Publisher
Maharshi Charaka Ayurveda
www.maharshicharaka.in

E-ISSN:2456-3110

Journal of Ayurveda and Integrated Medical Sciences

2026 Volume 11 Number 3 March

Research Article

Medicinal Bamboo Species

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Quality Control Constraints of Ochlandra Travancorica Benth. an Underexplored Medicinal Bamboo Species

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DOI:10.21760/jaims.11.3.17

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Introduction: Medicinal plants have formed the foundation of traditional healing systems since centuries; however, many such valuable resources are now facing the threat of extinction due to indiscriminate harvesting and inadequate conservation strategies. Ochlandra travancorica Benth. a lesser-known bamboo species, growing in southern parts of Inida. Culms and leaves of this bamboo are used in medicinal, cosmetic preparations.

Methodology: Test drug plants were collected from their natural habitat and authenticated. After separating the culms from the leaves, the material was cut into smaller pieces, shade-dried, and pulverized to obtain coarse and fine powder. These samples were subjected to comprehensive pharmacognostic evaluation and phytochemical standardization to establish quality and identity parameters.

Conclusion: Quality standards confirm its identity and reveal the presence of bioactive compounds, whereas physico-chemical standards denote its purity. HPTLC profile showed presence certain phytochemicals, like chlorogenic acid, gallic acid, caffeic acid, and ferulic acid. Thus, prepared standard monograph of this rare bamboo Ochlandra travancorica Benth. beneficial for future researches.

Keywords: Ochlandra travancorica Benth., Pharmacognosy, Phytochemistry, HPTLC

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How to Cite this Article

Sruthy KV, Suma V Mallya, Quality Control Constraints of Ochlandra Travancorica Benth. an Underexplored Medicinal Bamboo Species. J Ayu Int Med Sci. 2026;11(3):107-115.

Available From

https://jaims.in/jaims/article/view/5877/

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Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
None	Nil	Not required	10.36	

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Introduction

India is the cradle of some of the world's most ancient and enduring traditional medical systems, notably *Ayurveda, Siddha,* and *Unani*.[1] Rooted in holistic understanding of health & disease, *Ayurveda* has withstood the test of time and continues to be the most widely practiced traditional medical system in India.[2] Since centuries, *Ayurvedic* therapeutics has relied extensively on medicinal plants as primary sources of healing. However, in recent decades, many of these valuable herbal resources have come under severe threat due to overharvesting, deforestation, climate change, habitat loss, and unsustainable collection practices. The gradual disappearance of medicinal plants not only endangers ecological balance but also poses a serious threat to the continuity and integrity of *Ayurvedic* medicine, which is fundamentally dependent on naturally available plant resources. With more than 3,000 documented medicinal plant species and over 6,000 herbs used by local populations, the country has long served as a global hub of herbal medicine.[3] This diversity is not merely botanical but also cultural, as indigenous & tribal communities across India continue to preserve & practice folk medicinal knowledge passed down through generations.[4]

In the present era, when many classical herbs are becoming scarce or endangered, systematic exploration, documentation, and scientific validation of these *Anukta Dravyas (extrapharmacopeal)* assume immense significance. Much of this valuable ethnomedicinal knowledge remains confined to regional and tribal practices and risks being lost due to inadequate documentation. As practitioners and scholars of *Ayurveda*, it becomes both a responsibility and an opportunity to scientifically investigate these lesser-known medicinal plants, thereby enriching *Ayurvedic* Materia Medica and contributing to its global advancement.[5]

Ochlandra travancorica Benth. is one such lesser-known medicinal bamboo species, endemic to the Western Ghats of India, predominantly distributed in *Kerala, Karnataka* and parts of *Tamil Nadu*. It thrives in evergreen and semi-evergreen forests, particularly along riverbanks and streams.[6] This *Poaceae* bamboo is erect, shrubby, reed-like attains a height of 3–6 m, characterized by green culms with thin-walled internodes and broad, loosely attached culm sheaths.

The leaves are narrow-lanceolate with clasping sheaths, exhibiting typical bamboo features such as parallel venation and the presence of silica bodies.[7]

Traditionally, *Ochlandra travancorica* Benth. has held significant medicinal and utilitarian value among various tribal communities of *Kerala* especially in burn wound healing.[8] The peelings of mature culms are mixed with lime and applied to wounds to promote healing. Fresh mature culms are fashioned into surgical instruments, particularly by tribal midwives for cutting the umbilical cord.[9] The *Muthuvan* tribe employs powder scraped from the outer surface of the stem as a wound-dressing agent.[10]

Despite its extensive traditional usage, *Ochlandra travancorica* Benth. has been sparingly investigated scientifically. Present study aims to undertake a comprehensive pharmacognostic evaluation of this bamboo thereby providing a basic authentication data source.

