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Comparative account of morphological and diagnostic characterisation of medicinal plants, *Cassia acutifolia* Delile and *Cassia obovata* Collad. leaves in Uzbekistan

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Abstract

The anatomical structure of the leaves of *Cassia acutifolia* Delile and *Cassia obovata* Collad. under the conditions of Uzbekistan was comprehensively studied, and key diagnostic features were identified. During the examination of the leaf structure, several unique characteristics were observed. The epidermis consists of thin-walled cells arranged in rows, covered by a cuticle that aids in moisture retention. Notably, anomocytic stomata were present between the epidermal cells, and beneath the epidermis, a dense layer of palisade tissue was found. This tissue is densely packed with chloroplasts arranged in two to three rows. Additionally, the presence of xylem and phloem, which are essential for water and nutrient transport, was observed. These conducting fibers are surrounded externally by sclerenchyma, providing structural support. Another distinctive feature was the presence of essential oil papillae within the epidermis, further contributing to the plant's medicinal properties. As a result of this research, several diagnostic features were identified: Anomocytic stomata on the surface, a single row of thin epidermal cells with a thin cuticle, palisade tissue rich in chloroplasts, conducting fibers composed of xylem and phloem, and the presence of calcium oxalate crystals in the epidermis. These findings highlight the specific anatomical traits that distinguish these medicinal plants.

1. Introduction

The leaf (*folium* in Latin) is recognized as one of the primary vegetative organs of higher plants, fulfilling critical functions such as photosynthesis, transpiration, and gas exchange. Moreover, the leaves of certain medicinal plants serve as valuable raw materials, as they contain a wide array of chemical compounds, including macro and microelements, essential oils, and minerals, which contribute to their therapeutic potential. A notable example of such medicinal plants is *Cassia acutifolia* Delile and *Cassia obovata* Collad., herbaceous perennials from the legume family with significant medicinal properties. These plants are commonly cultivated on irrigated lands due to their usefulness in traditional and modern medicine (Abdullaev *et al.*,2016; Yogesh Chandra Tripathi, 2012) (Figure 1).

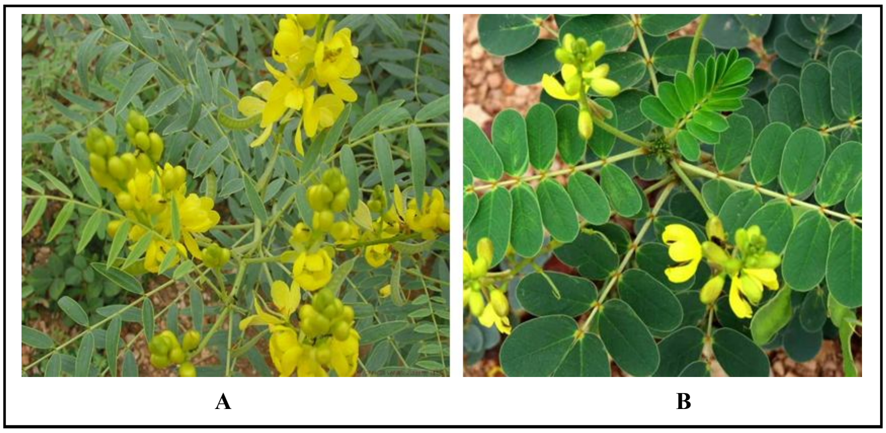

Figure 1: Overview of *Cassia* species: (A) *C. acutifolia* and (B) *C. obovata*.

C. acutifolia and *C. obovata* are well-known for their medicinal benefits worldwide, particularly in traditional healing practices. *C. acutifolia* contains sennosides, bioactive compounds that function as laxatives by stimulating bowel movements. This makes the plant effective in treating constipation and aiding in colon cleansing (Fuerst, 2012).

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Additionally, it is utilized to alleviate haemorrhoids, anal fissures, and bloating, while exhibiting antibacterial properties that support digestive health. However, caution is advised to avoid dependency resulting from prolonged use. Moreover, senna is often incorporated into detox regimens and weight loss supplements due to its ability to reduce water retention (Medicinal Plants of the World, 2016).

