Journal of
Plant Science & Research

Volume 12, Issue 2 - 2025

www.opensciencepublications.com

Pharmacognostic and Phytochemical Investigation of the Leaves of *Malvastrum coromandelianum* (L.) Garcke

Research Article

Shinde YP[1]*, Pachkore GL[2], Patale SS[1] and Barwant MM[3]

[1]*Department of Botany, Shri Amolak Jain Vidya Prasarak Mandal's Smt. S. K. Gandhi Arts, Amolak Science and P.H Gandhi Commerce College, Kada, Dist – Beed, Maharashtra, India.*

[2]*Department of Botany, Padmashree Vasantdada Patil College, Patoda Beed, Maharashtra, India.*

[3]*Sanjivani Rural Education Society's, Sanjivani Arts Commerce and Science College Kopargaon, Ahilynagar Maharashtra, India.*

***Corresponding author:** Yogesh Pandharinath Shinde, Department of Botany, Shri Amolak Jain Vidya Prasarak Mandal's Smt. S. K. Gandhi Arts, Amolak Science and P.H Gandhi Commerce College, Kada, Dist – Beed, Maharashtra, India. E-mail Id:ypshinde129@gmail.com

Article Information: Submission: 02/08/2025; **Accepted:** 24/08/2025; **Published:** 26/08/2025

Abstract

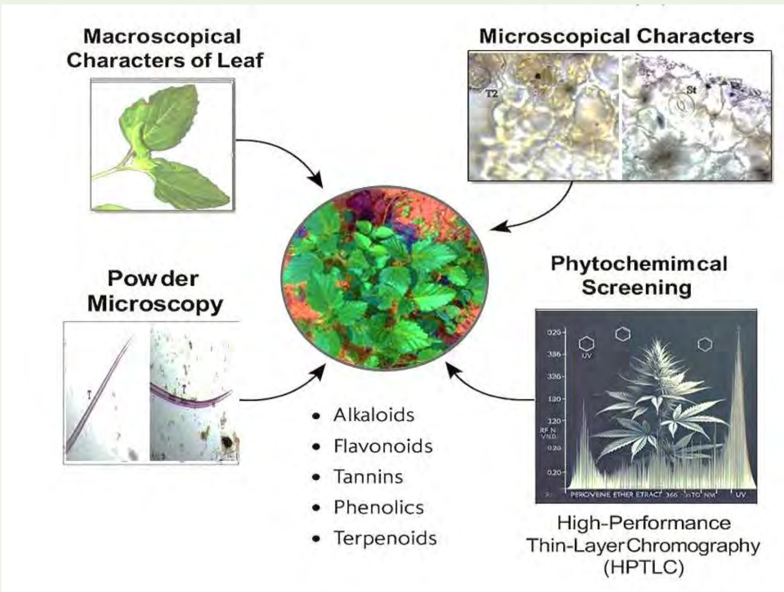
Malvastrum coromandelianum (L.) Garcke, commonly known as false mallow, belongs to the family Malvaceae and has been recognized for its ethnomedicinal significance. Ethnobotanical surveys have highlighted its use in treating various ailments, while pharmacological investigations have demonstrated its antinociceptive, anti-inflammatory, analgesic, and antibacterial properties. Despite its therapeutic potential, the lack of established standardization parameters for the herbal raw material of *M. coromandelianum* poses a significant challenge to ensuring its purity, quality, and consistency. Addressing this gap is critical for its effective use in traditional and modern medicine. The present study focuses on developing comprehensive standardization parameters for *M. coromandelianum*, including macroscopic, microscopic, phytochemical, and physicochemical evaluations. Establishing these standards will contribute to the scientific validation of this plant and facilitate its inclusion in pharmacopoeia monographs, thereby enhancing its applicability in the pharmaceutical and healthcare sectors.

