure 2B: Detail of the exodermis; Figure 2C: Detail of the central cylinder; Figure 2D: Positive reaction with Sudan III; Figure 2E: Positive reaction with phloroglucinol in the endodermis, xylem, and pith. (EX=Exodermis. C= Cortex. CC= Central cylinder. P = Parenchyma. EN= Endodermis. PC=Pericycle. M= Medulla. PH= Phloem. X= Xylem. BC = Casparian band)

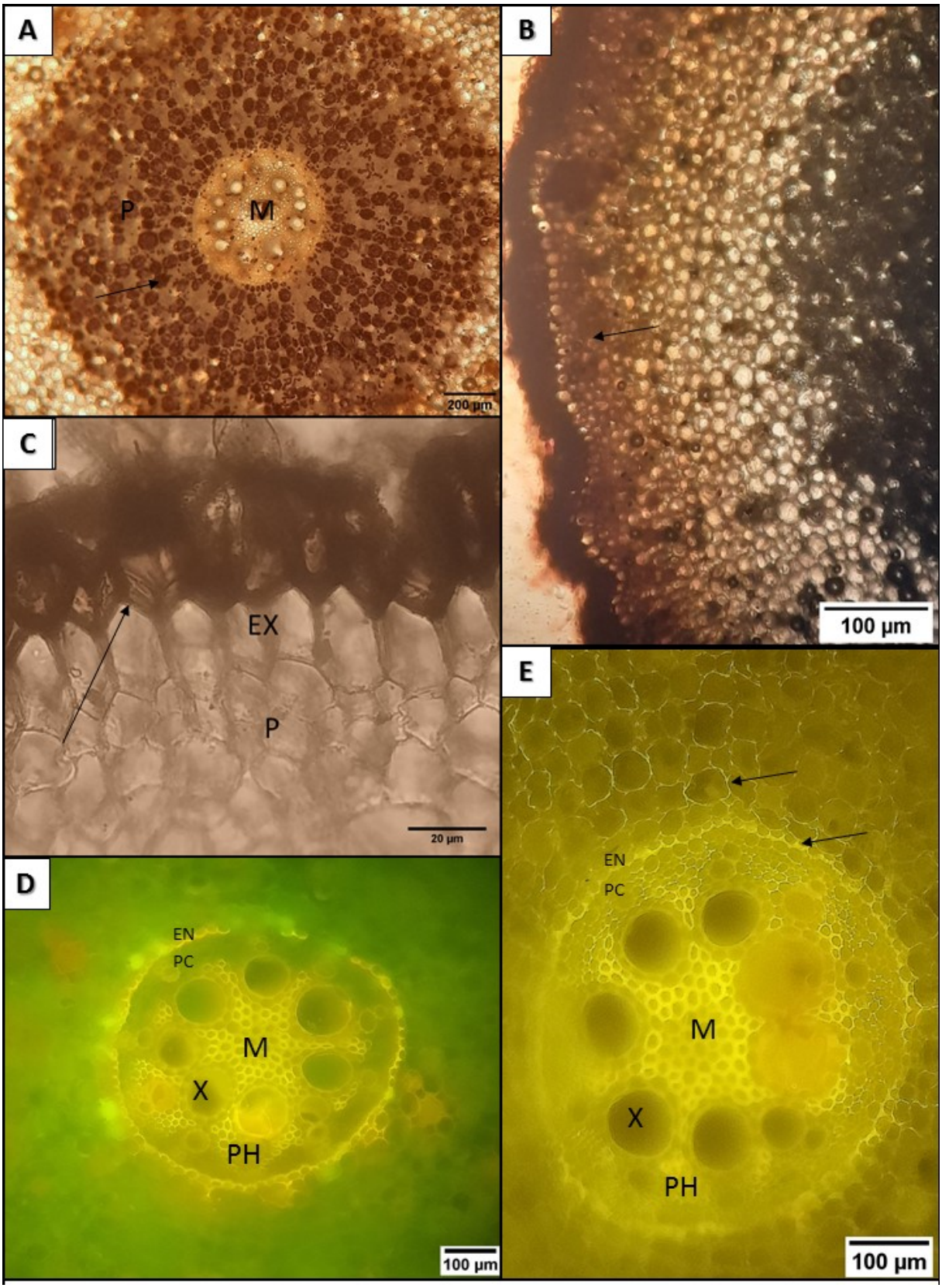

Figure 3A: Positive reaction with Lugol's solution; Figure 3B: Positive reaction with Dragendorff's reagent; Figure 3C: Positive reaction with $FeCl_3$; Figure 3D: AEDBE Blank at 366 nm; Figure 3E: Positive reaction with AEDBE at 366 nm. (P = Parenchyma. M= Medulla. EX=Exodermis. EN= Endodermis. PC=Pericycle. PH= Phloem. X= Xylem.)