In contrast, *C. obovata* is primarily recognized for its cosmetic applications. It promotes scalp health, strengthens hair follicles, and controls dandruff without altering hair color, thereby serving as a natural conditioner (Wichtl, 2004). The plant also possesses anti-inflammatory and antibacterial properties, making it useful for treating minor skin conditions such as eczema, ringworm, and fungal infections. Its mild laxative effect, along with antioxidant properties, enhances its role in supporting digestive health and combating oxidative stress (Van Wyk and Wink, 2017).

In Uzbekistan, *C. acutifolia*, locally known as "sano," thrives in the country's arid climate, contributing to the sustainable use of medicinal plants in both folk and modern medicine (Namozova, 2024). It is widely employed to treat digestive issues, providing an accessible and cost-effective remedy for constipation and bowel regulation. The plant's antioxidant and detoxifying properties align with the detox regimens practised in local traditions. Furthermore, it complements Uzbekistan's broader reliance on native medicinal flora, alongside species such as licorice (*Glycyrrhiza glabra*) and ferula plants, which are used to address respiratory and gastrointestinal conditions (Amonturdiev and Holikov, 2003). Together, these plants illustrate the importance of natural remedies in the region's healthcare practices.

The leaves of *C. acutifolia* and *C. obovata* are rich in bioactive compounds, including emodin, chrysophanic acid, calcium oxalate crystals, flavonoids, phenolic compounds, and mineral cations (Ayoub, 1975). Owing to these pharmaceutical properties, both plants are widely used in modern medicine to treat a variety of conditions, such as constipation (including during pregnancy), bowel and intestinal obstruction, acute inflammatory diseases of the urinary tract, gastrointestinal disorders, and compressed hernias. They are also employed in the treatment of gastrointestinal and uterine bleeding, skin diseases, and other ailments (Fatokun*et al.,* 2017). Research on *C. acutifolia* and *C. obovata* was conducted at the Tashkent Botanical Garden, named after Acad. F.N. Rusanov of the Institute of Botany, FA of the Republic of Uzbekistan. A doctoral student from the Research Institute of Forestry of the Republic of Uzbekistan led the experiments, which aimed to explore the distribution, medicinal properties, bioecology, agricultural and medicinal significance, morphoanatomy, cultivation methods, and introduction of these medicinal plants (Figure 2).The primary objective of this study is to investigate the anatomical characteristics of the leaves of *C. acutifolia* and *C. obovata* and to identify species-specific diagnostic features.

A B C

Figure 2: General overview of plants in the experimental field. (A) Medicinal plants, (B) *C. acutifolia* and (C) *C. obovata*.

2. Materials and Methods

To study the anatomical structure of the leaves of *C. acutifolia* and *C. obovata*the samples were fixed in 70% ethanol during the flowering phase of the plants' generative period. Leaf sections were prepared using the hand-cutting method, stained with safranin, and sealed with glycerol-gelatin as per the technique described by Barykina *et al.* (2004). The primary tissues and cells of plant organs were identified following the methods of Isav (1969) and Kiseleva (1971), with the epidermis described by Zakharevich (1954) and stomatal types by Baranova (1981). Microphotographs were captured using a computerized photomicroscope equipped with a Canon A123 digital camera and a Motic B1-220A-3 microscope. Upon sectioning, the leaves of *C. acutifolia* and *C. obovata* were observed to be long-lanceolate in shape with a pink-brown coloration (Figure 3).

