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PHYSICOCHEMICAL STANDARDIZATION AND PHYTOCHEMICAL EVALUATION OF *TECTONA GRANDIS* LINN. LEAF *CHURNA* WITH SPECIAL REFERENCE TO *BISARI* (WHITLOW)

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ABSTRACT

Tectona grandis Linn. is an important medicinal plant described in Ayurveda for its therapeutic utility in wound management and inflammatory disorders. The leaves are traditionally applied in conditions such as *Bisari* (Whitlow). The present study was undertaken to evaluate the pharmacognostical, physicochemical, phytochemical, and thin layer chromatographic characteristics of *Tectona grandis* leaves in order to establish standardization parameters. Fresh leaves were collected, authenticated, shade-dried, and powdered for analysis. Pharmacognostical evaluation including macroscopy, microscopy, and powder microscopy was carried out using standard procedures. Physicochemical parameters such as loss on drying, ash values, extractive values, and pH were determined according to standard guidelines. Preliminary phytochemical screening of various solvent extracts and TLC profiling of the methanolic extract were also performed. The study revealed characteristic pharmacognostical features useful for identification of the crude drug. Physicochemical analysis indicated acceptable moisture content and purity of the plant material. Preliminary phytochemical screening demonstrated the presence of flavonoids, tannins, phenolic compounds, proteins, and carbohydrates in different extracts. TLC profiling exhibited multiple separated bands with characteristic Rf values, confirming the presence of diverse

phytoconstituents. The findings support the traditional therapeutic relevance of *Tectona grandis* leaves and provide useful reference standards for identification, authentication, and quality control of the plant material.

KEYWORDS: *Tectona grandis*, Pharmacognostical evaluation, Physicochemical analysis, Phytochemical screening, TLC profiling, *Bisari* (Whitlow).

1. INTRODUCTION

Tectona grandis Linn., commonly known as teak, is a large deciduous tropical tree belonging to the family Lamiaceae (formerly Verbenaceae). The tree may attain a height of 30–40 m with characteristic fluting and buttresses at the base of older trees. The bark is light grayish-brown in colour. Leaves are large, opposite, shiny, and elliptic in shape, with the lower surface appearing gray and covered with glandular hairs. The flowers are small, white, bisexual, and arranged in large panicles, while the fruit is a green, hairy, woody, irregularly rounded drupe.[1]

Apart from its immense economic importance as a valuable timber plant, *Tectona grandis* has also been extensively described in classical Ayurvedic literature for its medicinal properties. In Ayurvedic texts such as *Bhavprakasha Nighantu*, the plant has been indicated in various pathological conditions including *Bisari* (Whitlow), where the leaves are traditionally used externally in paste form for local application. The Hindi commentary of *Bhavprakasha Nighantu* specifically mentions the application of leaf paste over *Bisari* (Whitlow).[2] The plant is described to possess properties such as *Kashaya rasa*, *Krimighna* (antimicrobial), *Shothahara* (anti-inflammatory), and *Ropana* (wound-healing) actions, which support its traditional therapeutic applications.[2][3]

Whitlow is a painful suppurative inflammatory condition affecting the fingers and is commonly associated with swelling, tenderness, localized infection, and pus formation.[4][5] In Ayurveda, Management of *Bisari* includes the use of drugs possessing anti-inflammatory, antimicrobial, cleansing, and wound-healing properties.[6][7] The traditional use of *Tectona grandis* leaves in such conditions suggests its potential therapeutic utility, thereby warranting scientific evaluation and standardization.

Standardization of herbal drugs is an essential step for ensuring their identity, purity, safety, and therapeutic efficacy. Pharmacognostical evaluation provides diagnostic characteristics

useful for identification and authentication of crude drugs, while physicochemical parameters such as loss on drying, ash values, extractive values, and pH help establish quality control standards. Preliminary phytochemical screening assists in identifying major classes of bioactive constituents responsible for pharmacological activity. In addition, Thin Layer Chromatography (TLC) serves as an important chromatographic tool for generating phytochemical fingerprints and assessing the chemical profile of herbal materials.[8][9]

Previous scientific studies on *Tectona grandis* leaves have reported the presence of flavonoids, tannins, phenolic compounds, glycosides, and other secondary metabolites possessing antimicrobial, antioxidant, anti-inflammatory, and wound-healing activities.[10][11][12] However, limited literature is available regarding comprehensive pharmacognostical standardization, physicochemical evaluation, phytochemical profiling, and TLC fingerprint analysis of *Tectona grandis* leaf *Churna* with special reference to *Bisari* (Whitlow), indicating a significant research gap.