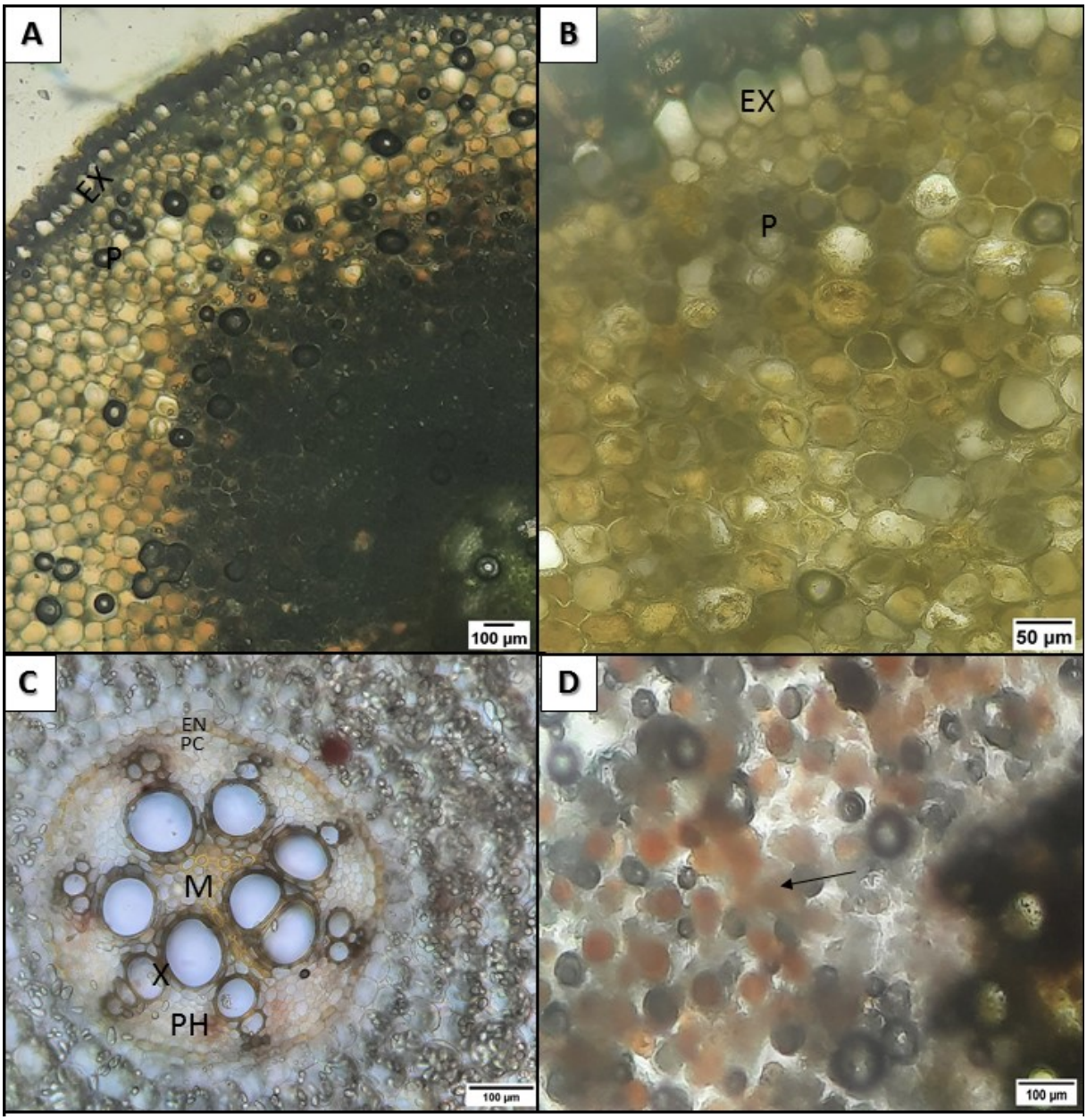

Figure 4A and B: Positive reaction with anisaldehyde sulfuric acid; Figure 4C: Positive reaction with vanillin sulfuric acid; Figure 4D: Positive reaction with $SbCl_3$. (EX=Exodermis. P = Parenchyma. M= Medulla. EN= Endodermis. PC=Pericycle. PH= Phloem. X= Xylem.)

Discussion

The World Health Organization (WHO) considers the generation of scientific evidence for the rational use of medicinal plants imperative (WHO 2013). To achieve this, it is essential to identify the botanical identity of species unequivocally. In this regard, Upton *et al* (2019) have emphasized the importance of morphological and microscopic identification methods for medicinal plants.

Given the intense flow of people and goods between the neighboring countries of Paraguay and Argentina (Bruno *et al* 2013), it is necessary to know the nature of the plant remedies used by the Paraguayan community residing in the Republic of Argentina. While it is assumed that migrant communities have a homogeneous body of knowledge due to cultural reaffirmation and inertia (Grimson 2001), there are also hybridization processes resulting from combining different cultures (Ladio & Albuquerque 2014). It is also essential to consider the possibility of a similar process occurring due to internal migrations from north western Argentinian provinces bordering Paraguay to the metropolitan area of Buenos Aires, which would raise similar hybridization processes (Pizzolitto 2006).