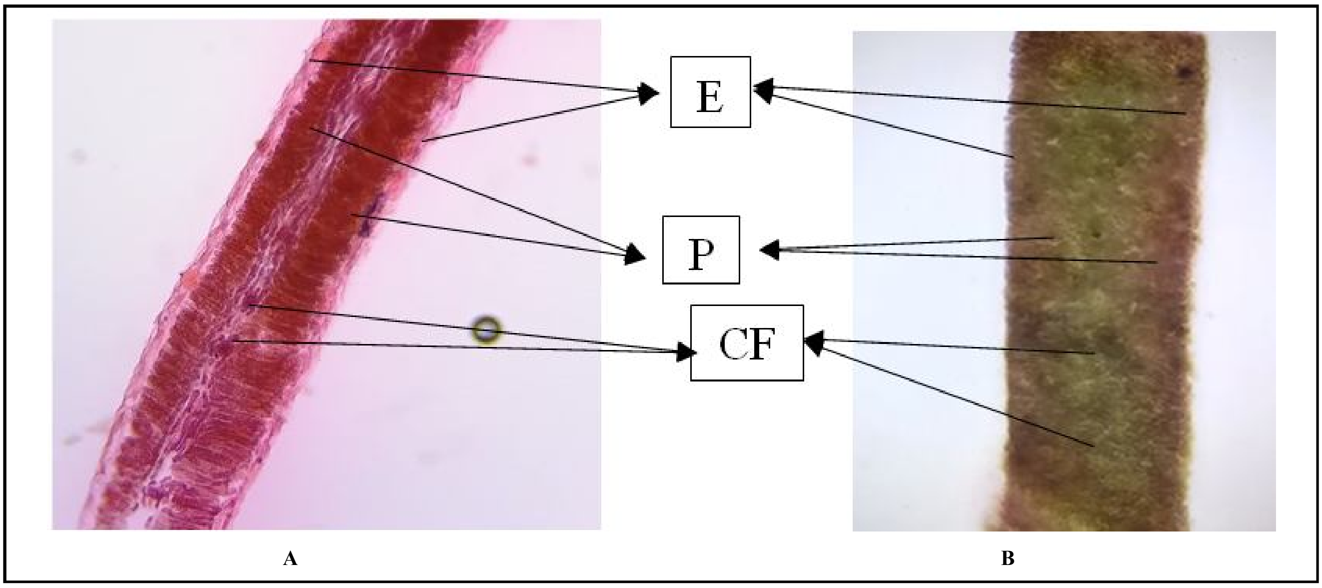

Figure 3: General cross-sectional view of leaves. (A) *C. acutifolia* and (B) *C. obovata*.
E - Epidermis, P - Palisade, CF - Conducting fibers.

3. Results

The leaf of *C. acutifolia*is characterized by a quadrangular epidermis that covers both the upper and lower surfaces. This epidermis features thin outer walls and contains a limited number of papillae or trichomes, which have root-like bases visible on both sides (Figure 2A).Within the cells of the lower epidermis, there are stomata (or leaf pores) (Figure 2B). Each stoma is surrounded by a pair of guard cells, which regulate the opening and closing of the stomata to facilitate gas exchange within the leaf. Additionally, the epidermis contains druse cells, as illustrated in Figure 4B.