Keywords: *Malvastrum Coromandelianum*; Phytochemical Standardization; Total Flavonoid Content; Total Phenolic Content; Pharmacological Evaluation

Introduction

Malvastrum coromandelianum (L.) Garcke, a member of the family Malvaceae, is a perennial or annual herb widely distributed in tropical and subtropical regions of the world. It is commonly referred to as false mallow, broom weed, or clock plant due to its morphological resemblance to other members of the Malvaceae family (Saxena & Rao, 2018) [1]. Ethnobotanical surveys have documented the use of *M. coromandelianum* in diverse traditional healthcare systems across Asia, Africa, and the Americas, emphasizing its global therapeutic relevance (Yadav & Mohite, 2020) [2].

In India, particularly in the Kalsubai region of the Western Ghats, tribal communities utilize the leaves and stems of *M. coromandelianum* to treat skin disorders, wounds, and inflammatory



Graphical Abstract:

conditions (Irudayaraj & Fabiola, 2022) [3]. The plant is also applied as a poultice to alleviate pain, as an anti-inflammatory agent, and for treating dysentery and gastrointestinal disturbances (Khonsung et al., 2006; Saxena & Rao, 2018) [4,1]. Within the framework of the Indian traditional medicine system, it is recognized for its anti-inflammatory, analgesic, antidysenteric, and antimicrobial properties (Reddy et al., 2001; Sittiwet et al., 2008) [5,6].

Pharmacological studies have validated many of these traditional claims, reporting significant antinociceptive (Reddy et al., 2001) [5], anti-inflammatory (Khonsung et al., 2006) [4], antimicrobial (Sittiwet et al., 2008) [6], and antioxidant activities (Yadav & Mohite, 2020; Divya & Kumar, 2018) [2,7]. In addition, recent investigations have identified bioactive phytoconstituents, including flavonoids such as tiliroside and quercetin, which contribute to its antioxidant potential (Divya & Kumar, 2018) [7]. Larvicidal properties against *Aedes aegypti* and other vector species have also been documented, highlighting the plant's diverse pharmacological spectrum (Irudayaraj & Fabiola, 2022) [3].

Despite these findings, there is a notable lack of comprehensive pharmacognostical and phytochemical standardization of *M. coromandelianum*. The absence of standardized quality control parameters for crude herbal drugs poses a risk to ensuring purity, consistency, and therapeutic efficacy (Mukherjee, 2002; Harborne, 1984) [8,9]. Such deficiencies often result in variations in chemical composition, which can compromise the reliability of herbal preparations and limit their acceptance in modern pharmacopoeias (Chase & Pratt, 1949; Farnsworth, 1966) [10,11].

The present study addresses these limitations by focusing on the pharmacognostic and physicochemical evaluation of *M. coromandelianum*. Microscopic examination, powder analysis, fluorescence studies, and phytochemical profiling were conducted to provide diagnostic features for its proper identification and authentication. Additionally, physicochemical parameters, including moisture content, ash values, and extractive values, were determined to ensure the quality and safety of the raw material. Quantitative estimation of total phenolic and flavonoid contents was also performed to highlight its antioxidant potential, further supporting its therapeutic value (Adesegun et al., 2009; Chang et al., 2002; Hatano et al., 1989) [12-14], [15-28].

This systematic evaluation aims to establish a scientific foundation for the traditional uses of *M. coromandelianum* and facilitate its integration into formal medicinal applications. The findings contribute to the development of standardized quality control parameters, which are crucial for the acceptance of herbal drugs in the pharmaceutical industry and for ensuring safety and efficacy in patient care.

Material and Methods

Plant Collection and Authentication

The plant *Malvastrum coromandelianum* (L.) Garcke was collected from the Kalsubai region of the Western Ghats, Maharashtra, India. The plant was authenticated by experts in the Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Maharashtra. A voucher specimen (00832) was prepared and deposited in the herbarium of the Department of Botany for future reference.

Preparation of Plant Material

The collected plant material was thoroughly washed under running tap water to remove dirt and any adhering matter. Fresh plant material was used for the microscopical study to examine structural characteristics. A portion of the leaves was air-dried in the

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shade, powdered using a mechanical grinder, and sieved through a 60# mesh. The powdered material was used for the determination of physicochemical parameters, including ash values and extractive values.