Materials and Methods

Collection and Authentication

The culms and leaves of *Ochlandra travancorica* Benth. were collected from their natural habitat. Plant authenticated and a voucher specimen deposited at Department of Pharmacognosy, SDM Centre for Research and Allied sciences, Udupi with Voucher no. SDMCRAAS / 1707/ 23020801. Few samples were preserved in FAA solution for microscopy. Rest of sample was shade dried and used for further study.[11]

Macroscopic Evaluation

External features of the test sample *Ochlandra travancorica* Benth. Culm & leaf were documented. The macroscopic features were compared with local flora for authentication.[12]

Microscopic Evaluation

TS of culms and leaf were taken with sharp blade & observed under microscope after proper staining, as per the standard guidelines.[13]

Powder Microscopy

A pinch of powdered sample of culm was mounted on a microscopic slide with a drop of glycerine water.

Characters were observed using Zeiss AXIO trinocular microscope attached with Zeiss Axiocam camera under bright field light. Magnification of the figures are indicated by the precalibrated scale bars using Zeiss Axio vision Software.**[14]**

Physico-chemical Standardisation

Culm powder was evaluated for Physico-chemical tests like moisture content, total ash, acid insoluble ash, water soluble ash, alcohol and water-soluble extractive.**[15]**

Preliminary Phytochemical analysis

Preliminary phytochemical study of culm powder was carried out for the detection of various phytochemical constituents as per the standard guidelines.**[16]**

HPTLC

Chromatography study of Plant culm powder was carried out as per the standard guidelines. Sample is dissolved in 10 ml of chloroform and chloroform soluble portion was used for TLC. 4 and 8µl of the ethanol extract of samples of *Ochlandra travancorica* Benth. culm extract was applied on a precoated silica gel F_{254} on aluminium plates to a band width of 8mm using Linomat 5 TLC applicator. The plate was developed in Toluene: Ethyl acetate: Formic acid: Methanol (3.0: 3.0: 0.6: 0.8) and the developed plates were visualized under short UV, long UV and scanned under UV 280nm. Rf, color of the spots, densitometric scan and 3D Chromatograms were recorded.**[17]**

Results

Macroscopic Study

Culms

Erect thin walled, solid at nodes. Height usually 3-7m, with diameter of 2.5-5cm. Internodes 45-60cm long, smooth, green when young, later turning yellowish-brown. Yellowish-green externally in colour with smooth shiny surface. Fibrous to cut with hollow internodes. Don't posses any characteristic odour and are tasteless. (Figure 1a)

Leaf

Leaf simple, oblong lanceolate around 10-20cm long, 1.5-3.5cm broad, with acuminate tip and broad base, shortly petiolate. (Figure 1b)



Figure 1a: Macroscopy Culms of Ochlandra travancorica Benth.

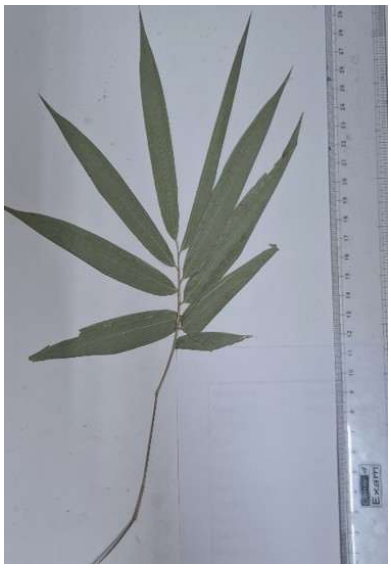


Figure 1b: Macroscopy leaf of Ochlandra travancorica Benth.

Figure 1: Macroscopy of *Ochlandra travancorica* Benth.

Microscopy of culms

TS of culm showed presence of cortex, epidermis, meta xylem, parenchyma, percyclic fibres, sclerenchyma, vascular bundle & xylem. Vascular bundles are prominently distributed throughout the ground tissue, containing metaxylem elements, xylem, and phloem. (Figure 2)