Therefore, the present study was undertaken to carry out pharmacognostical evaluation, physicochemical standardization, preliminary phytochemical screening, and TLC profiling of *Tectona grandis* Linn. leaf *Churna* with special reference to its traditional therapeutic relevance in *Bisari* (Whitlow). The findings of the study may contribute towards establishing reference standards for identification, authentication, quality control, and future pharmacological investigations of the plant material.

1.1 Classical Categorization

Table 1: Classical categorization of *Tectona grandis* in different Nighantus.

NIGHANTU	VARGA
Kaiyadeva Nighantu[13]	Aushadi Varga
Nighantu Adarsha[3]	Nirgundyadi Varga
Priya Nighantu[14]	Saradi Varga
Madanpal Nighantu[15]	Shatadi Varga
Bhavprakasha Nighantu[2]	Vatadi Varga
Raj Nighantu[16]	Prabhadradi Varga

1.2 Ayurvedic pharmacodynamic properties *(Rasapanchaka)*

Table 2: Ayurvedic pharmacodynamic properties *(Rasapanchaka)* of *Tectona grandis* Linn.[3]

Rasa	Kashaya, Madhura
Virya	Shita
Vipaka	Katu
Doshaghanta	Tridoshaghana

2. MATERIALS AND METHODS

2.1 Collection and Identification of Plant Material

Fresh mature leaves of *Tectona grandis* Linn. were collected from Shree Vatika, the herbal garden of Shri Ayurved Mahavidyalaya, Nagpur, Maharashtra, India, in December 2025. The plant material was identified using the labelled accession board and QR code-linked botanical records available in the garden, and further confirmed by the Head of the Department of Dravyaguna Vigyana.

The leaves were washed, shade dried, and pulverized to obtain *Churna* for subsequent pharmacognostical, physicochemical, and preliminary phytochemical evaluation.[8]

2.2 Preparation of Leaf *Churna* (Powder)

The shade-dried leaves of *Tectona grandis* Linn. were coarsely powdered using a mechanical grinder to obtain *Churna*. The prepared *Churna* was stored in a clean, airtight container and used for powder microscopy, physicochemical, and preliminary phytochemical evaluation.[17]

2.3 Pharmacognostical Evaluation

The Pharmacognostical evaluation of *Tectona grandis* Linn. leaves was carried out using standard macroscopic, microscopic, and powder microscopic procedures. Fresh leaves were evaluated for morphological characters such as colour, shape, size, margin, apex, venation. Thin transverse sections through the midrib region were prepared manually, stained with safranin, mounted in glycerine, and examined under a compound microscope. For powder microscopy, a portion of the coarsely powdered leaf material was passed through clean cloth to obtain finer powder and examined for diagnostic characters such as fibres, vessels, epidermal cells, trichomes, and crystals.[8]

2.4 Physicochemical Analysis

Physicochemical analysis of the prepared leaf *Churna* of *Tectona grandis* Linn. was carried out using standard procedures to determine quality control parameters such as loss on drying, total ash, acid-insoluble ash, water-soluble ash, water-soluble extractive value, and pH. The analyses were performed according to standard guidelines for herbal drug evaluation.[18][19]

2.5 Preparation of Plant Extracts

Coarse powder of Tectona grandis leaves (5 g) was taken in separate conical flasks and extracted with 100 mL of different solvents (aqueous, ethanol, methanol, hydro-alcoholic, chloroform, and ether) to obtain a 1:20(w/v) extract. The mixtures were subjected to vigorous stirring for 6 hours followed by maceration for 18 hours at room temperature. The extracts were filtered through Whatman No. 1 filter paper and the filtrates were used for preliminary phytochemical Screening.[17]

2.6 Preliminary Phytochemical Screening

Preliminary phytochemical screening of the various solvent extracts of *Tectona grandis* Linn. Leaves was performed using standard qualitative chemical tests to detect the presence of major phytoconstituents. The extracts were evaluated for carbohydrates by Molisch's test; flavonoids by Shinoda test, alkaline reagent test, and zinc dust test; tannins by ferric chloride test and lead acetate test; amino acids by Ninhydrin test; glycosides by Baljet's test; steroids and triterpenoids by Liebermann–Burchard test; proteins by Xanthoproteic test; alkaloids by Mayer's test; saponins by Froth test; and phenolic compounds by sodium nitrite test. The results were recorded as presence (+), absence (−), or not tested (NT), wherever applicable.[18][19]

2.7 Thin Layer Chromatographic Analysis (TLC)

Thin layer chromatographic analysis of the methanolic extract of *Tectona grandis* leaves was carried out using pre-coated silica gel 60 F_{254} aluminium TLC plates as stationary phase. For preparation of the test extract, 1.5 g of leaf powder was extracted with 10 mL of methanol and filtered. The mobile phase consisted of Toluene: Ethyl acetate: Formic acid in the ratio of 4.5: 4: 1. The TLC chamber was pre-saturated with the solvent system before chromatographic development. A small spot of the methanolic extract was applied on the baseline of the TLC plate using a capillary tube, and the plate was developed by ascending chromatography until the solvent front approached the upper marked line.