Phytochemical and Standardization Studies

Dried powdered leaf material was subjected to standardization procedures to determine ash values (total ash, acid-insoluble ash, and water-soluble ash) and extractive values (water-soluble and alcohol-soluble extractives).

Microscopical Analysis

Fresh plant material was used for microscopic examination to study the internal structure and anatomical features of the plant. The observations were documented using standard staining techniques and microscopy.

Phytochemical Screening

Preliminary phytochemical screening was conducted on the powdered plant material to detect the presence of bioactive compounds, including alkaloids, flavonoids, phenolics, tannins, and terpenoids. Advanced analysis using high-performance thin-layer chromatography (HPTLC) was performed to detect and quantify key phytochemicals, such as β-sitosterol.

Result and Discussion

Macroscopic Characters of Leaf

Malvastrum coromandelianum is a strong-stemmed, woody-rooted herbaceous plant that grows up to 1 m in height. The leaves are ovate to ovate-elliptic in shape, measuring approximately 4.5 cm in length and 3.5 cm in width. The apex of the leaves varies from sharp to blunt, with a prominent midrib and serrated margins. The leaves are three-nerved from the base, and the petiole (leaf stalk) ranges from 1.5 to 4 cm in length. These characteristic features are depicted in (**Figure 1a)** (entire plant) and (**Figure 1b)** (detailed view of the leaf).

Microscopical Characters

The histological study of the leaf was conducted on both the lamina and midrib regions (**Figure 2a**). The transverse section of the leaf lamina is dorsiventral, with a single-layered upper and lower epidermis, which is compactly arranged and cutinized (**Figure 2b**). The epidermis displays two types of modifications: trichomes and stomata.

Two types of trichomes were observed:

1. **Unicellular, uniseriate, lignified covering trichomes**, which are more abundant on the lower epidermis than the upper epidermis (**Figure 2c**).
2. **Bi-cellular head, sessile, non-lignified glandular trichomes**, present on both the upper and lower epidermis (**Figure 2a, Figure 2d**).

The leaf also contains **three-celled, unequal anisocytic type stomata**, which are well-distributed across the lamina region (**Figure 2e**). The mesophyll consists of spongy parenchyma, which does not contain any ergastic cell content.

Microscopical Characters Midrib Region of leaf

The midrib region of the leaf exhibits a similar type of epidermis as the lamina, but it is devoid of stomata. The dorsal surface of the midrib has a concave shape. Beneath both the upper and lower epidermis, there are two to three layers of collenchyma with thick cellulosic cell walls, arranged compactly. These layers provide mechanical support and contribute to the expansion of the leaf lamina. The central region of the midrib contains a vascular bundle, responsible for the conduction of food and nutrients, surrounded by spongy parenchyma. The vascular bundle is arc-shaped and bi-collateral in arrangement, with the phloem surrounding the xylem. The phloem consists of sieve tubes and companion cells, but phloem fibers are absent. The xylem is characterized by well-developed spiral vessels, which facilitate the conduction of water (**Figure 2f**).