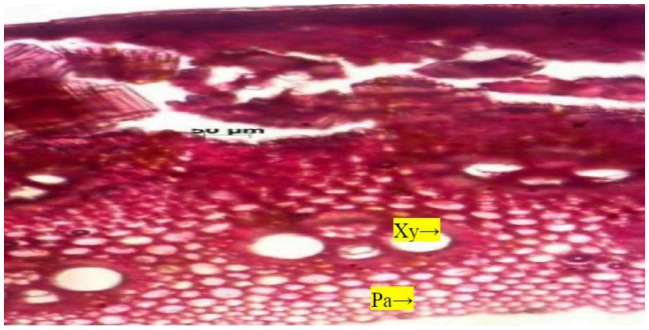


Figure 2a

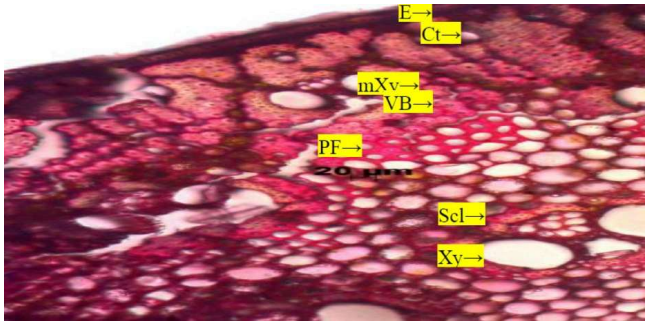


Figure 2b

Ct - cortex; E - epidermis; mXy - meta xylem; Pa – Parenchyma; PF - percyclic fibres; Scl - sclerenchyma; VB - vascular bundle; Xy - xylem

Figure 2: Microscopy of Culm *Ochlandra travancorica* Benth.

Microscopy of Leaf

Microscopy of leaf showed presence of epidermis, vascular bundle with lignified inner sheath, fusoid cells, bulliform cells, silica bodies, plicate cells, papillae, Pericyclic fibres, Xylem, Phloem and Sclerenchyma fibre. (Figure 3)

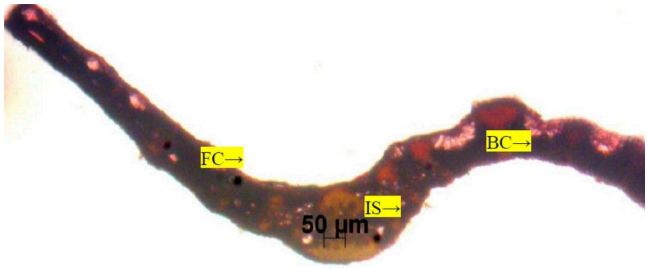


Figure 3a: Microscopy of leaf blade

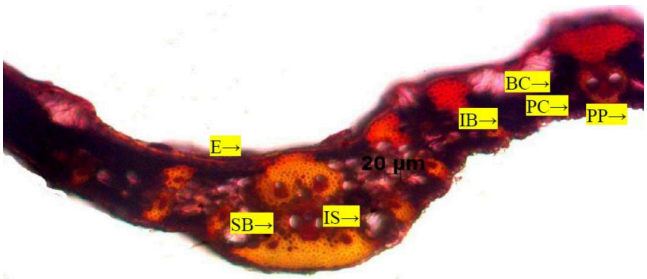


Figure 3b: Midrib

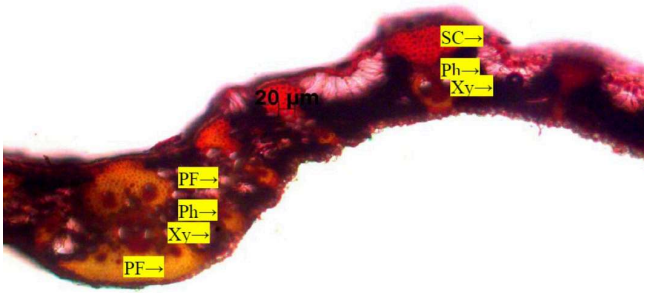


Figure 3c: Lamina

E – Epidermis; IS – Vascular bundle with lignified inner sheath; FC – Fusoid cells; BC – Bulliform cells; SB – Silica bodies; PC – Plicate cells; PP – Papillae; PF – Pericyclic fibres; Xy – Xylem; Ph – Phloem; SC – Sclerenchyma fibre

Figure 3: Microscopy of Leaf *Ochlandra travancorica* Benth.

