A Comparative Pharmacognostic Evaluation of the Leaves of Tulsi (Ocimum basilicum L.) and (Ocimum sanctum L.)

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ABSTRACT

Background: Pharmacognostic evaluation plays a key role in standardizing herbal medicines, ensuring their efficacy and safety. This study aimed to conduct a detailed macroscopic and microscopic analysis of the leaves of Ocimum basilicum L. (Sweet Basil) and Ocimum sanctum L. (Holy Basil).

Methods: Leaves of O. basilicum L. and O. sanctum L. were subjected to macroscopic and microscopic examinations. Macroscopic analysis measured leaf length and described their shapes. Microscopic examination involved observing the leaf epidermis and mesophyll structure.

Results: O. basilicum Linn. leaves typically measured 4–8 cm in length, displaying an elliptic ovate shape, while O. sanctum L. leaves were smaller, measuring about 2–2.5 cm and exhibiting an ovate shape. Microscopic examination revealed distinct differences between the two species: O. sanctum L. displayed a square-shaped epidermis with parenchymatous cells and sclerenchyma patches, whereas O. basilicum L. showcased a dorsiventral mesophyll structure with stomata and glandular trichomes.

Conclusion: The macroscopic and microscopic characteristics identified in this study provide valuable insights for the standardization, authentication, and quality control of herbal medicines containing O. basilicum L. and O. sanctum L. These findings contribute to ensuring the efficacy and safety of herbal formulations derived from these plants.

1. INTRODUCTION

The Ocimum genus, a prominent member of the Lamiaceae family, holds significant importance in various fields, especially in Ayurveda, the traditional Indian system of medicine. While the exact number of species within this genus remains uncertain, Ocimum basilicum L. (Sweet Basil) and Ocimum sanctum L. (Holy Basil) stand out for their therapeutic potential and historical significance in Ayurvedic practices. Bhavaprakash Nighantu[1] has described the properties of Tulsi in Pushpa varga.[2] Raj Nighantu has described 18 synonyms of Tulsi.[3]

Tulsi (Ocimum sp.) is renowned for its effectiveness in treating a range of ailments, including skin disorders, pain in the flank region, cough, respiratory disorders, and fever.

Surpala acknowledges the remarkable attributes of Tulsi plants, renowned for their medicinal benefits and spiritual significance. In his writings, he offers guidance on cultivating, caring for, and harnessing the therapeutic properties of Tulsi for physical well-being and spiritual practices.[4]

O. basilicum L., native to the warm regions of the Indo-Malayan territories, is valued not only for its aromatic fragrance but also for its diverse uses in Ayurveda. Its essential oils and swaras (juice) extracted from leaves are integral in treating shwas (respiratory) and digestive issues, shirashula (headaches), Kasa (cough), gastrointestinal disturbances, and even Jwara (fever). In addition, its seeds, known for their mucilaginous properties, effectively relieve chronic dysentery and alleviate constipation, demonstrating its multifaceted therapeutic benefits.

Tulsi (Holy Basil) revered in Ayurveda for its sacred and medicinal qualities, holds a special place in Indian culture. Considered to
have divine blessings, it symbolizes health and well-being. Its pharmacological benefits, including antioxidant, antidiabetic, cardioprotective, and immunostimulant properties, align with Ayurvedic principles.

Although *O. basilicum* L. and *O. sanctum* L. share heritage within Ayurvedic medicine, their histological and pharmacognostic differences remain relatively unexplored. This article aims to illuminate these distinctions through a comprehensive comparative analysis (Tables 1 and 2), exploring their intricate anatomical structures and pharmacological constituents. By elucidating their unique characteristics and therapeutic potentials within the framework of Ayurveda, we seek to provide valuable insights for future research and enhance the utilization of these botanical treasures in traditional and modern healing practices.

2. MATERIALS AND METHODS

2.1. Collection of the Sample

Fresh leaves of *O. basilicum* L. and *O. sanctum* L. were collected from the campus of Shri Dhanwantry Ayurvedic College and Hospital, Chandigarh (Herbal Garden) in February 2024. The leaves were washed under running tap water and blotted dry.

2.2. *Panchendriya pareeksha* (Organoleptic Examination) of the Fresh Drug

Organoleptic characters of the leaves of Tulsi by Shravanendriya (Auditory), Sparshanendriya (Tactile), Chakshurendriya (Visual), Rasanendriya (Taste) and Ghranendriya (Odour) has been evaluated (Table 3).

2.3. Macroscopic and Microscopic Evaluation

Macroscopic characters such as shape, size, and margins were recorded as per visual observation. For the micrometric evaluation, the fresh leaves were used. Sections were visualized under Compound microscope after slide preparation by transverse sectioning using dissecting kit.

