# Standardization and Evaluation of *Clerodendrum viscosum* Leaves Using Pharmacognostic and Physicochemical Parameters

**Akila Sukumaran[1], Vivek[2], Ansa Mathew[3]**

[1]Research Scholar, Institute of Pharmacy, Shri Jagdishprasad Jhabarmal Tibrewala University, Vidyanagari, Jhunjhunu, Rajasthan – 333001, India

[2]Institute of Pharmacy, Shri Jagdishprasad Jhabarmal Tibrewala University, Vidyanagari, Jhunjhunu, Rajasthan – 333001, India.

[3]Dr. Joseph Marthoma Institute of Pharmaceutical Sciences and Research, Kerala, India.

*Correspondence: akhilasuku86@gmail.com

**Abstract**

The present study was undertaken to establish the pharmacognostic and physicochemical standards of Clerodendrum viscosum leaves to ensure their identity, purity, and quality for future herbal and pharmacological applications. Fresh and healthy leaves were collected from Kasaragod district, Kerala, and were authenticated through standard botanical procedures. The plant material was carefully cleaned, shade-dried, and powdered to obtain a uniform sample suitable for further analysis. Pharmacognostic evaluation included detailed macroscopical, microscopical, and powder microscopic studies. Macroscopical analysis revealed characteristic features such as ovate leaves with dentate margins, hairy surfaces, and a distinct odor. Microscopic examination confirmed a typical dorsiventral leaf structure with well-developed palisade and spongy parenchyma, anomocytic stomata, multicellular trichomes, and a prominent bicollateral vascular bundle. Powder microscopy further supported the identity by showing epidermal cells, lignified xylem fibers, calcium oxalate crystals, and both covering and glandular trichomes.

Quantitative microscopy provided standard leaf constants, including vein islet number, stomatal number, stomatal index, and palisade ratio, which serve as reliable parameters for authentication. Physicochemical evaluation was performed according to WHO and pharmacopoeial guidelines. The total ash, water-soluble ash, and acid-insoluble ash values indicated minimal contamination and good sample purity. Extractive values suggested the presence of both polar and moderately polar phytoconstituents. Moisture content was found to be low, indicating good stability and reduced risk of microbial spoilage. Additional parameters such as foaming index, swelling index,

foreign organic matter, and crude fiber content further confirmed the quality and consistency of the plant material. Overall, the results of this study provide comprehensive pharmacognostic and physicochemical standards for Clerodendrum viscosum leaves. These findings can serve as a valuable reference for the identification, quality control, and standardization of this medicinal plant in future research and herbal drug development.

**Keywords:** Clerodendrum viscosum, pharmacognostic evaluation, physicochemical analysis, microscopy, powder microscopy, leaf constants, ash values, extractive values, quality control, herbal drug standardization, medicinal plants, WHO guidelines.

## 1. Introduction

Medicinal plants have served as a cornerstone of healthcare systems across the world for thousands of years and continue to be a major source of therapeutic agents in both traditional and modern medicine. Even today, plant-derived compounds contribute significantly to the development of new drugs, especially in areas such as anti-inflammatory, antimicrobial, anticancer, and antioxidant therapies. According to the World Health Organization (WHO), nearly 80% of the population in developing countries relies on herbal medicines for primary healthcare needs [1]. This widespread use highlights the importance of medicinal plants not only as therapeutic agents but also as valuable resources for pharmaceutical research. However, with the growing global demand for herbal products, issues related to quality, safety, efficacy, and authenticity have become increasingly important. Herbal drugs are often subjected to adulteration, substitution, and contamination due to improper identification, collection, and processing practices. Such inconsistencies may significantly affect their therapeutic efficacy and safety profile. Therefore, standardization of medicinal plants through pharmacognostic and physicochemical evaluation is essential to establish their identity, purity, and quality [2]. These parameters act as fundamental tools in the detection of adulterants and in ensuring reproducibility and consistency in herbal drug formulations.