Powder Microscopy

Powder revealed structural fragments including fibres, tracheids, vessels, pitted vessels, pollen grains, starch grains, and bundles of fibres. The presence of long, thick-walled fibres and tracheary elements with pits is consistent with bamboo tissue characteristics. (Figure 4)

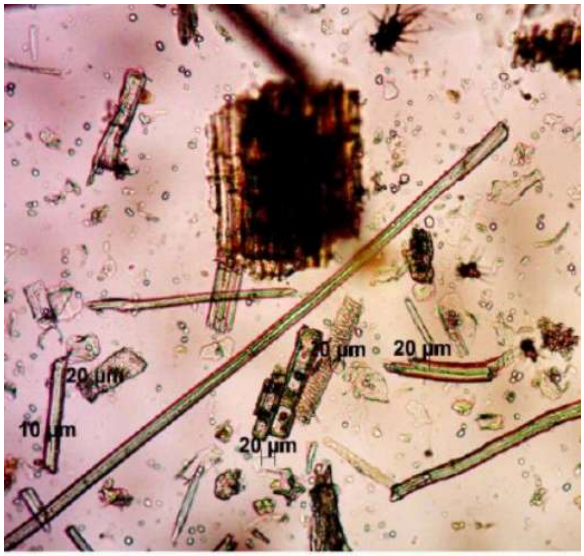


Fig. 4.a Fibres, Tracheids, Vessels

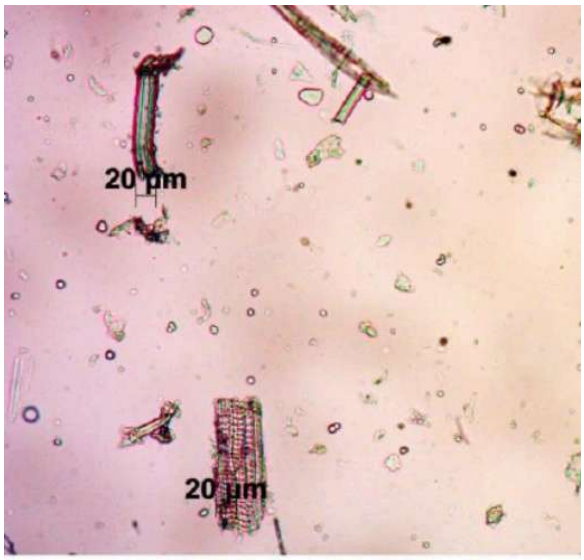


Fig. 4.b Pitted vessels

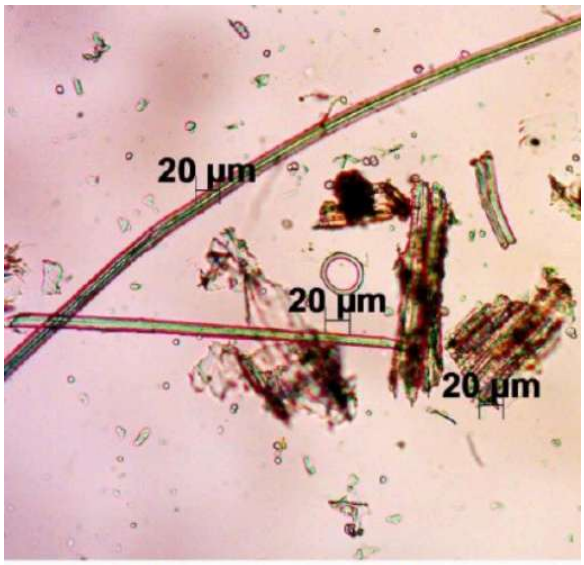


Fig. 4.c Fibres, Pollens

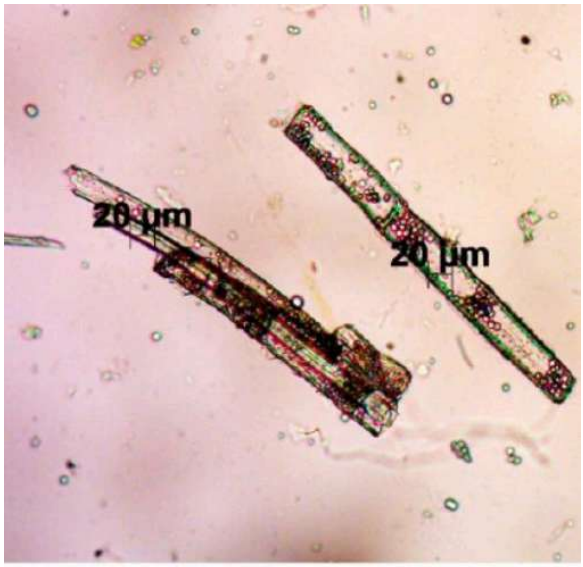


Fig. 4.d Pitted vessels

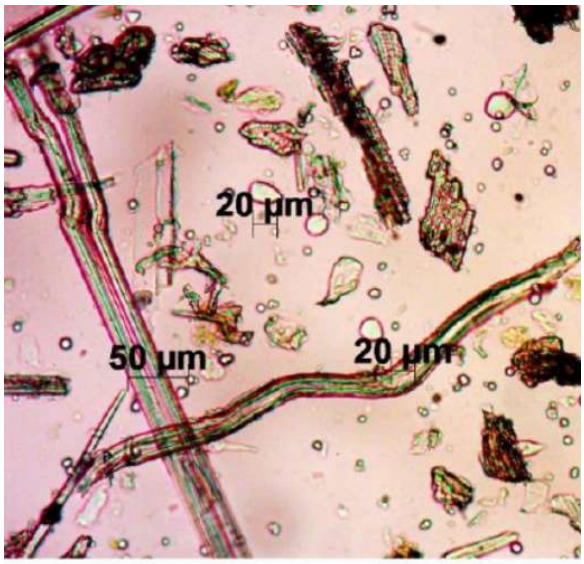


Fig. 4.e Fibres, Starch grains



Fig. 4.f Bundle of fibres

Figure 4: Powder microscopy of *Ochlandra travancorica* Benth. Culm

Physico-chemical standards

Physicochemical analysis provides essential baseline data about purity of test drug (Table 1).

Table 1: Physico-chemical standards of *Ochlandra travancorica* Benth.

Parameter	Results n = 3 (%w/w) (Avg.± SD)
Moisture content	7.68±0.01
Total Ash	1.40±0.68
Acid Insoluble Ash	0.91±0.01
Water soluble Ash	0.00±0.00
Alcohol soluble extractive value	20.63±0.01