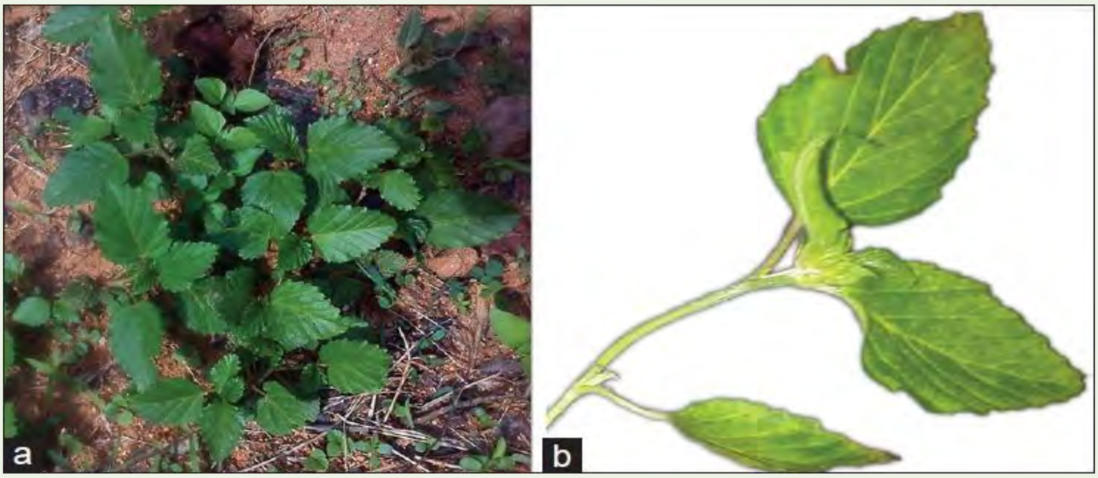

Figure (1a, 1b): Malvastrum coromandelianum leaf morphology.

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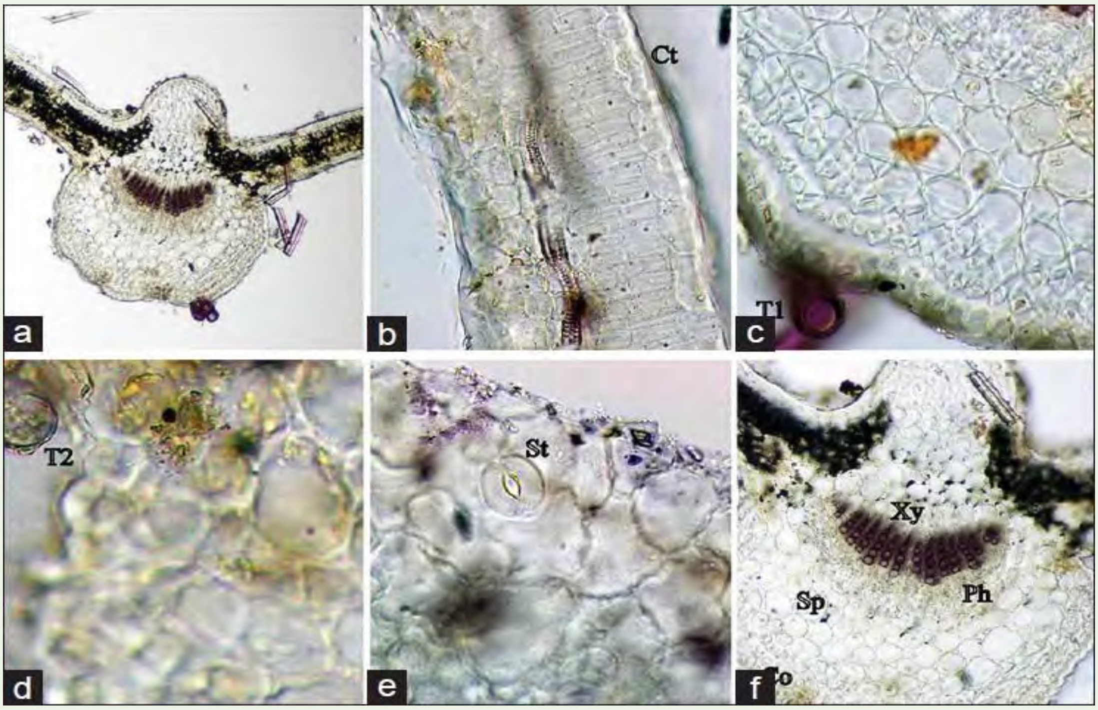

Figure 2(a) Transverse section of leaf passing through midrib. (2b) Transverse section of leaf lamina. (2c) Transverse section of midrib showing collenchyma covering trichome. (2d) Surface view of leaf for glandular trichome. (2e) Surface view of leaf for stomata. (2f) Transverse section of leaf passing through midrib Ct: Cuticle, T1: Covering trichome, T2: Bi-cellular sessile glandular trichome, St: Stomata, Xy: Xylem, Ph: Phloem, Sp: Spongy parenchyma, Co: Collenchyma.