The developed plate was removed, dried, and visualized under visible light after spraying with ninhydrin reagent. The Rf values were calculated by dividing the distance travelled by the solute by the distance travelled by the solvent front.[9]

3. RESULTS AND DISCUSSION

3.1 Pharmacognostical Evaluation of *Tectona grandis* Leaves

3.1.1 Macroscopic Characters

The leaves of *Tectona grandis* are simple, large, and consist of a single lamina. They are broadly ovate to elliptical in shape, measuring approximately 40 cm in length and 25 cm in width. The upper surface is green, while the lower surface is comparatively pale or dull green. The margin is entire and smooth. The apex is acute to slightly acuminate, and the base appears attenuated.

Venation is reticulate with a strong pinnate pattern. The midrib is prominent with well-developed lateral veins forming a distinct network, which is clearly visible on the leaf surface. The upper surface is rough in texture with fine venation prominently visible. The lower surface exhibits more prominent and raised venation, with the midrib projecting outward and the surface appearing less glossy.

The petiole is short and stout, measuring approximately 5 cm in length. The macroscopic features of the upper and lower surfaces of the leaf are illustrated in Figures 1 and 2.

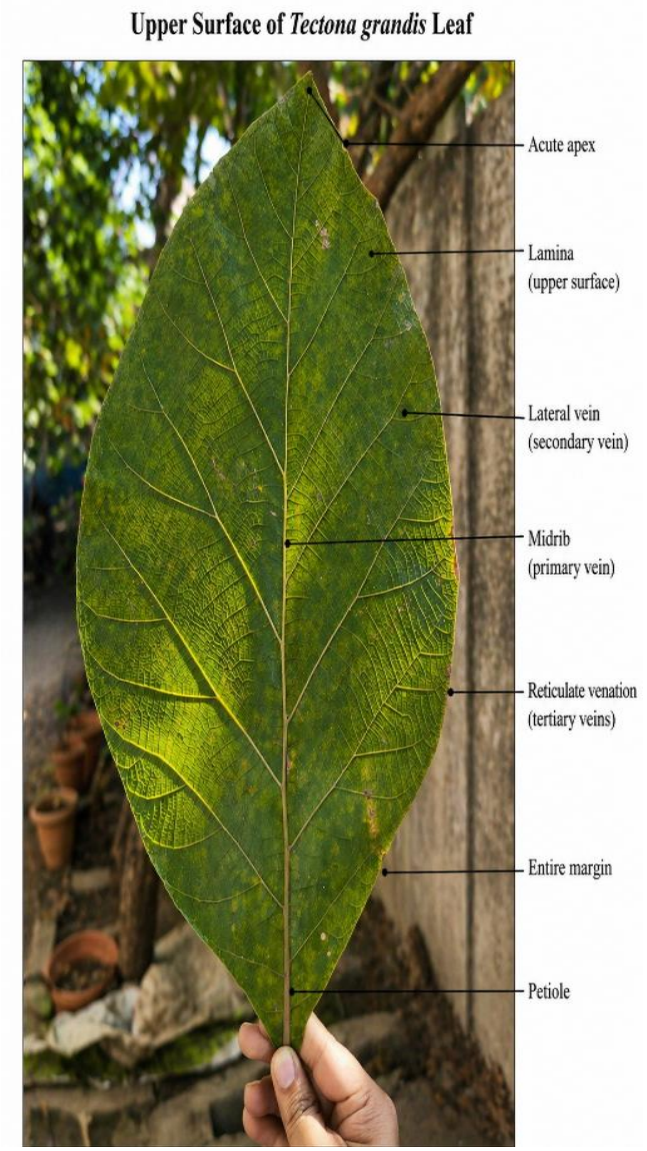

Fig. 1: Upper surface of *Tectona grandis* leaf showing venation pattern and morphological characteristics.