Water soluble extractive value	0.00±0.00

Preliminary Phytochemical Analysis

Aqueous extract of test drug showed the presence of carbohydrates and coumarins, while all other constituents such as alkaloids, steroids, tannins, flavonoids, saponins, terpenoids, phenols, carboxylic acids, amino acids and resins were not detected. Alcoholic extract revealed the presence of steroids, carbohydrates, and resins. (Table 2)

Table 2: Preliminary phytochemical constituents of *Ochlandra travancorica* Benth.

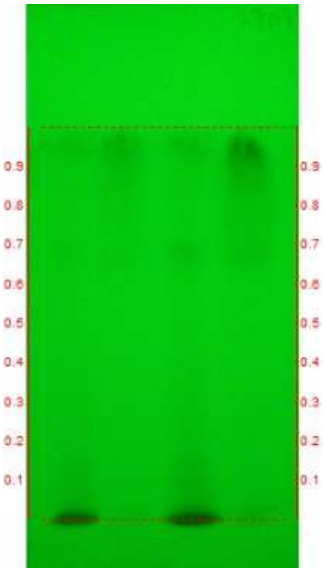
Test	Aqueous extract	Alcoholic extract
Alkaloid	-	-
Steroid	-	+
Carbohydrate	+	+
Tannin	-	-
Flavanoids	-	-
Saponins	-	-
Terpenoid	-	-
Coumarins	+	-
Phenols	-	-
Carboxylic acid	-	-
Amino acids	-	-
Resin	-	+

(+) = Present; (-) = Negative

HPTLC

High-Performance Thin Layer Chromatography (HPTLC) analysis of the ethanol extract of *Ochlandra travancorica* Benth. culm was performed using the solvent system toluene: ethyl acetate: formic acid: methanol (3.0:3.0:0.6:0.8v/v/v/v).

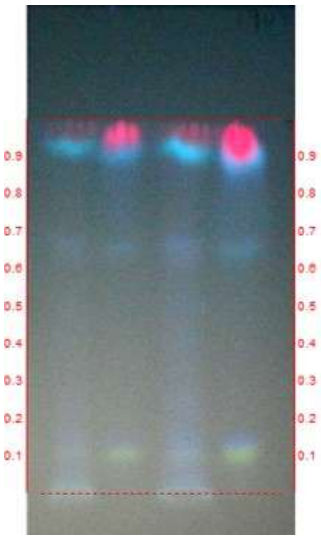
The chromatographic profile observed under short UV (254nm) and long UV (366nm) (Table 3) (Figure 5) (Figure 6).