In addition to these cultural processes, the botanical identity of the species adds complexity to the issue. As mentioned earlier, species from the Commelinaceae family are often called **santa lucía**. However, some of them are known by the name **santa lucía morotí** ("morotí" meaning white in Guaraní), such as *T. fluminensis, C. platyphylla*, and *C. erecta*. The first two has white flowers, while the latter has blue flowers. However, in some cases, the roots are used instead of the flowering aerial parts, making difficult to determine the species. This study identified the plant material marketed in the Ciudad Autónoma de Buenos Aires under the name **santa lucía morotí** as *Commelina platyphylla* Klotzsch ex Seub. (Commelinaceae). This species is not native to the area where it was purchased. According to the literature, its southernmost distribution would be in the Province of Entre Ríos (Flora Argentina s.f.). This suggests that this species is not collected in the area and reaches the street vendors from other provinces or countries. In addition to the reports of its use in Paraguay, *C. platyphylla* has been reported to be used by the *"criollos"* in the eastern province of Formosa, which is near the border with Paraguay. Specifically, they use the bracts of the fresh flower as an ophthalmic remedy and crush the roots as a refreshing agent, mixed with cold infusions of **yerba mate** (*Ilex paraguariensis* St. Hil., Aquifoliaceae) (Anconatani 2021).

It is important to compare these findings with previously reported anatomical data. Hofreiter and Tillich (2002) conducted an intensive investigation into the anatomical characteristics of roots from species in the Commelinaceae family. These authors selected the following features: the number of cell layers in the exodermis and outer cortex, the presence of a sclerenchyma ring, the arrangement of cells in the inner cortex and vessels, and the presence of sclerenchyma in the central cylinder. Additionally, they morphologically characterized the roots as fusiform storage roots, tuberous roots, or absent. In this regard, it can be observed that *C. platyphylla* possesses fusiform storage roots with abundant starch, an exodermis with a single cell layer, an outer primary cortex with multiple cell layers and intercellular spaces, and an outer primary cortex adjacent to the central cylinder with a regular arrangement. The central cylinder has sclerenchyma in its pith, and its vessels are arranged in a star-shaped pattern.

The best described species within the *Commelina* genus in the aforementioned study are: *Commelina communis* L., *Commelina leiocarpa* Benth., and *Commelina graminifolia* Sessé & Moc. All of them have a single cell layer in the exodermis with a sclerenchyma ring. On the other hand, *Commelina benghalensis* L. does not have this ring. Regarding the endodermis, all of them have cells with U-shaped Casparian bands, and their vascular units have a star-shaped arrangement embedded in the medullary sclerenchyma. *C. platyphylla* shares with these species the U-shaped Casparian bands and the medullar sclerenchyma surrounding the vessels. The study also describes *Commelina coelestis* Willd. (syn *Commelina tuberosa* L.), which, like the species studied in this work, has fusiform storage roots and lacks a sclerenchyma ring. However, unlike *C. platyphylla*, this species has endodermis without lignification and parenchyma cells in the pith.

In the histochemical reactions, alkaloids, flavonoids, polyphenols, and saponins were characterized. The detection of these metabolites provides evidence that could support phytochemical and pharmacological research with the aim of validating their ethnomedicinal use. However, data on the phytochemistry of this species are limited. The presence of quercetin and kaempferol glycosides, as well as C-glycosides of flavonoids, has been reported in the Commelinaceae family, although the species studied in this work has not been previously investigated (Martinez & Swain 1985, Manhas & Kaul 2023). Furthermore, alkaloids (Kim *et al*. 1999) and terpenes (Khatun *et al.* 2019) have been reported in other species of this genus.

The roots of this species, in addition to the aforementioned uses, are employed in infusion or decoction as an anti-rheumatic remedy and for the treatment of dermatological conditions such as warts and ringworm or leprosy (Mereles 2001). On the other hand, its use as a refreshing agent and the mucilage from the bracts have been mentioned, particularly in the treatment of conjunctivitis (Basualdo *et al*. 2003, Basualdo *et al*. 2004, Vera 2009).

Conclusion

The botanical species to which the plant material marketed under the name **santa lucía morotí** in informal street vendors in the Ciudad Autónoma de Buenos Aires, Argentina, belongs has been successfully identified. Additionally, anatomical, micrographic, and histochemical characteristics have been obtained, enabling its diagnosis and characterization for use in quality control. It can also be affirmed that, despite the potential cultural hybridization between the ethnomedical and biomedical systems of the migrant population and the local population, there is no observed replacement with another species compared to what has been reported in the literature, at least for this plant material.

Declarations

Availability of data and materials: Not applicable

Competing interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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