*Clerodendrum viscosum* (Family: Lamiaceae) is a medicinal shrub widely distributed in tropical and subtropical regions, particularly in India, Bangladesh, and Southeast Asia. The plant is commonly known for its strong odor and characteristic morphological features. Traditionally, it has been extensively used in various indigenous systems of medicine for the treatment of numerous ailments such as skin infections, wounds, inflammation, fever, bronchial disorders, and gastrointestinal disturbances [3]. The leaves of the plant are especially recognized for their

therapeutic importance and are frequently employed in herbal preparations. Phytochemical investigations of Clerodendrum viscosum have revealed the presence of a wide range of bioactive compounds, including flavonoids, phenolic acids, terpenoids, steroids, alkaloids, and glycosides. These phytoconstituents are known to contribute to the diverse pharmacological activities exhibited by the plant [4]. Several experimental studies have demonstrated that the leaf extracts possess significant antimicrobial, antioxidant, anti-inflammatory, analgesic, and antipyretic properties [5,6]. These findings strongly support its traditional medicinal uses and highlight its potential as a source of bioactive therapeutic agents. In addition to phytochemical and pharmacological studies, some reports have also explored the biological activities of the plant, including hepatoprotective, wound healing, and cytotoxic effects. Despite these promising findings, the majority of previous research has primarily focused on the biological and chemical aspects of the plant, with comparatively limited emphasis on its pharmacognostic standardization [7]. Proper pharmacognostic evaluation, including macroscopical, microscopical, and powder microscopic analysis, is essential for the accurate identification and authentication of crude plant materials.

Microscopic characterization plays a crucial role in distinguishing closely related species and detecting adulteration. Features such as stomatal type, trichome structure, vascular arrangement, and presence of calcium oxalate crystals serve as reliable diagnostic markers. Quantitative microscopy, including parameters such as stomatal index, vein islet number, and palisade ratio, provides numerical standards that can be used for quality control and comparison [2]. Furthermore, physicochemical parameters such as ash values, extractive values, moisture content, foaming index, swelling index, and crude fiber content are widely used to assess the purity, composition, and stability of plant materials. Ash values help in determining the presence of inorganic impurities such as sand and soil, while extractive values provide an estimate of the amount of active constituents present in different solvents. Moisture content is a critical factor influencing the shelf life and susceptibility to microbial contamination [8]. Despite the availability of scattered information, there is still a lack of a comprehensive and integrated study that combines pharmacognostic, quantitative microscopic, and physicochemical evaluation of Clerodendrum viscosum leaves. This gap in knowledge may hinder the proper identification and standardization of the plant material, thereby affecting its quality and therapeutic consistency. The novelty of the present study lies in its systematic and detailed approach to establishing pharmacognostic

standards for Clerodendrum viscosum leaves. Unlike previous studies, this work integrates multiple evaluation techniques, including macroscopical, microscopical, powder microscopy, quantitative microscopy, and physicochemical analysis, in accordance with WHO and pharmacopoeial guidelines. This comprehensive profiling provides a reliable scientific framework for the authentication and quality control of the plant material.

The central hypothesis of this study is that a detailed and systematic pharmacognostic and physicochemical evaluation of Clerodendrum viscosum leaves will generate reproducible diagnostic features and standardized values that can serve as reference parameters for quality assessment. It is further hypothesized that these parameters will help in detecting adulteration, ensuring purity, and maintaining consistency in herbal formulations derived from this plant.

Therefore, the present investigation was undertaken to establish detailed pharmacognostic and physicochemical standards for Clerodendrum viscosum leaves. The findings of this study are expected to provide a strong scientific basis for the identification, authentication, and quality control of this medicinal plant, thereby supporting its safe and effective use in herbal medicine and future pharmacological research.