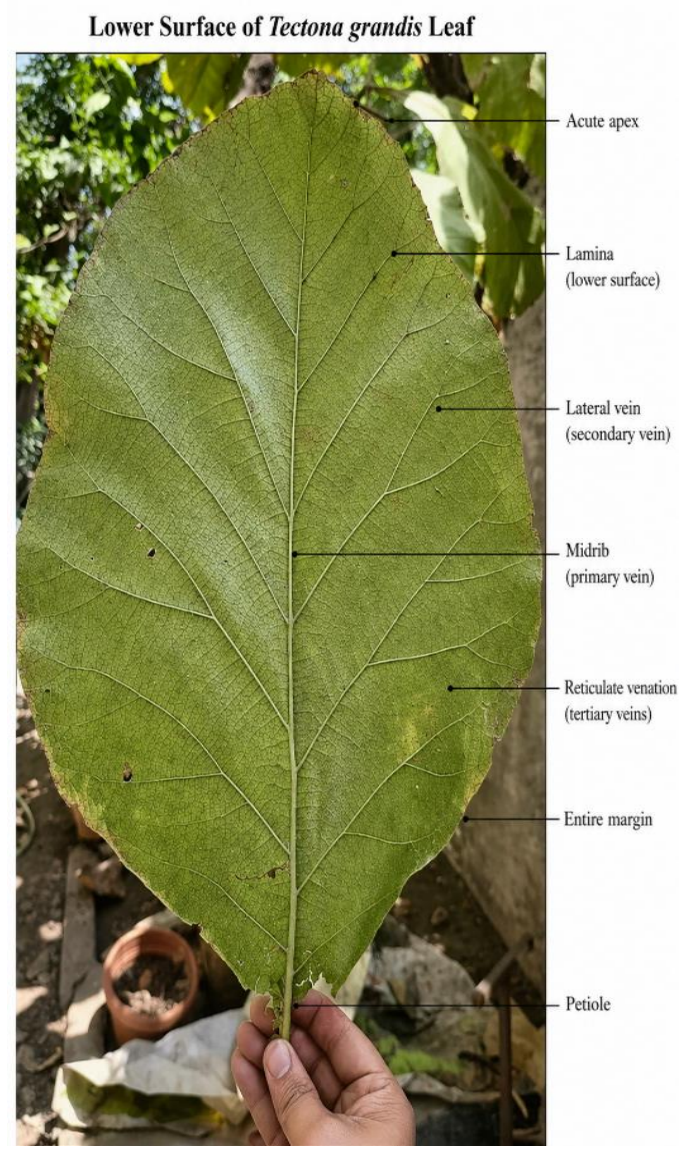

Fig. 2: Lower surface of *Tectona grandis* leaf showing venation pattern and morphological characteristics.

3.1.2 Transverse Section of Leaf

Microscopic examination of the transverse section of *Tectona grandis* leaf revealed distinct epidermal layers enclosing mesophyll tissue. A prominent vascular strand was observed in the vein region with associated supporting tissues. These features serve as diagnostic characters for identification of the crude leaf drug. Microscopic features observed in the transverse section of *Tectona grandis* leaf, including upper epidermis, mesophyll tissue, vascular bundle, and lower epidermis, are shown in Figure 3.