3. RESULTS AND DISCUSSION

3.1. Transverse Section of Leaves of *O. sanctum* L.

3.1.1. Macroscopic features

*Tulsi* is a highly branched, small herb, typically reaching heights of 30–75 cm. All parts of the plant are utilized in medicine, particularly the fresh and dried leaves. The leaves are oblong and pointed, with a smooth or slightly toothed edge, and they are covered in fine hairs and tiny glandular dots. They are green and possess an aromatic fragrance with a mildly spicy taste. The flowers of *tulsi* are purplish and arranged in clusters called racemes. The nutlets of the plant are slightly flattened and round, ranging from pale brown to red in color. The seeds are reddish-black and also round in shape.[9]

3.2. Microscopic Features

The *tulsi* leaf exhibits dorsiventral structure. Stomata, predominantly found on the lower surface, are of the diacytic type [Figure 1a]. The epidermal cells have undulating walls and a thin cuticle. Beneath the upper epidermis, there is a single layer of elongated palisade cells [Figure 2b]. The mesophyll comprises four to six layers of spongy parenchymatous cells with intercellular spaces and oil glands [Figure 1c]. The leaf features both covering and glandular trichomes. The covering trichomes are uniseriate, multicellular, and often elongated (100–400 μm). Glandular trichomes are sessile, with a radiate head composed of eight cells and a common cuticle, forming a bladder-like structure characteristic of the Labiatae family. In addition, a few glandular trichomes with a unicellular stalk and a spherical unicellular head can be observed. In the midrib region, collenchymatous cells are present below both the upper and lower epidermises. Xylem bundles are arranged in an arc, with the phloem located on the dorsal side of the xylem [Figure 1d].[6]

3.3. Transverse Section of Leaves of *O. basilicum*

3.3.1. Macroscopic features

The leaves are arranged simply, in opposite pairs that cross at right angles (decussate), and are shaped like ellipses or lanceheads, with pointed tips and wedge-shaped bases. They measure 4–8 cm in length and 2–3 cm in width, with margins that are typically smooth but may be slightly serrated. The upper surface is nearly hairless (glabrous) and a bright green color, while the petioles are 6–12 mm long. The leaves emit a pleasantly aromatic odor and have a spicy, slightly salty taste.[7]

3.3.2. Microscopic features

The transverse section (TS) of the leaf, passing through the midrib, resembles a pot shape, with a convex lower surface and an almost flat upper surface. Beneath the upper surface, there are 4–5 rows of collenchymatous tissue [Figure 2a]. The lower side appears obscure, with a centrally located meristele consisting of 8–12 uniseriate rows of vessels, parenchyma, and an arc of phloem [Figure 2b]. The epidermis of the leaf blade is grooved in places, housing numerous sessile glandular trichomes with 8-celled heads, as well as others with unicellular or multicellular stalks and one, two, or many-celled heads [Figure 2c]. In addition, a few simple, multicellular, uniseriate trichomes are mostly located over the costae on both surfaces. The mesophyll tissue is made up of 7–10 rows of spongy parenchyma and 1–2 rows of radially arranged cells of poorly developed palisade tissue [Figure 2d]. Traces of meristoles protected by a parenchymatous sheath, traverse throughout the mesophyll tissue. In surface view, the cells of both epidermises are wavy, with the lower epidermis having more sinuous walls and containing diacytic stomata.[7]

The number of glandular and tectorial trichomes per surface unit is decreased from the base to the top of the stem. The tectorial trichomes are uniseriate, consisting of three cells, with an acute apex and a bi-or multicellular basis.[8]

4. CONCLUSION

The pharmacognostic evaluation of the leaves of *O. basilicum* L. (Sweet Basil) and *O. sanctum* L. (Holy Basil) provides valuable insights into their macroscopic and microscopic characteristics. In conclusion, the microscopic transverse sections of *O. sanctum* L. and *O. basilicum* L. leaves exhibit notable differences in various features.[9] While both species display wavy epidermal cells with diacytic stomata,[10] *O. sanctum* L. typically has 2–4 rows of collenchyma, a centrally located meristele composed of 8–12 uniseriate vessels, and a mesophyll tissue with 7–10 rows of spongy parenchyma.[11] In contrast, *O. basilicum* L. presents 4–5 rows of collenchyma, a similar central meristele composition, and a wider zone of spongy parenchyma extending up to the area of meristele.[12] In addition,[13] the trichome characteristics differ, with *O. sanctum* L.
having glandular trichomes with 4-celled heads, while *O. basilicum* L. exhibits multicellular curved trichomes and various other types. These variations in microscopic features provide valuable insights into the distinct anatomical structures of these two *Ocimum* species.\(^{[14]}\)

These findings contribute to the standardization and authentication of *O. basilicum* L. and *O. sanctum* L. for quality control in herbal medicine formulations. This study enhances our understanding of these medicinal plants and their potential therapeutic applications in traditional and modern healing practices. Further research into the pharmacological properties and therapeutic benefits of these species can provide additional insights into their medicinal value and expand their use in healthcare.