Short UV

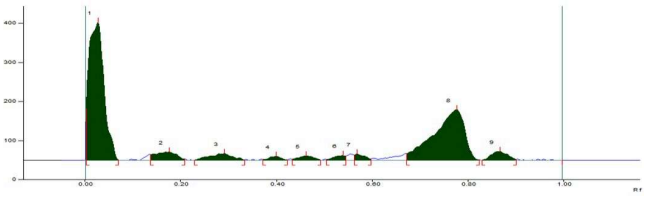
Table 3: Rf value of *Ochlandra travancorica* Benth. culm extract

Short UV	Long UV
-	0.10 (F. yellow)
-	0.66 (F. blue)
0.70 (Green)	-
0.84 (Green)	-
-	0.93 (F. blue)
-	-



Long UV

Figure 5: HPTLC photo documentation of ethanol extract of *Ochlandra travancorica* Benth. Culm extract



Track 3, ID: Ochlandra travancorica extract

Peak	Start Position	Start Height	Max Position	Max Height	Max %	End Position	End Height	Area	Area %
1	0.00 Rf	131.0 AU	0.03 Rf	351.7 AU	59.51 %	0.07 Rf	0.8 AU	7984.0 AU	47.80 %
2	0.14 Rf	14.4 AU	0.18 Rf	20.8 AU	3.52 %	0.21 Rf	3.5 AU	699.1 AU	4.19 %
3	0.23 Rf	0.4 AU	0.29 Rf	17.5 AU	2.96 %	0.33 Rf	1.4 AU	608.8 AU	3.65 %
4	0.37 Rf	2.3 AU	0.40 Rf	10.2 AU	1.72 %	0.42 Rf	1.1 AU	184.9 AU	1.11 %
5	0.43 Rf	2.8 AU	0.46 Rf	11.5 AU	1.94 %	0.49 Rf	0.1 AU	261.0 AU	1.56 %
6	0.50 Rf	2.1 AU	0.54 Rf	12.1 AU	2.05 %	0.55 Rf	11.3 AU	215.9 AU	1.29 %
7	0.56 Rf	13.7 AU	0.57 Rf	15.9 AU	2.69 %	0.60 Rf	3.7 AU	249.0 AU	1.49 %
8	0.67 Rf	17.7 AU	0.78 Rf	128.9 AU	21.81 %	0.82 Rf	0.9 AU	5939.0 AU	35.56 %
9	0.83 Rf	0.0 AU	0.87 Rf	22.5 AU	3.80 %	0.90 Rf	2.7 AU	560.1 AU	3.35 %

Figure 6: Ochlandra travancorica culm extract - Chlorogenic acid – (4.19%), Gallic acid – (1.49%), Caffeic acid (35.56%), Ferulic acid (3.35%)

Discussion

Ochlandra travancorica Benth. a lesser-known bamboo species, growing in southern parts of Inida. Culms and leaves of this bamboo are used in medicinal, cosmetic preparations.

Systematic pharmacognostic features recorded on any drugs helps in its authentication as well as further research.

Macroscopy

Culms are erect, thin, reflecting slender woody grass habit. Long internodes of culms, turning yellowish -brown on maturity, indicate normal lignification and aging. Distinct nodes and internodes with slightly swollen nodes bearing ring-like scars of fallen sheaths are characteristic & aid in species differentiation. These are tasteless and odourless, suggesting the absence of prominent volatile constituents.

Leaves are alternately arranged, simple, & oblong-lanceolate in shape, measuring about 10–20 cm in length & 1.5–3.5 cm in breadth. The cartilaginous, finely serrulate margin and acuminate apex are distinctive features, while the rounded base with a short petiole supports efficient attachment to the culm. The striate leaf sheath, often fringed with bristles, along with a short and entire ligule, is characteristic of the grass family and aids in taxonomic confirmation.**[18]**

Microscopy

TS of culm showed the presence of an outer epidermis with underlying cortex provides mechanical protection and resistance against environmental stresses. The vascular bundles are prominently distributed throughout the ground tissue, containing metaxylem elements, xylem, and phloem, which play vital role in conduction & mechanical support. The abundance of pericyclic fibres and sclerenchymatous tissues contributes to the characteristic rigidity and tensile strength of bamboo culms. The parenchymatous ground tissue surrounding these bundles aids in storage and provides flexibility, an adaptation often seen in fast-growing grass species like bamboo.**[19]** Overall, these features support the use of culm material in traditional applications such as weaving, construction, and handicrafts.

Microscopy of leaf showed characteristic features. The epidermis is well developed, sometimes with papillae, which reduces water loss and contributes to leaf surface protection. The presence of bulliform cells reflects the plant's adaptation to regulate leaf rolling during drought, helping in moisture conservation. The vascular bundle surrounded by a lignified inner sheath (bundle sheath) is a key diagnostic feature for bamboo species and indicates efficient conduction and structural reinforcement.

Fusoid cells, plicate mesophyll, and silica bodies are characteristic of *Poaceae* family members which confirm identity of the species.**[20]**

Silica deposition plays a defensive role against herbivory, while sclerenchyma fibres associated with vascular tissues provide mechanical stability.**[21]** These microscopic traits aid in distinguishing *Ochlandra travancorica* Benth. from morphologically similar bamboo species.