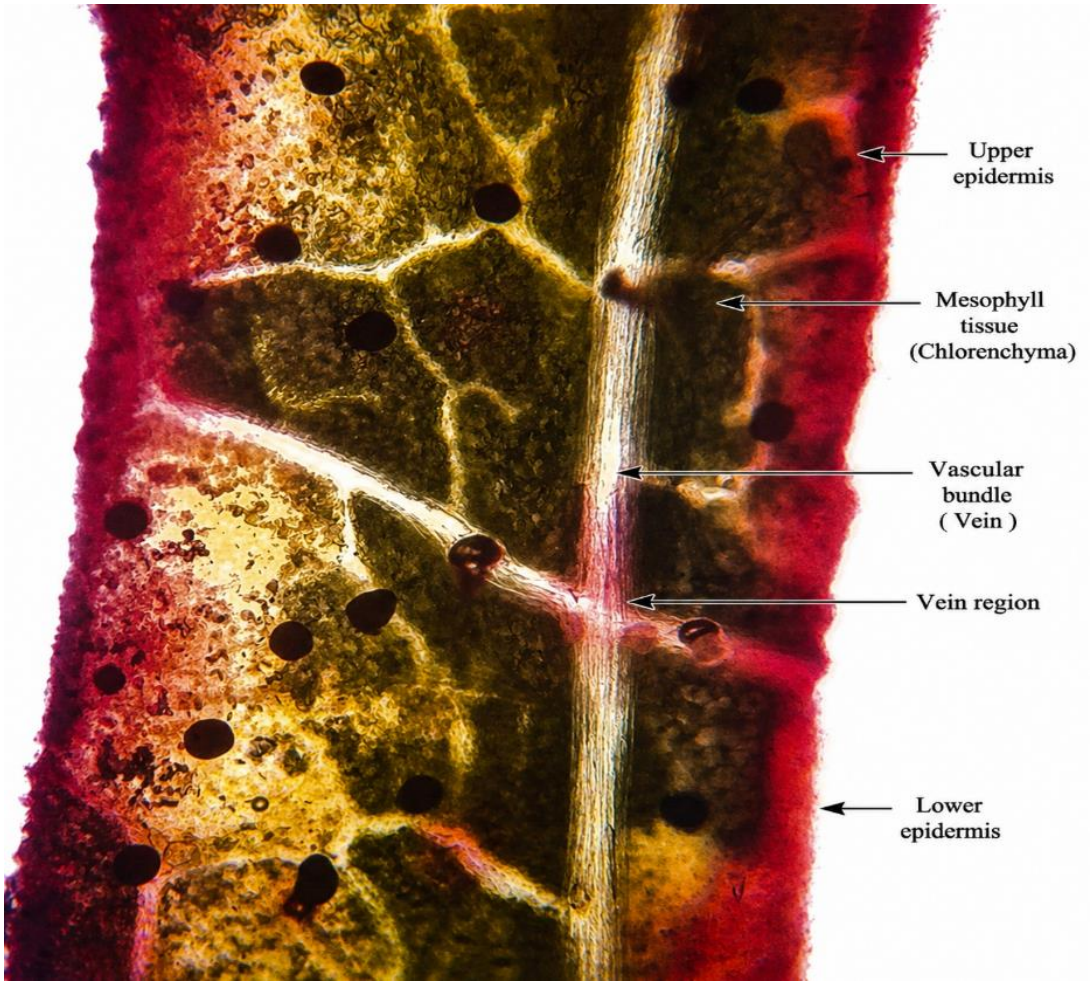

Figure 3: Transverse section of *Tectona grandis* leaf showing upper epidermis, mesophyll tissue, vascular bundle and lower epidermis (Safranin stain).

3.1.3 Powder Microscopy

Powder microscopy of *Tectona grandis* leaf powder revealed elongated thick-walled lignified fibre fragments with narrow lumen, along with parenchymatous tissue debris. Presence of fibres constitutes an important diagnostic character for identification of the powdered drug. Diagnostic powder microscopic features of *Tectona grandis* leaf, including lignified fibre fragments and other cellular debris (10X), are shown in Figure 4.