## 2. MATERIALS AND METHODS

### 2.1 Plant Collection, Authentication, and Processing

Fresh leaves of Clerodendrum viscosum were collected from Kasaragod district, Kerala, India, during October. Healthy, disease-free plant material was selected to ensure quality. Collection was carried out during early morning hours to minimize environmental stress and preserve phytoconstituents [9]. The collected leaves were washed thoroughly with running water followed by distilled water to remove impurities. The plant was authenticated by a qualified taxonomist, and a voucher specimen was deposited in the herbarium for future reference [10]. The leaves were shade-dried at room temperature until constant weight was achieved, then powdered using a mechanical grinder and passed through a 40-mesh sieve. The powdered material was stored in airtight containers for further analysis [11].

### 2.2 Pharmacognostic Evaluation

Macroscopical examination of the leaves was carried out to evaluate morphological characteristics such as size, shape, color, odor, taste, venation, and surface texture, and these features were compared with standard botanical descriptions for proper identification [12]. For microscopical evaluation, transverse sections (T.S.) of fresh leaf, petiole, stem, and root were prepared using

free-hand sectioning techniques, stained with suitable reagents like safranin and fast green, and examined under a microscope to observe anatomical features including epidermis, vascular bundles, trichomes, and stomata [13,14]. In addition, powder microscopy was performed by treating the powdered leaf material with appropriate reagents and observing diagnostic features such as epidermal cells, lignified xylem fibers, calcium oxalate crystals, and trichomes [15]. Furthermore, quantitative microscopy was conducted to determine parameters such as stomatal number, stomatal index, vein islet number, vein termination number, and palisade ratio, where multiple readings were recorded and average values were calculated to ensure accuracy and reliability [16].

**2.3 Physicochemical Evaluation**

Physicochemical analysis of the plant material was carried out in accordance with WHO and pharmacopoeial guidelines to assess its quality and purity [17]. The determination of ash values, including total ash, water-soluble ash, acid-insoluble ash, and sulphated ash, was performed by incineration of the powdered drug to evaluate the presence of inorganic impurities and contamination [18]. Extractive values were determined using solvents such as water, alcohol, and ether by maceration, followed by filtration and evaporation to dryness, and the percentage yield was calculated to estimate the amount of active constituents [19]. Moisture content was evaluated using the loss on drying method, where the sample was dried at a controlled temperature until a constant weight was achieved [20]. The foaming index was determined to assess the presence of saponins by preparing a decoction, shaking it, and measuring the height of the foam produced [21]. The swelling index was measured by soaking the plant material in water and observing the increase in volume, indicating the presence of mucilage and polysaccharides [22]. In addition, foreign organic matter was evaluated by separating and calculating the percentage of extraneous materials present in the sample to ensure purity [23]. Finally, crude fiber content was determined through acid and alkaline digestion followed by incineration, providing information on the structural components such as cellulose and lignin present in the plant material [24].

**3. Results**

**3.1 Plant Collection and Authentication**

The leaves of Clerodendrum viscosum were successfully collected, authenticated, and processed. The plant material was found to be fresh, healthy, and free from contamination. Shade drying

preserved its quality, and the powdered drug showed a greenish-brown color with uniform particle size, confirming its suitability for further study (Table 3.1)

**Table 1:** Details of plant collection, authentication, and processing of *Clerodendrum viscosum* leaves

| Parameter | Observation |
|---|---|
| Plant name | *Clerodendrum viscosum* Vent. |
| Family | Lamiaceae |
| Collection site | Beka, Kasaragod District, Kerala |
| Collection period | October 2023 |
| Plant part used | Leaves |
| Physical condition | Fresh, healthy, disease-free |
| Drying method | Shade-drying |
| Powder color | Greenish-brown |
| Particle size | Uniform (40-mesh) |
| Storage condition | Airtight, moisture-proof container |
| Authentication | Confirmed; voucher specimen deposited |

### 3.2 Pharmacognostic Evaluation

#### 3.2.1 Macroscopical Evaluation

Macroscopical examination revealed characteristic features such as ovate leaves, dentate margins, hairy surfaces, and reticulate venation. These features confirmed the identity of the plant material (Figure 2).

