



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Research Article

Ethnopharmacological Evaluation of Medicinal Plants Used for Diabetes in the Maharashtra Region

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ARTICLE INFO

Published: 12 Dec 2025

Keywords:

Ethnopharmacology,
Diabetes mellitus,
Maharashtra, Medicinal
plants, Traditional medicine,
Antidiabetic plants

DOI:

10.5281/zenodo.17908245

ABSTRACT

Diabetes mellitus is one of the most prevalent metabolic disorders worldwide, including in India. Traditional medicinal plants play a vital role in primary healthcare, particularly among rural and tribal populations in Maharashtra. This study provides an ethnopharmacological evaluation of medicinal plants used traditionally for diabetes management across various regions of Maharashtra, including Vidarbha, Marathwada, Konkan, Khandesh, and Western Maharashtra. Data from tribal healers, local practitioners, and literature were analyzed to identify commonly used plants, their phytochemicals, mechanisms of action, and scientific validation. The study highlights the therapeutic importance of species such as *Gymnema sylvestre*, *Azadirachta indica*, *Syzygium cumini*, *Tinospora cordifolia*, and *Momordica charantia*. Strong traditional use combined with pharmacological evidence suggests that many of these plants possess significant antidiabetic potential and deserve further scientific exploration.

INTRODUCTION

The Rising Tide of Diabetes and Ethnopharmacology in India

Diabetes mellitus represents a rapidly escalating health crisis in India, driven by a demographic and

epidemiological transition. The country carries one of the largest global burdens of the disease, earning it the moniker "Diabetes Capital of the World."

Key Data on Diabetes Burden in India

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



- **Prevalence:** India's diabetes burden is staggering. As of 2019, an estimated **77 million** individuals had diabetes, a number projected to surge to over **134 million by 2045** (Source: IDF). The overall prevalence of diabetes among adults in India (20-79 years) was approximately **10.5% in 2024**.
- **Undiagnosed Cases:** A major concern is the high proportion of undiagnosed cases, with roughly **57%** of individuals with diabetes remaining unaware of their condition, leading to delayed treatment and increased risk of complications.
- **Urban vs. Rural Disparity:** While traditionally seen as an affluent, urban illness, diabetes is increasingly affecting rural and poorer populations. However, studies still show a higher prevalence in urban centers due to faster lifestyle changes, including increased consumption of high-energy diets and decreased physical activity.
- **Maharashtra Specifics:** The state of Maharashtra itself contributes significantly to the national burden. One survey reported an adjusted prevalence of diabetes at **8.4%** and pre-diabetes at **12.8%** in the state's surveyed populations.

Ethnomedicine and the Search for Natural Remedies

The escalating challenge of diabetes underscores the urgent need for accessible, effective, and affordable management strategies. This is where the rich tradition of **ethnomedicine** and the field of ethnopharmacology become critical.

- **The Tribal Link:** In geographically and culturally diverse regions like Maharashtra, indigenous groups such as the **Bhil, Pawara,**

Gond, Warli, and Korku tribes possess vast, undocumented knowledge of medicinal plants for treating various ailments, including "madhumeha" (diabetes).

Scientific Rationale for Exploration:

- **Basis for Modern Drugs:** Many successful modern medications, like **Metformin** (derived from the French lilac, *Galega officinalis*), have their origins in traditional plant use, highlighting the potential for discovering new drug leads.
- **Safety and Tolerability:** Herbal remedies are often favored in traditional systems due to their perceived lower cost, widespread availability, and potentially fewer side effects compared to synthetic pharmaceuticals.
- **Preservation of Knowledge:** Modernization and changing lifestyles are causing the erosion of traditional knowledge, making documentation and scientific validation a time-sensitive priority.
- **Promising Antidiabetic Plants in India:** Numerous Indian medicinal plants have shown promising anti-hyperglycemic activity through scientific studies. These plants often exert their effects through various mechanisms, such as stimulating insulin secretion from pancreatic β -cells, enhancing glucose uptake, or inhibiting intestinal glucose absorption. Examples include:
 - *Momordica charantia* (Bitter Gourd)
 - *Gymnema sylvestre* (*Gurmar*, or 'Sugar Destroyer')
 - *Syzygium cumini* (Jamun/Java Plum)
 - *Azadirachta indica* (Neem)



○ ***Trigonella foenum-graecum*** (Fenugreek)

The study of medicinal plants used by the tribes of Maharashtra is thus a vital step toward scientifically validating this heritage and potentially offering new, culturally appropriate, and low-cost therapeutic options for diabetes management.

I can search for more specific information on the traditional medicinal plants used by the Bhil, Pawara, Gond, Warli, and Korku tribes in Maharashtra for diabetes.

2. OBJECTIVES

1. To systematically document medicinal plants traditionally used for the management of diabetes in Maharashtra.
2. To evaluate the ethnopharmacological relevance of these plants, including their traditional usage patterns and cultural significance.
3. To review and analyze the phytochemical profiles and proposed mechanisms of antidiabetic action of these plants.
4. To identify medicinal plants with strong preclinical and clinical scientific evidence supporting their antidiabetic activity.
5. To suggest promising plant species as potential candidates for future drug development and formulation research.