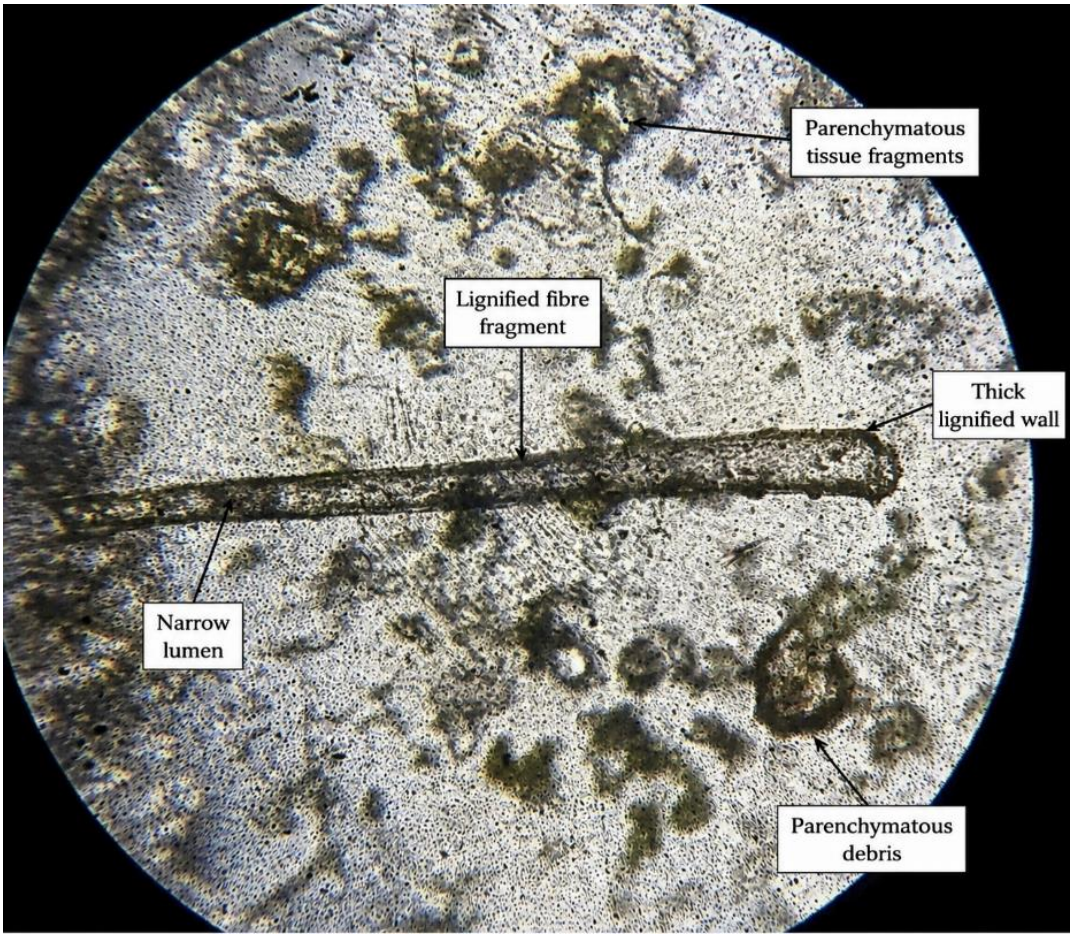

Figure 4: Powder Microscopy of *Tectona grandis* leaf showing lignified fibre fragment & other cellular debris(10X)

3.2 Physicochemical Evaluation of *Tectona grandis* Leaf Powder

Physicochemical evaluation of *Tectona grandis* leaf powder revealed important quality control parameters. The moisture content (loss on drying) was found to be 8.78% w/w, indicating comparatively low moisture content, which may help reduce microbial deterioration and improve storage stability. The total ash value was 13.94% w/w, reflecting the total inorganic content of the drug, while acid-insoluble ash was 7.55% w/w, indicating the presence of siliceous matter or earthy impurities. Water-soluble ash was observed as 11.15% w/w, suggesting the proportion of water-soluble inorganic constituents. The water-soluble extractive value was 18.82% w/w, indicating appreciable quantities of polar soluble constituents. The alcohol-soluble extractive value was 8.77% w/w, showing the presence of moderately soluble phytoconstituents. The pH of 1% aqueous solution was found to be 6.48, indicating a near neutral nature of the drug. The physicochemical values obtained in the present study were found to be comparable with previously reported studies[12] on *Tectona grandis* leaves, although slight variations were observed, which may be attributed to

geographical source, environmental conditions, and processing methods. These parameters may serve as reference standards for identification and quality control of *Tectona grandis* leaf powder. The physicochemical parameters are presented in Table 3.

Table 3: Physicochemical parameters of Tectona grandis leaf powder.

Parameters	Result (% w/w)
Moisture content (Loss on drying)	8.78
Total ash	13.94
Acid-insoluble ash	7.55
Water-soluble ash	11.15
Water-soluble extractive	18.82
Alcohol-soluble extractive	8.77
pH	6.48

All values are expressed as % w/w except pH

3.3 Preliminary Phytochemical Screening of Various Solvent Extracts of *Tectona grandis* Leaves

Preliminary phytochemical screening of various solvent extracts of *Tectona grandis* Linn. leaves demonstrated the presence of diverse secondary metabolites distributed according to solvent polarity. Carbohydrates were indicated in aqueous, hydroalcoholic, chloroform, and ether extracts. Flavonoids showed positive reactions predominantly in ethanol, methanol, hydroalcoholic, chloroform, and ether extracts, suggesting better extractability in organic solvents. Tannins were detected mainly in methanolic and selected polar extracts, while proteins were observed in several extracts. Phenolic constituents were present in aqueous, ethanolic, hydroalcoholic, chloroform, and ether extracts. Saponins were detected in the aqueous extract, whereas alkaloids, glycosides, amino acids, and triterpenoids were not prominently observed under the present test conditions. The presence of flavonoids, tannins, and phenolic compounds may contribute to antioxidant, antimicrobial, and wound-healing potential traditionally attributed to the plant. Among the tested solvents, hydroalcoholic and ethanolic extracts exhibited broader phytochemical profiles, indicating their suitability for further phytochemical investigation. The results of preliminary phytochemical screening of various solvent extracts are summarized in Table 4.

Table 4: Preliminary phytochemical screening of various solvent extracts of *Tectona grandis* Linn. Leaves.