Figure 1: Fresh leaves of *Clerodendrum viscosum* Vent. Showing ovate shape, dentate margin, and hairy surface

3.2.2 Microscopical Evaluation

Microscopic analysis showed a typical dorsiventral leaf structure with well-developed palisade and spongy parenchyma, anomocytic stomata, multicellular trichomes, and a bicollateral vascular bundle, confirming the authenticity of the plant (Figure 2)

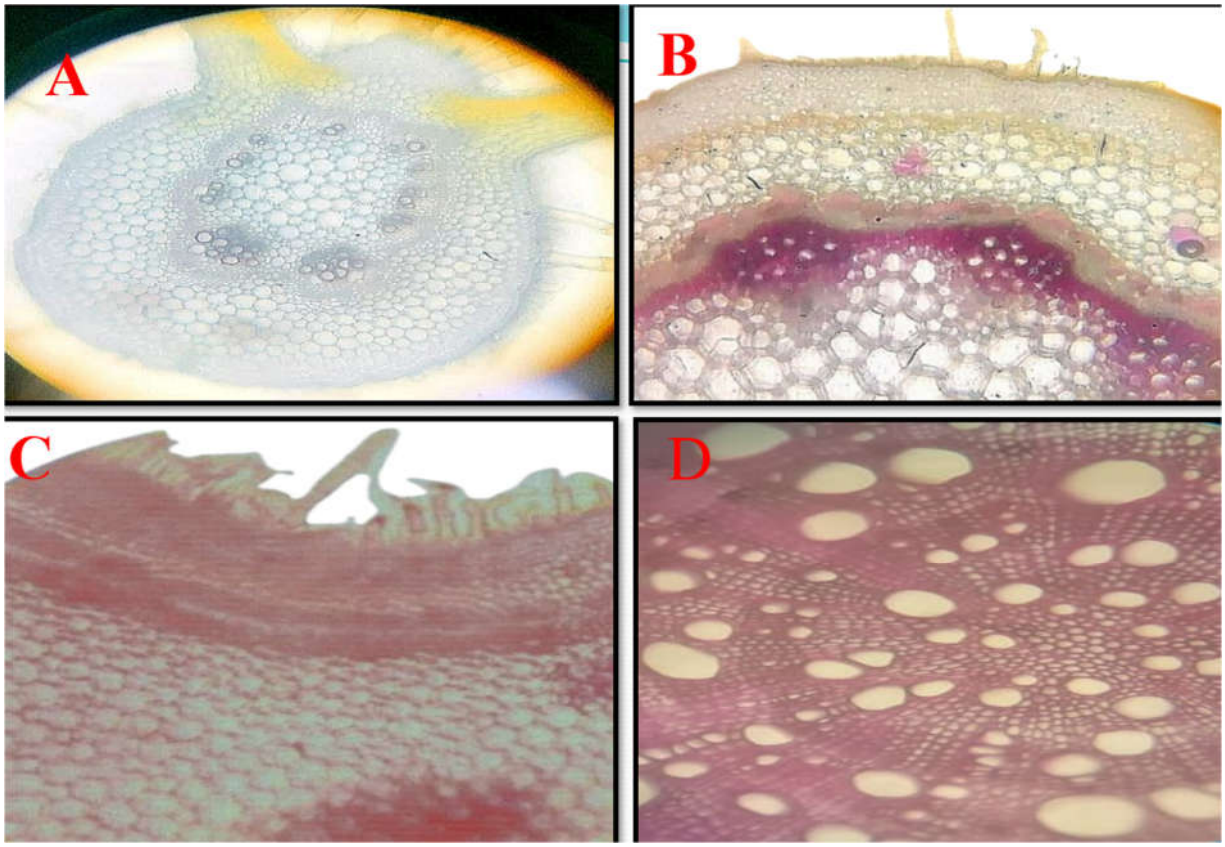


**Figure 2:** Microscopic histological sections of *Clerodendrum viscosum* and related parts showing anatomical features: (A) Histology of leaf displaying dorsiventral structure; (B) Transverse section (T.S.) of petiole of *Clerodendrum viscosum* ; (C) Transverse section (T.S.) of stem of *Clerodendrum viscosum* (D) Transverse section (T.S.) of root of *Clerodendrum viscosum* illustrating characteristic vascular arrangement and cellular organization.