Powder Microscopy

Powder microscopy of the leaf revealed the presence of **unicellular, lignified covering trichomes** with a smooth cuticle (**Figure 3a and b), spiral xylem vessels**, which are slightly lignified (**Figure 3c),** and **anisocytic stomata (Figure 3d).**

Physical Constants

Ash value determination is a critical parameter for assessing the quality of herbal raw material, as a higher ash value may indicate adulteration or improper processing. The percentage variation in the weight of ash across different samples of the same drug is usually minimal, and any significant deviation suggests a change in quality. The percentages of **total ash, acid-insoluble ash,** and **water-soluble ash** are presented in **Table 1.**Similarly, extractive value determination is essential for evaluating the quality of the raw material. A lower extractive value may indicate that the raw material has been exhausted or poorly processed. The results of **water-soluble** and **alcohol-soluble extractive values** are also provided in (**Table 1).**

Phytochemical screening

The dried leaf powder of M. coromandelianum was successively extracted using a Soxhlet apparatus with solvents of increasing polarity, including petroleum ether, chloroform, acetone, and methanol, followed by maceration with water. The percentage yield of the extract was highest in the aqueous and methanolic extracts, while the lowest yield was observed in the acetone extract (Table 2). The results of chemical tests revealed the presence of various secondary metabolites, such as alkaloids, fixed oils, saponins, phenolic compounds, tannins, carbohydrates, and proteins. These findings are summarized in (Table 3), while the fluorescence analysis results are provided in (Table 4).

Total Phenolic and Flavonoid Content Estimation

Plant phenolics are well-known for their antioxidant properties and play a significant role in protecting plants from oxidative stress. In the present study, the methanolic extract of *Malvastrum coromandelianum* exhibited the highest content of phenolic compounds, as shown in (**Table 5).** These findings underscore the potential of phenolics as important bioactive components with therapeutic applications.

Flavonoids, renowned for their wide range of biological activities, are essential markers for quality control in herbal raw materials. In this study, the chloroform extract showed the highest flavonoid content, followed by the methanolic extract, as presented in (**Table 5**). This indicates that the chloroform extract may possess a higher concentration of flavonoids, which could contribute to its bioactivity.

High-Performance Thin-Layer Chromatography (HPTLC)

High-Performance Thin-Layer Chromatography (HPTLC) is a versatile and effective tool for the identification and quantification of secondary plant metabolites. When properly applied, HPTLC provides a clear visual representation of the compounds present in the test samples. In this study, β-sitosterol was identified and quantified

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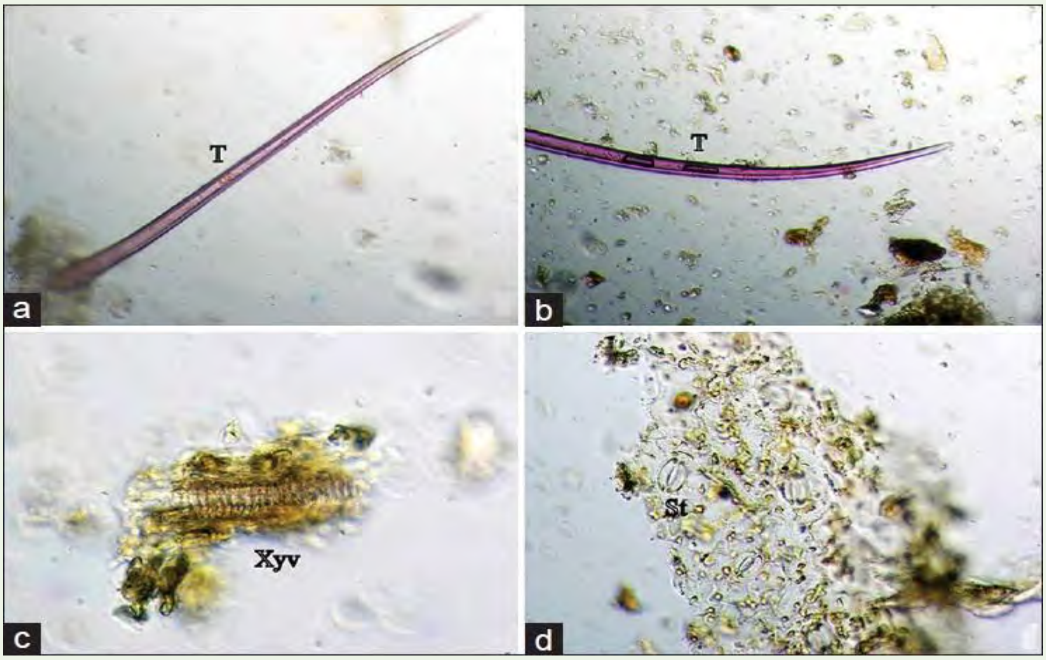