Phytochemicals	Test performed	Solvents					
		Aqueous	Ethanol	Methanol	Hydro-alcoholic	Chloroform	Ether
Carbohydrate	Molisch's test	+	-	-	+	+	+
Flavonoids	Shinoda test	-	+	+	+	+	+
	Alkaline reagent test	+	-	-	+	+	+
	Zinc dust test	-	+	-	-	-	-
Tannin	Ferric chloride test	-	-	+	-	-	-
	Lead acetate test	+	+	-	+	-	+
Amino acid	Ninhydrin test	-	-	-	-	-	-
Glycoside	Liebermann's Burchard test	-	-	-	-	-	-
Triterpenoid test	Liebermann's Burchard test	-	-	-	-	-	-
Protein	Xanthoproteic test	+	-	+	+	+	+
Alkaloid	Mayer's test	-	-	-	-	-	-
Saponin	Froth test	+	NT	NT	NT	NT	NT
Phenol	Sodium Nitrite test (Confirmatory)	+	+	-	+	+	+

Note: *NT = Not tested*

3.4 TLC Profile of Methanolic Extract of *Tectona grandis* Leaves

Thin layer chromatographic profiling of the methanolic extract of Tectona grandis leaves revealed the presence of multiple phytoconstituents with distinct coloured bands after chromatographic development and derivatization with ninhydrin reagent. The chromatogram demonstrated satisfactory separation of constituents using Toluene: Ethyl acetate: Formic acid (4.5: 4: 1) as mobile phase on silica gel 60 F_{254} TLC plates.

The developed chromatogram showed Green, Orange, Pink, and Yellow coloured bands with different Rf values, indicating the presence of phytoconstituents with varying polarity and differential affinity towards the stationary and mobile phases. The observed chromatographic profile supports the findings of preliminary phytochemical screening and confirms the phytochemical complexity of the methanolic extract of *Tectona grandis* leaves. The generated TLC fingerprint may serve as a useful reference for identification, authentication, and quality control standardization of the plant material. The Rf values and colour characteristics of the

separated bands observed in TLC analysis are presented in Table 5. The TLC profile of methanolic extract of *Tectona grandis* leaf powder, including mid-process and final chromatographic plates after derivatization with ninhydrin reagent, is illustrated in Figure 5.