**3.2.3 Powder Microscopy**

Powder microscopy revealed diagnostic features such as epidermal cells, lignified xylem fibers, calcium oxalate crystals, and trichomes, which further supported the identification of the crude drug (Figure 3).

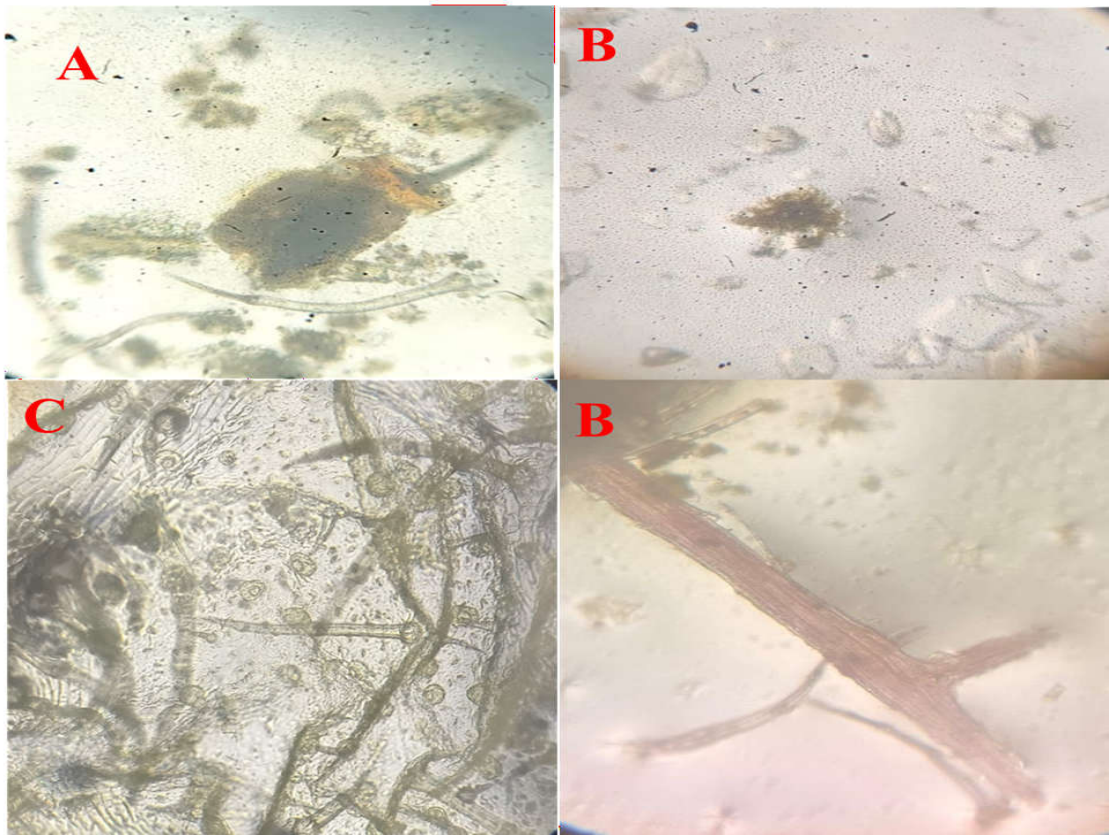


**Figure 3.** Powder microscopy of *Clerodendrum viscosum* leaf powder showing (A) epidermal cells and unlignified phloem fibers, (B) calcium oxalate crystals, (C) covering and glandular trichomes, and (D) lignified xylem fibers.