Figure (3a-3d): Powder microscopy of leaf. T: Unicellular, lignified, covering trichome, XyV: Xylem vessel, St: Anisocytic stomata.

Table 1: Ash Values and Extractive Values of *Malvastrum coromandelianum.*

Sr no	Parameter	Value (%)
1	Total Ash	5.6%
2	Acid-Insoluble Ash	1.2%
3	Water-Soluble Ash	0.7%
4	Water-Soluble Extractive Value	22%
5	Alcohol-Soluble Extractive Value	18%

Table 2: Percentage yield of different extracts by successive solvent extraction of *Malvastrum coromandelianum* leaf.

Sr No	Solvent	Percentage Yield (%)
1	Petroleum Ether	2.5%
2	Chloroform	4.0%
3	Acetone	1.0%
4	Methanol	8.5%
5	Aqueous	10.2%

Table 3: Qualitative chemical analysis of *Malvastrum coromandelianum.*

Sr No	Secondary Metabolite	Petroleum Ether	Chloro-form	Ac-etone	Metha-nol	Aque-ous
1	**Alkaloids**	-	-	-	+	+
2	**Fixed Oils**	-	+	-	+	-
3	**Saponins**	-	-	-	+	+
4	**Phenolic Compounds**	-	-	-	+	+
5	**Tannins**	-	+	-	+	+
6	**Carbohydrates**	+	+	+	+	+
7	**Proteins**	-	-	-	+	+

Table 4: Fluorescence analysis of leaf powder of *Malvastrum coromandelianum*

Sr No	Reagent Used	Fluorescence Observed
1	**UV Light (254 nm)**	Yellow-green fluorescence
2	**UV Light (365 nm)**	Blue fluorescence
3	**Visible Light**	Greenish-yellow color

Table 5: Total Phenolic and Flavonoid Content Estimation.

Sr No	Solvent Extract	Total Phenolic Content (mg GAE/g)	Total Flavonoid Content (mg QE/g)
1	Petroleum Ether	3.2	1.5
2	Chloroform	5.5	2.0
3	Acetone	7.0	3.2
4	Methanol	9.8	5.0
5	Aqueous	11.2	6.5

in the petroleum ether extract of *Malvastrum coromandelianum* through HPTLC analysis.

The developed chromatogram at 366 nm confirmed the presence of β-sitosterol, with an Rf value of 0.26 and an area under the curve (AUC) of 459.8 in the sample (Figure 4). This was compared with the standard β-sitosterol, which exhibited an identical Rf value of 0.26 and a higher AUC of 1068.1 (Figure 5). Further confirmation was obtained through overlay spectral analysis, as shown in (Figure 6). The developed plate, after derivatization with 10% sulfuric acid in methanol under 366 nm, is presented in (Figure 7). The percentage yield of β-sitosterol in the petroleum ether extract was found to be 1.7% w/w.β-Sitosterol, a prominent phytosterol, is known for its