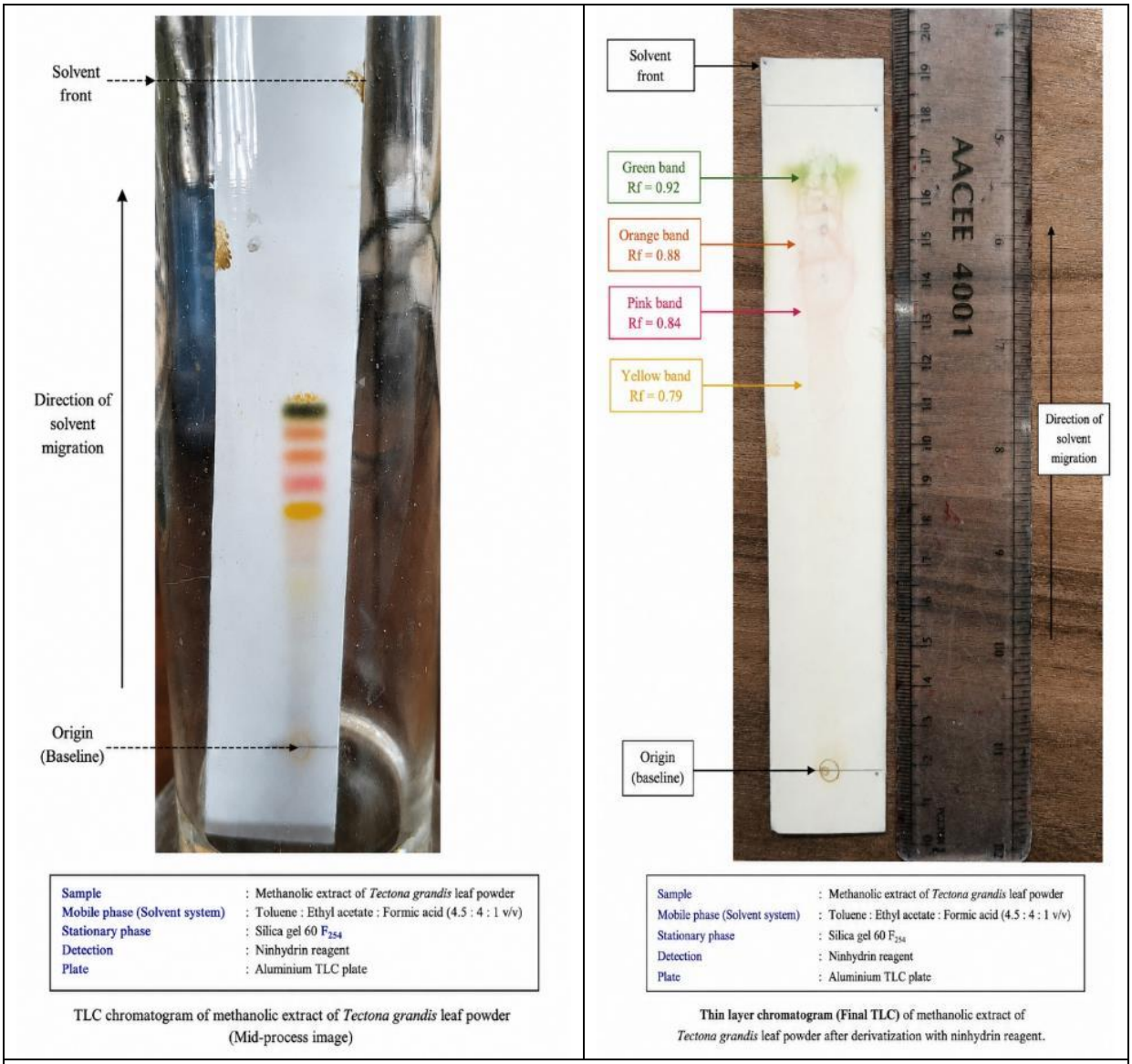

Figure 5: Thin layer chromatographic profile of methanolic extract of *Tectona grandis* leaf powder showing mid-process and final TLC plates after derivatization with ninhydrin reagent.

Table 5: TLC profile and Rf values of methanolic extract of *Tectona grandis* leaf powder.

S. No.	Colour of band	Distance travelled by solute (cm)	Distance travelled by solvent front (cm)	Rf value
1	Green	16.3	17.7	0.92
2	Orange	15.6	17.7	0.88
3	Pink	14.9	17.7	0.84
4	Yellow	14.0	17.7	0.79

3.5 Ayurvedic and Phytopharmacological Correlation with *Bisari* (Whitlow)

Bisari (Whitlow) is a painful inflammatory condition affecting the fingers and is commonly associated with swelling, tenderness, suppuration, and localized infection. In Ayurvedic literature, such conditions may be correlated with inflammatory and suppurative lesions requiring drugs possessing *Shothahara* (anti-inflammatory), *Vedanasthapana* (analgesic), *Vrana Shodhana* (wound cleansing), and *Vrana Ropana* (wound-healing) properties. *Tectona grandis* Linn. has been traditionally described for its therapeutic utility in inflammatory disorders and wound management, and the Hindi commentary of *Bhavaprakasha Nighantu* specifically mentions the application of leaf paste over *Bisari* (Whitlow).

In the present study, pharmacognostical evaluation established characteristic diagnostic features useful for identification and authentication of the crude drug, while physicochemical parameters generated standardization values for quality assessment of the leaf powder. Preliminary phytochemical screening revealed the presence of flavonoids, tannins, phenolic compounds, proteins, and carbohydrates in different solvent extracts. Furthermore, TLC profiling of the methanolic extract demonstrated multiple separated coloured bands with characteristic Rf values, indicating the presence of diverse phytoconstituents and providing a characteristic chromatographic fingerprint of the plant material.

Flavonoids, tannins, and phenolic compounds are widely reported to possess antimicrobial, antioxidant, anti-inflammatory, and wound-healing activities, which may contribute to the therapeutic potential of *Tectona grandis* leaves in *Bisari* (Whitlow). The chromatographic fingerprint generated through TLC analysis further supports the phytochemical complexity and standardization of the plant material. Thus, the present pharmacognostical, physicochemical, phytochemical, and chromatographic findings scientifically support the traditional use of *Tectona grandis* leaves in the management of *Bisari* (Whitlow).

4. CONCLUSION

The present study established pharmacognostical, physicochemical, phytochemical, and TLC profiling standards for Tectona grandis Linn. leaves. Macroscopic, microscopic, and powder microscopic evaluations provided important diagnostic characteristics for identification and authentication of the crude drug. Physicochemical parameters generated reference values useful for quality control and standardization of the leaf powder. Preliminary phytochemical screening revealed the presence of several bioactive constituents including flavonoids, tannins, phenolic compounds, proteins, and carbohydrates in different solvent extracts.

TLC profiling of the methanolic extract demonstrated multiple separated coloured bands with characteristic Rf values, generating a characteristic chromatographic fingerprint for the plant material. The observed pharmacognostical, physicochemical, phytochemical, and chromatographic findings scientifically support the traditional therapeutic relevance of *Tectona grandis* leaves in *Bisari* (Whitlow), as described in classical Ayurvedic literature. The study may serve as a useful reference for future research, identification, authentication, quality control, standardization, and formulation development involving *Tectona grandis* leaves. Further pharmacological and clinical investigations are recommended to validate its therapeutic efficacy.

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