### 3.2.4 Quantitative Microscopy

Quantitative microscopy showed standard values such as vein islet number (16.66), vein termination number (11.11), higher stomatal index in the lower epidermis, and palisade ratio of 4.0, confirming the hypostomatic nature of the leaf (Table 2)

**Table 2:** Results showing quantitative microscopy of leaves of *Clerodendrum viscosum*

| SI. No | Parameters | Results |
|---|---|---|
| 1. | Vein islet number | 16.66 |
| 2. | Vein termination number | 11.11 |
| 3. | Stomatal number | |
| | Lower epidermis | 620.77 |
| | Upper epidermis | 225.73 |

| | | |
|---|---|---|
| 4. | Stomatal index | |
| | Lower epidermis | 27.19 |
| | Upper epidermis | 9.85 |
| 5. | Palisade ratio | 4.0 |
| 6. | Fibre parameters | |
| | Length | 13.5 |
| | Width | 4.6 |

**3.3 Physicochemical Evaluation**

Physicochemical analysis revealed that total ash value (9.20% w/w), water-soluble ash (0.80% w/w), and acid-insoluble ash (2.63% w/w) were within acceptable limits, indicating minimal contamination. Extractive values suggested the presence of polar and moderately polar constituents. Moisture content (7.05% w/w) indicated good stability, while foaming index (167) confirmed the presence of saponins. Swelling index (2.0 mL), low foreign matter (1.86% w/w), and crude fiber content (81.5% w/w) further supported the quality and purity of the plant material (Table 3)

**Table 3:** Consolidated Physicochemical Parameters of Clerodendrum viscosum Leaf Powder

| Sl. No | Parameter | Result (Mean ± Range) | Unit |
|---|---|---|---|
| 1 | Total Ash Value | 9.20 (9.12–9.28) | % w/w |
| 2 | Water-Soluble Ash | 0.80 (0.75–0.85) | % w/w |
| 3 | Acid-Insoluble Ash | 2.63 (2.61–2.65) | % w/w |
| 4 | Sulphated Ash | 13.5 (13.3–13.6) | % w/w |
| 5 | Water-Soluble Extractive Value | 7.1 (6.9–7.3) | % w/w |
| 6 | Alcohol-Soluble Extractive Value | 6.0 (5.8–6.9) | % w/w |
| 7 | Ether-Soluble Extractive Value | 0.4 (0.3–0.5) | % w/w |

| | | | |
|---|---|---|---|
| 8 | Moisture Content (LOD) | 7.05 (7.00–7.10) | % w/w |
| 9 | Foaming Index | 167 | — |
| 10 | Swelling Index | 2.0 (1.8–2.2) | mL |
| 11 | Foreign Organic Matter | 1.86 (1.68–2.0) | % w/w |
| 12 | Crude Fiber Content | 81.5 | % w/w |

**4. Discussion**

The present study was undertaken to establish comprehensive pharmacognostic and physicochemical standards for Clerodendrum viscosum leaves, which are essential for ensuring their identity, purity, and quality. The results obtained from the study were found to be consistent with previously reported data, thereby confirming the authenticity of the plant material.

The macroscopical evaluation revealed characteristic morphological features such as ovate leaves with dentate margins, hairy surfaces, and a distinct odor. These features are in close agreement with standard botanical descriptions reported in earlier studies, thereby supporting the correct identification of the plant [25]. Such morphological characteristics serve as primary diagnostic parameters and are particularly useful in the preliminary identification of crude drugs.