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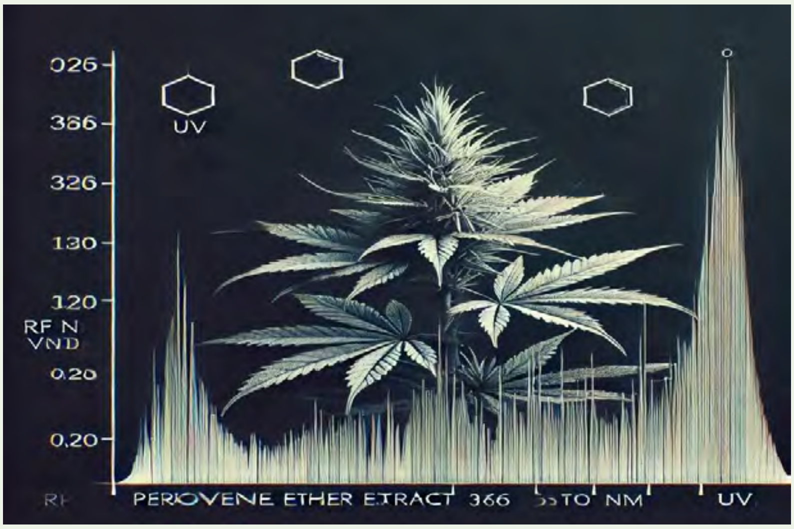

Figure 4: High-Performance Thin-Layer Chromatography Chromatogram of Petroleum Ether Extract of *Malvastrum coromandelianum* Leaf.

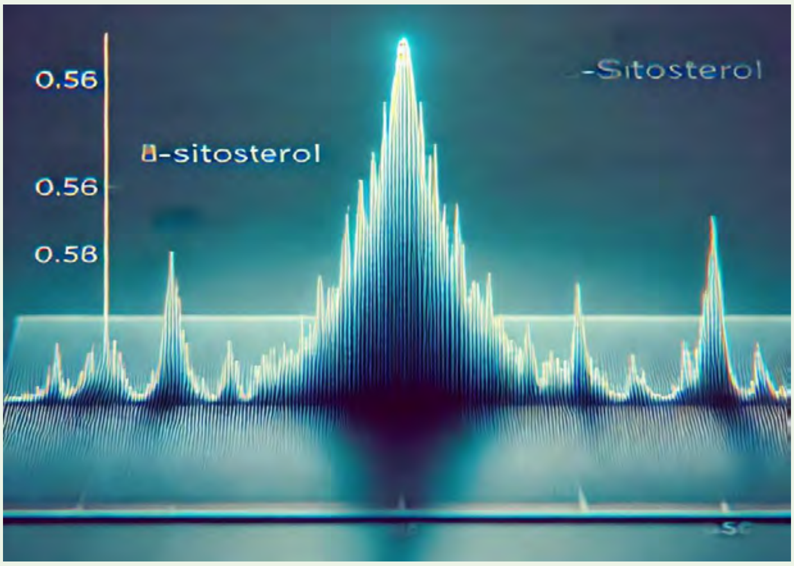

Figure 5: High performance thin layer chromatography chromatogram of standard β-sitosterol.

various biological activities, including analgesic, anthelminthic, antimutagenic, anti-inflammatory, and antihepatotoxic properties [19][20][21]. (Figure 4) presents the HPTLC chromatogram of the petroleum ether extract of *Malvastrum coromandelianum* leaf. The presence of β-sitosterol is confirmed by the peak corresponding to an Rf value of 0.26, with an area under the curve (AUC) of 459.8. The chromatogram was developed under 366 nm UV light for visual identification of the compounds.

Conclusion

The evaluation of crude drugs plays a crucial role in determining their identity, purity, and quality. Purity refers to the absence of extraneous materials, while quality pertains to the amount of active constituents present in the drug. Macroscopic and microscopic evaluations are vital parameters for assessing the identity of herbal raw materials, while the qualitative and quantitative screening of secondary metabolites focuses on ensuring the quality of these materials. Additionally, the therapeutic potential of a plant is directly related to the nature and concentration of its phytoconstituents. Therefore, evaluating the chemical composition of herbal raw materials is essential for confirming their quality. In conclusion, the various macroscopic, microscopic, physical, and phytochemical parameters discussed in this study for *M. coromandelianum* can serve as reliable tools for its identification, authentication, and standardization.

Acknowledgement

The authors express their sincere gratitude to the Department of

Botany, Shri Amolak Jain Vidya Prasarak Mandal's Smt. S. K. Gandhi Arts, Amolak Science and P.H. College, for providing the necessary laboratory facilities and support to carry out this research work successfully. Their encouragement and technical assistance were invaluable throughout the course of this study.

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