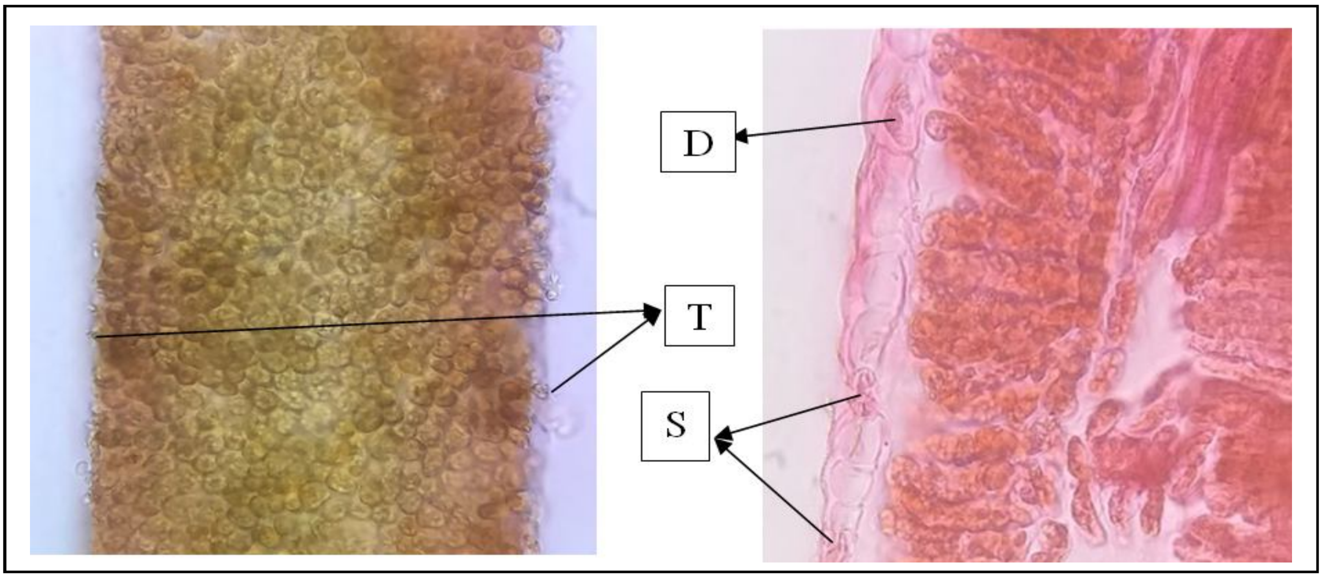

Figure 4: Transverse section of plant leaves showing papillae and mouthparts (upper) and drupes. (A) *C. obovata* and (B) *C. acutifolia*. D - Drupes, T - Trichomes, S - Stomata.

In *C. obovata,* the internal structure of the leaf is characterized by an upper and lower epidermis, both of which are covered with papillae on their outer surfaces (Figure 2). The epidermis is further protected by a thin cuticle, and both surfaces contain stomata (leaf pores) and unicellular trichomes.The mesophyll, or leaf pulp, is located between the upper and lower epidermis and consists of parenchyma cells. These parenchyma cells are divided into palisade parenchyma, which is densely packed and filled with chloroplasts, and rounded columnar parenchyma, which contains air spaces and conducting strands. The palisade parenchyma typically forms two rows beneath the upper epidermis. This arrangement indicates the plant's light-loving nature, as the presence of multiple layers enhances light absorption. The chloroplast-rich cells, particularly in the palisade tissue, contribute to the leaf's green colouration and are crucial for photosynthesis, which facilitates the synthesis of complex organic compounds. The mesophyll exhibits a dorsiventral structure; between the two layers of palisade tissue lies a series of conductive bundles responsible for the transport of water and mineral nutrients from the roots to the mesophyll cells. These conductive fibers comprise the xylem and phloem, with the xylem transporting water and minerals, while the phloem, consisting of sieve tubes and companion cells, is responsible for the transport of organic substances. Literature indicates that these conductive fibers are abundant in calcium oxalate crystals and contain phenolic compounds, such as alkaloids, flavonoids, and anthraquinones, in both the epidermis and palisade cells (Pawade and Swati, 2018). The mesophyll's dorsoventral structure is a defining characteristic of this species, which aligns with findings regarding *Cassia angustifolia* Wahl. that it belongs to a similar type within the broader classification of this group (Elaheh *et al.,* 2023). Anatomical parameters of the leaf organoids have been measured and are presented in Table 1.

Table 1: Anatomical features of the leaves of *C. acutifolia* and *C. obovata*

S.No.	Parameters	Indicators of *C. acutifolia* (μm)	Indicators of *C. obovata* (μm)
1.	Height of the epidermis	10,2 ± 0,3	11,3 ± 0,3
2.	Width of the epidermis	7,6 ± 0,2	8,7 ± 0,2
3.	Thickness of the outer wall of the epidermis	2,6 ± 0,1	2,6 ± 0,1
4.	Palisade length	13,2 ± 0,4	12,1 ± 0,4
5.	Palisade width	7,1 ± 0,2	6,2 ± 0,2