Microscopical analysis further strengthened the authentication of the plant material by revealing a typical dorsiventral leaf structure, which is a characteristic feature of dicotyledonous plants. The presence of well-developed palisade and spongy parenchyma, anomocytic stomata, multicellular covering trichomes, glandular trichomes, and a bicollateral vascular bundle were observed. These findings are in accordance with earlier pharmacognostic reports on Clerodendrum viscosum and related species [26]. The presence of calcium oxalate crystals, both in the lamina and midrib regions, further supports its diagnostic significance, as such crystals are commonly reported in medicinal plants and play an important role in plant defense mechanisms [27].

Powder microscopy also revealed significant diagnostic features such as epidermal cells, lignified xylem fibers, trichomes, and calcium oxalate crystals. These observations are consistent with standard pharmacognostic characteristics described for crude plant drugs and provide reliable criteria for identification, especially in powdered form where macroscopic features are lost [28].

Quantitative microscopy provided numerical values for parameters such as stomatal number, stomatal index, vein islet number, vein termination number, and palisade ratio. The higher stomatal index observed in the lower epidermis confirms the hypostomatic nature of the leaf, which is typical of many dicot plants. These values were found to be within acceptable ranges and comparable to previously reported data, thereby reinforcing their importance in quality control and standardization [29].

Physicochemical evaluation plays a crucial role in determining the purity and quality of plant materials. The total ash value obtained in the present study was within the permissible limits, indicating minimal contamination with inorganic matter such as soil and sand. Similarly, low acid-insoluble ash values suggest negligible presence of siliceous impurities, which confirms proper cleaning and handling of the plant material [30]. The water-soluble ash values further indicate the presence of water-soluble inorganic salts.

Extractive values obtained using water, alcohol, and ether solvents provide an estimate of the nature and quantity of phytoconstituents present in the plant material. The higher water-soluble extractive value observed in this study suggests the presence of polar compounds such as glycosides, tannins, and flavonoids. Alcohol-soluble extractives indicate the presence of moderately polar constituents, while low ether-soluble extractive values suggest minimal presence of non-polar compounds such as fats and waxes. These findings are in agreement with previous phytochemical studies on Clerodendrum viscosum [31].

The moisture content of the powdered leaves was found to be low, indicating good storage stability and reduced risk of microbial growth. Moisture content is a critical parameter, as excessive moisture can lead to degradation of active constituents and microbial contamination [32]. The foaming index observed in the study confirms the presence of saponins, which are known for their surface-active properties and pharmacological significance. Similarly, the swelling index indicates the presence of mucilage and polysaccharides, which contribute to the therapeutic potential of the plant [33].

The low percentage of foreign organic matter observed in the study indicates proper collection, cleaning, and processing of the plant material. This parameter is essential for ensuring the purity of crude drugs and minimizing contamination [34]. The crude fiber content obtained reflects the structural composition of the plant, including cellulose and lignin, which contribute to its mechanical strength.

Overall, the results obtained from pharmacognostic, quantitative microscopic, and physicochemical evaluations are consistent with standard guidelines and previously reported data. The findings confirm the authenticity and quality of Clerodendrum viscosum leaves and provide a set of reliable diagnostic parameters for their identification and standardization.

The present study fills an important gap in the literature by providing a comprehensive and integrated evaluation of Clerodendrum viscosum leaves. The established parameters can serve as reference standards for future research, quality control, and herbal drug development. Furthermore, these findings will be useful in preventing adulteration and ensuring consistency in herbal formulations derived from this plant.

**5. Summary and conclusion**

The study was carried out to establish pharmacognostic and physicochemical standards of Clerodendrum viscosum leaves. Macroscopic and microscopic evaluation confirmed characteristic features such as dorsiventral leaf structure, trichomes, stomata, and vascular arrangement. Quantitative microscopy provided standard leaf constants, while physicochemical parameters such as ash values, extractive values, and moisture content indicated good quality and purity. The findings support the authenticity and standardization of the plant material.The study successfully established diagnostic pharmacognostic and physicochemical parameters for Clerodendrum viscosum leaves. These parameters can be used for identification, quality control, and prevention of adulteration. The results provide a scientific basis for the standardization and future utilization of this medicinal plant.