Powder microscopy

Powder characteristic of test drug revealed pitted vessels and tracheids indicate the type of secondary thickening present, which assists in water conduction. Starch grains reflect the storage function of ground parenchyma, and pollen grains may be due to floral residues during powder preparation.

These powder characters are crucial for identification of species in its processed or powdered form, especially in herbal drug standardization, preventing adulteration and ensuring quality control.**[22]**

Physico-chemical Standardisation

Physicochemical content of drug showed standard quantitative and qualitative parameters. The moisture content (7.68±0.01%) was found to be within the acceptable range, indicating reduced risk of microbial contamination & enzymatic degradation, thus ensuring better shelf life of the crude drug.**[23]**

Total ash (1.40±0.68%) value signifies the presence of inorganic matter, whereas the acid-insoluble ash (0.91±0.01%) suggests presence of siliceous substances, possibly due to environment or soil contamination. Notably, the absence of water-soluble ash (0.00±0.00%) indicates negligible contribution from water-soluble inorganic salts, which adds to the specificity of the drug.

The extractive values demonstrated a clear difference between alcohol and water-soluble fractions. The alcohol-soluble extractive (20.63±0.01%) was markedly higher than the water-soluble extractive (0.00±0.00%), signifying that the majority of secondary metabolites are soluble in alcohol rather than water. This strongly suggests the ethanol or hydroalcoholic solvents would be most suitable for extracting bioactive compounds such as alkaloids, flavonoids, or terpenoids from this plant material. **[24]**

Phytochemical Analysis

The detection of carbohydrates in aqueous extract indicates potential nutritive value and suggests that water is an effective solvent for extracting primary metabolites. The presence of coumarins is noteworthy as these compounds are associated with diverse biological activities including antimicrobial, wound healing and anti-oxidant properties.**[25]**

Steroids in alchoholic extract are bioactive compounds with potential role in anti-inflammatory and hormonal activities. Their presence in the alcoholic extract indicates that ethanol is a better solvent for extracting moderately polar to non-polar compounds. Resins are complex mixtures of terpenoids and phenolic compounds with known antimicrobial and protective properties. Their detection in alcoholic extract further underlines the solvent's efficiency in solubilizing such secondary metabolites.**[26]**

HPTLC

Under short UV (254nm), the stem extract showed two prominent green fluorescent bands at Rf 0.70 and 0.84. Under long UV (366nm), stem extract displayed bands at Rf 0.10 (fluorescent yellow) and Rf 0.66 (fluorescent blue). The stem extract also showed a blue fluorescent band at Rf 0.93.(Table 3, Figure 5). The markers are taken as chlorogenic acid, gallic acid, caffeic acid and ferulic acid asper literature on activity profile of culm.

The densitometric scan at 280 nm confirmed the presence of these compounds in extract. In the stem extract, chlorogenic acid (4.19%), gallic acid (1.49%), caffeic acid (35.56%), and ferulic acid (3.35%) were identified.

Conclusion

Ochlandra travancorica Benth. is an extrapharmacopoeal bamboo species endemic to Western Ghats commonly found in Kerala, Karnataka and Tamil Nadu. Culms of these plants are used by traditional healers in treating wound, skin eruptions using various dosage forms. Quality standards confirm its identity and reveal the presence of bioactive compounds such as steroids, coumarins, chlorogenic acid, gallic acid caffeic acid and ferullic acid, whereas physico chemical standards denote its purity. HPTLC profile showed presence certain phytochemicals, like chlorogenic acid, gallic acid, caffeic acid, and ferulic acid.

Thus, prepared standard monograph of this rare bamboo *Ochlandra travancorica* Benth. beneficial for future researches.

References

1. Pandey MM, Rastogi S, Rawat AKS. Indian traditional Ayurvedic system of medicine and nutritional supplementation. Evid Based Complement Alternat Med. 2013;2013:376327. *doi:10.1155/2013/376327 [Crossref][PubMed][Google Scholar]*

2. Shi Y, Zhang C, Li X. Traditional medicine in India. J Tradit Chin Med Sci. 2021;8:S51-5. *doi:10.1016/j.jtcms.2020.06.007 [Crossref][PubMed][Google Scholar]*

3. Kumar S, Dobos GJ, Rampp T. The significance of Ayurvedic medicinal plants. J Evid Based Complement Altern Med. 2017;22(3):494-501. *doi:10.1177/2156587216671392 [Crossref][PubMed][Google Scholar]*