The table presents the anatomical measurements of the epidermis and palisade tissue for both species. The height of the epidermis is recorded as 10.2 ± 0.3 μm for *C. acutifolia* and 11.3 ± 0.3 μm for *C. obovata*. The width of the epidermis measures 7.6 ± 0.2 μm for *C. acutifolia* and 8.7 ± 0.2 μm for *C. obovata*, while the thickness of the outer wall is 6 ± 0.1 μm for both species. In terms of palisade tissue, the length is reported as 13.2 ± 0.4 μm for *C. acutifolia* and 12.1 ± 0.4 μm for *C. obovata*, with widths measuring 7.1 ± 0.2 μm and 6.2 ± 0.2 μm, respectively. These findings indicate that *C. acutifolia* and *C. obovata* share similar anatomical characteristics, as evidenced by their closely aligned measurements. This suggests that both species belong to the same category, demonstrating their shared botanical features.

4. Discussion

The anatomical structure of the leaves of *C. acutifolia* and *C. obovata* has not been extensively studied; however, research on other species within the *Cassia* genus provides valuable insights. For example, *Senna alata*, commonly found in amazonian grasslands, has been noted for its medicinal properties. Anatomical and histological analyses of *S. alata* leaves revealed two types of trichomes, a dorsiventral mesophyll, crystalline calcium oxalate in the epidermis, and an abaxial epidermis rich in papillae (Sãvulescu *et al.,* 2018). Further literature highlights a quantitative microscopy study conducted to determine the palisade coefficient of the leaf of *Cassia mimosoides* L. (Gautam Fichadiya and Harisha, 2017). This investigation focused on the percentage of palisade tissue within the leaf mesophyll, utilizing new methods that may contribute to future standardization efforts. Additionally, morphological and anatomical studies of *Senna alexandrina* Mill. have revealed notable characteristics of the plant. Specifically, the presence of 4-5 rows of sclerenchyma tissue located atop the phloem in conducting fibers was established as a diagnostic feature, along with the observation that the conducting fibers comprise both large medial and small lateral fibers (Shmygareva *et al.,*2015). *Senna alexandrina* (synonymous with *C. acutifolia*, *C. angustifolia* Vahl., and *C. alexandrina*) is a perennial xerophytic plant native to the semi-arid and arid zones of India. The high demand for its leaves has encouraged farmers to cultivate this crop, characterized by its ease of cultivation, minimal care requirements, and drought tolerance (Ashish Kumar and Lal, 2022). Pharmacognostic studies have recognized senna as a natural laxative widely recommended in Central Asia and included in the pharmacopoeias of countries such as India, the USA, the UK, and Germany. Its efficacy stems from the presence of polyphenols, glucosides, sennazine, and other biologically active substances(Haifa *et al.,* 2022).

5. Conclusion

Through, a comprehensive analysis of existing literature, we found extensive studies on the therapeutic properties, medicinal applications, economic significance, chemical composition, and phytochemical profiles of various species. However, the anatomical structure of the leaves, particularly in *C. acutifolia*, remains largely unexplored. This underscores the importance of identifying plants based on their taxonomic characteristics. Our research revealed that the leaves of *C. acutifolia* contain significant bioactive compounds, such as anthraquinone, glycosides, and sennosides, which contribute to the plant's medicinal properties.

In our anatomical study, we observed several unique structural features: The leaves exhibit a thin-walled epidermis arranged in rows, which is complemented by a cuticle that helps retain moisture. Notably, anomocyte orifices were identified within the epidermis, facilitating gas exchange. Beneath the epidermis lies a dense arrangement of palisade tissues rich in chloroplasts, essential for efficient photosynthesis. The vascular system is comprised of conductive fibers that include both the xylem and phloem, with the phloem being externally surrounded by sclerenchyma, providing additional structural support. Furthermore, the presence of papillae secreting essential oils highlights the plant's unique anatomical characteristics.The diagnostic features identified in our study include an upper epidermis of the anomocyte type, characterized by a single-layered epidermis with a thin cuticle, palisade tissues abundant in chloroplasts, and conductive fibers composed of both xylem and phloem. These findings not only enhance our understanding of *C. acutifolia* but also emphasize the necessity for further anatomical investigations of this species and other related plants.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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