**6. References**

1. World Health Organization. WHO guidelines on quality control methods for medicinal plant materials. Geneva: WHO; 2011.
2. Kokate CK, Purohit AP, Gokhale SB. Pharmacognosy. 55th ed. Pune: Nirali Prakashan; 2014.
3. Kirtikar KR, Basu BD. Indian Medicinal Plants. 2nd ed. Dehradun: International Book Distributors; 2005.
4. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. London: Chapman and Hall; 1998.

5. Singh A, Kumar R. Antimicrobial activity of Clerodendrum viscosum leaf extracts. J Ethnopharmacol. 2013;145(2):567–573.
6. Das S, Bhattacharya S. Pharmacological activities of Clerodendrum species: A review. Int J Pharm Sci Rev Res. 2014;25(1):123–129.
7. Evans WC. Trease and Evans Pharmacognosy. 16th ed. London: Saunders Elsevier; 2009.
8. World Health Organization. Quality control methods for herbal materials. Geneva: WHO; 2011.
9. WHO. Guidelines on good agricultural and collection practices (GACP) for medicinal plants. Geneva: World Health Organization; 2003.
10. Jain SK, Rao RR. Handbook of field and herbarium methods. New Delhi: Today and Tomorrow's Printers; 1977.
11. Kokate CK. Practical Pharmacognosy. 4th ed. Pune: Vallabh Prakashan; 2005.
12. Trease GE, Evans WC. Pharmacognosy. 16th ed. London: Saunders Elsevier; 2009.
13. Johansen DA. Plant Microtechnique. New York: McGraw-Hill; 1940.
14. Esau K. Plant Anatomy. 2nd ed. New York: Wiley; 1965.
15. Wallis TE. Textbook of Pharmacognosy. 5th ed. London: CBS Publishers; 1985.
16. Brain KR, Turner TD. The Practical Evaluation of Phytopharmaceuticals. Bristol: Wright-Scientechnica; 1975.
17. WHO. Quality control methods for herbal materials. Geneva: World Health Organization; 2011.
18. Indian Pharmacopoeia Commission. Indian Pharmacopoeia. Ghaziabad: IPC; 2018.
19. Harborne JB. Phytochemical Methods. London: Chapman and Hall; 1998.
20. AOAC. Official Methods of Analysis. 18th ed. Washington DC: AOAC; 2005.
21. Kokate CK. Practical Pharmacognosy. Pune: Vallabh Prakashan; 2005.
22. WHO. Quality control methods for medicinal plant materials. Geneva: WHO; 2011.
23. Indian Pharmacopoeia Commission. Indian Pharmacopoeia. Ghaziabad: IPC; 2018.
24. AOAC. Official Methods of Analysis. 18th ed. Washington DC: AOAC; 2005.
25. Kirtikar KR, Basu BD. Indian Medicinal Plants. Dehradun: International Book Distributors; 2005.
26. Esau K. Plant Anatomy. 2nd ed. New York: Wiley; 1965.

27. Franceschi VR, Nakata PA. Calcium oxalate in plants: formation and function. Annu Rev Plant Biol. 2005;56:41–71.
28. Wallis TE. Textbook of Pharmacognosy. 5th ed. London: CBS Publishers; 1985.
29. Brain KR, Turner TD. The Practical Evaluation of Phytopharmaceuticals. Bristol: Wright-Scientechnica; 1975.
30. Indian Pharmacopoeia Commission. Indian Pharmacopoeia. Ghaziabad: IPC; 2018.
31. Harborne JB. Phytochemical Methods. London: Chapman and Hall; 1998.
32. AOAC. Official Methods of Analysis. Washington DC: AOAC; 2005.
33. Kokate CK. Practical Pharmacognosy. Pune: Vallabh Prakashan; 2005.
34. World Health Organization. Quality control methods for herbal materials. Geneva: WHO; 2011.