4. Vyas H, Panara KB. Determination of Anukta Dravya through classical Ayurvedic principles. J Res Educ Indian Med. 2019;00(0). *doi:10.5455/JREIM.82-1513143868 [Crossref][PubMed][Google Scholar]*

5. Kumari RJ, Srivastava P, Srivastava G. A review on extrapharmacopeal drugs in Vatavyadhi. J Ayurveda Integr Med Sci. 2019;4(6):16-21. *[Crossref][PubMed][Google Scholar]*

6. Bhat GK. Flora of Udupi. Udupi: Indian Naturalist; 2003. *[Crossref][PubMed][Google Scholar]*

7. Anonymous. The Wealth of India. New Delhi: Council of Scientific and Industrial Research; 1996. *[Crossref][PubMed][Google Scholar]*

8. Bhat KG. Flora of South Kanara (Dakshina Kannada and Udupi District of Karnataka). Udupi: Taxonomy Research Centre; 2014. *[Crossref][PubMed][Google Scholar]*

9. Manjithotam J. Ethnobotanical studies of the tribal populations of Devikulam Taluk [dissertation]. Kottayam: Mahatma Gandhi University; 1997. *[Crossref][PubMed][Google Scholar]*

10. Bhat KG, Nagendran CR. Sedges and grasses. 1st ed. Dehradun: Bishen Singh Mahendra Pal Singh; 2001. *[Crossref][PubMed][Google Scholar]*

11. Shashidharan H, Mallya SV, Prabhu S, Sunilkumar KN. Identity parameters on traditionally used antiurolithiatic herb Scoparia dulcis Linn. J Ayurveda Integr Med Sci. 2017;2(6):70-6. *[Crossref][PubMed][Google Scholar]*

12. Mallya SV, Prabhu S, Vishwanatha U, Sunilkumar KN. Anatomical atlas of Panchavalkala: effective healing of five bark drugs used in gynecological disorder. J Ayurveda Herb Med. 2018;4(1):6-13. *[Crossref][PubMed][Google Scholar]*

13. Rao C, Mallya SV, Prabhu S. Histological illustration of fresh and one-year old preserved fruits Dhanyaka (Coriandrum sativum Linn.). Int J Bot Stud. *2020;5(3):264-6 [Crossref][PubMed] [Google Scholar]*

14. Lachita CV, Mallya SV, Naik T, Prabhu S. Quality control outprints of Kamala (Nelumbo nucifera Gaertn.), an aquatic medicinal plant. J Drug Deliv Ther. *2022;12(3):20-4 [Crossref][PubMed][Google Scholar]*

15. Harborne JB. Phytochemical methods: a guide to modern techniques of plant analysis. 2nd ed. London: Chapman and Hall; 1984. *[Crossref] [PubMed][Google Scholar]*

16. Jain A, Parashar A, Nema R, Narsinghani T. High performance thin layer chromatography (HPTLC): a modern analytical tool for chemical analysis. Curr Res Pharm Sci. 2014;4(8):14. *[Crossref][PubMed] [Google Scholar]*

17. Bhat KG, Nagendra CR. Sedges and grasses. Dehradun: Bishen Singh Mahendra Pal Singh; 2001. *[Crossref][PubMed][Google Scholar]*

18. Khandelwal KR. Practical pharmacognosy: techniques and experiments. Pune: Nirali Prakashan; 2008 . *[Crossref][PubMed][Google Scholar]*

19. Kokate CK, Purohit AP, Gokhale SB. Pharmacognosy. Pune: Nirali Prakashan; 2006. *[Crossref][PubMed][Google Scholar]*

20. Li Y, et al. The effect of developmental and environmental factors on secondary metabolites in medicinal plants. Plant Physiol Biochem. 2020;148:80-9. *[Crossref][PubMed][Google Scholar]*

21. Wallis TE. Textbook of pharmacognosy. New Delhi: CBS Publishers and Distributors; 1985. *[Crossref][PubMed][Google Scholar]*

22. Mukherjee PK. Quality control of herbal drugs. New Delhi: Business Horizons; 2002. *[Crossref] [PubMed][Google Scholar]*

23. Altemimi A, et al. Phytochemicals: extraction, isolation, and identification of bioactive compounds from plant extracts. Plants (Basel). 2017;6(4):42. *[Crossref][PubMed][Google Scholar]*

24. Sharma RK, Arora R. Herbal drugs: a twenty-first century perspective. New Delhi: Medical Publishers (P) Ltd; 2006. *[Crossref][PubMed] [Google Scholar]*

25. Evans WC. Trease and Evans' pharmacognosy. London: WB Saunders Ltd; 2002. *[Crossref] [PubMed][Google Scholar]*

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