5. ACKNOWLEDGMENT
Nil.

6. AUTHORS’ CONTRIBUTIONS
All the authors contributed equally to the design and execution of the article.

7. FUNDING
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8. ETHICAL APPROVALS
This study does not require ethical clearance as it is an experimental study.

9. CONFLICTS OF INTEREST
Nil.

10. DATA AVAILABILITY
This is an original manuscript, and all data are available for only review purposes from the principal investigators.

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REFERENCES


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Figure 1: (a-d) Microscopic features of Ocimum sanctum

Figure 2: (a-d) Microscopic features of Ocimum basilicum
### Table 1: Morphological difference between the leaves of *Ocimum basilicum* L. and *Ocimum sanctum* L.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th><em>Ocimum basilicum</em> L.</th>
<th><em>Ocimum sanctum</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>4–8 cm in length</td>
<td>2–2.5 cm in length</td>
</tr>
<tr>
<td>Shape</td>
<td>Elliptic ovate shape with a pointed apex and a slightly rounded base</td>
<td>Ovate or elliptic shape, with a pointed apex and a slightly tapered base</td>
</tr>
<tr>
<td>Color and texture</td>
<td>Bright green to Purplish-green</td>
<td>Dark green with purple-tinged veins</td>
</tr>
<tr>
<td>Leaf arrangement</td>
<td>Opposite</td>
<td>Opposite</td>
</tr>
<tr>
<td>Leaf type</td>
<td>Simple</td>
<td>Simple</td>
</tr>
<tr>
<td>Venation</td>
<td>Reticulate</td>
<td>Reticulate</td>
</tr>
<tr>
<td>Margin</td>
<td>Smooth or slightly serrated</td>
<td>Serrated or toothed</td>
</tr>
</tbody>
</table>

### Table 2: Microscopic differences between the leaves of *Ocimum basilicum* L. and *Ocimum sanctum* L.

<table>
<thead>
<tr>
<th>Features</th>
<th><em>Ocimum basilicum</em> L.</th>
<th><em>Ocimum sanctum</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collenchyma layers</td>
<td>2–4 rows</td>
<td>4–5 rows</td>
</tr>
<tr>
<td>Vascular bundle composition</td>
<td>Central meristele composed of 8–12 uniseriate vessels, parenchyma, and phloem</td>
<td>Central meristele composed of 8–12 uniseriate vessels, parenchyma, and phloem</td>
</tr>
<tr>
<td>Mesophyll tissue composition</td>
<td>7–10 rows of spongy parenchyma and 1–2 rows of radially arranged cells of ill-developed palisade tissue</td>
<td>Wide zone of spongy parenchyma extending up to the area of meristele</td>
</tr>
<tr>
<td>Epidermis features</td>
<td>Wavy cells with diaecytic stomata</td>
<td>Wavy cells with diaecytic stomata</td>
</tr>
<tr>
<td>Trichome characteristics</td>
<td>Glandular trichomes with 4-celled heads, some with single-cell stalks</td>
<td>Multicellular curved trichomes, simple multicellular uniseriate trichomes, sessile glandular trichomes with 8-celled heads, and others with multicellular stalks and one, two, or many-celled heads</td>
</tr>
</tbody>
</table>

### Table 3: The Organoleptic evaluation of the leaves of the fresh drug *O. basilicum* L. and *Ocimum sanctum* L.

<table>
<thead>
<tr>
<th>Pareeksha (Examination)</th>
<th><em>Ocimum basilicum</em> L.</th>
<th><em>Ocimum sanctum</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shravanendriya (Auditory)</td>
<td>No characteristic sound</td>
<td>No characteristic sound</td>
</tr>
<tr>
<td>Sparshanendriya (Tactile)</td>
<td>Smooth or sightly wrinkled texture</td>
<td>Smooth</td>
</tr>
<tr>
<td>Chakshurendriya (Visual)</td>
<td>Bright Green- Purplish green</td>
<td>Dark Green with Purple-tinged veins</td>
</tr>
<tr>
<td>Rasanendriya (Taste)</td>
<td>Bitter, Pungent</td>
<td>Bitter, Pungent</td>
</tr>
<tr>
<td>Ghranendriya (Odour)</td>
<td>Sweet, Aromatic</td>
<td>Spicy, Aromatic</td>
</tr>
</tbody>
</table>