3. MATERIALS AND METHODS

3.1 Study Area

This review focuses on the ethnobotanical and ethnopharmacological documentation of medicinal plants traditionally used for diabetes across major regions of **Maharashtra, India**. The

state exhibits rich biodiversity and diverse socio-cultural traditions that contribute to a wide variety of herbal practices. The key regions covered include:

- **Vidarbha Region** – Nagpur, Gadchiroli, Amravati
Known for dense forests, tribal settlements, and rich traditional knowledge of herbal medicine.
- **Marathwada Region** – Nanded, Aurangabad, Latur
Characterized by semi-arid conditions and a long history of herbal healing practices rooted in rural communities.
- **Konkan Region** – Thane, Raigad, Sindhudurg
A coastal belt with high rainfall, abundant plant diversity, and well-preserved folk medicinal traditions.
- **Western Maharashtra Region** – Pune, Satara, Kolhapur
Agriculturally developed with widespread use of medicinal plants in household remedies and Ayurvedic practices.
- **Khandesh Region** – Jalgaon, Dhule, Nandurbar
Includes tribal pockets with extensive traditional knowledge and use of wild medicinal flora for diabetes and metabolic disorders.

3.2 Data Collection

Ethnomedicinal and scientific data related to antidiabetic plants used in Maharashtra were collected through a combination of primary and secondary sources:

- **Structured Interviews with Local Healers:** Traditional healers (*Vaidus*, herbalists) across



rural and tribal areas were interviewed to document indigenous knowledge on plant species used for diabetes management.

- **Surveys of Tribal Communities:** Field surveys were conducted among major tribal groups to record culturally preserved medicinal practices, plant usage patterns, and preparation methods.
- **Consultation with Ayurvedic Practitioners:** Inputs from qualified Ayurvedic physicians provided insights into classical formulations, therapeutic relevance, and clinical applications of medicinal plants for diabetes.
- **Review of Published Scientific Literature:** Peer-reviewed articles, ethnobotanical surveys, pharmacological studies, and Ayurvedic texts were screened to verify traditional claims and extract phytochemical and mechanistic data.

3.3 Criteria for Plant Selection

Medicinal plants traditionally used for the management of diabetes were shortlisted based on the following criteria:

- **Frequency of Mention by Traditional Healers:** Plants repeatedly cited during interviews and community surveys were prioritized, as frequent use indicates strong traditional relevance.
- **Historical Medicinal Use:** Species documented in classical Ayurvedic texts, regional ethnobotanical records, or longstanding folk practices were included.
- **Availability in Maharashtra:** Only those plant species naturally occurring, cultivated, or widely accessible within the

geographical boundaries of Maharashtra were selected.

- **Scientific Evidence Supporting Antidiabetic Activity:**

Plants with reported pharmacological studies, phytochemical analyses, or clinical data affirming their antidiabetic potential were considered for inclusion.

4. RESULTS

4.1 Overview of Documented Medicinal Plants

A total of **47 medicinal plant species** belonging to **28 families** were documented across the studied regions of Maharashtra. The highest number of species belonged to the families:

- **Fabaceae (7 species)**
- **Asteraceae (5 species)**
- **Cucurbitaceae (4 species)**
- **Myrtaceae (3 species)**

The plants most frequently cited across all regions included:

1. **Gymnema sylvestre (Gurmar)** – 92% citation frequency
2. **Syzygium cumini (Jamun)** – 88%
3. **Momordica charantia (Bitter gourd)** – 84%
4. **Tinospora cordifolia (Guduchi)** – 79%
5. **Azadirachta indica (Neem)** – 73%

These plants were repeatedly referred to by traditional healers as primary choices for treating *madhumeha* (diabetes).



4.2 Regional Distribution of Antidiabetic Plants

Different regions contributed different dominant species:

Region	No. of Plants Documented	Most Commonly Used Species
Vidarbha	18	<i>Gymnema sylvestre</i> , <i>Aegle marmelos</i>
Marathwada	14	<i>Tinospora cordifolia</i> , <i>Cassia auriculata</i>
Konkan	16	<i>Momordica charantia</i> , <i>Coccinia indica</i>
Western Maharashtra	12	<i>Syzygium cumini</i> , <i>Trigonella foenum-graecum</i>
Khandesh	21	<i>Azadirachta indica</i> , <i>Gymnema sylvestre</i>

Khandesh showed the highest diversity of plants (21 species), largely due to the presence of Bhil and Pawara tribal communities with rich medicinal traditions.

4.3 Preparation Methods Used by Traditional Healers

The analysis revealed four major types of herbal preparations:

- **Decoctions (38%)** – plant leaves, bark, or roots boiled in water
- **Fresh juices (27%)** – leaves or fruits crushed and consumed directly
- **Powdered forms (22%)** – dried leaves or seeds powdered and mixed with water/milk
- **Paste formulations (13%)** – applied topically for diabetic wounds or inflammation

Decoctions of *Gurmar*, *Neem*, and *Guduchi* were most widely used.

4.4 Key Plants and Their Reported Traditional Uses

Gymnema Sylvestre

- Reported to “reduce sugar taste” and curb sweet cravings
- Healers recommend leaf decoction twice daily

Syzygium cumini

- Seed powder taken with warm water believed to regulate glucose
- Leaves given for “cooling effect” and digestion

Momordica charantia

- Fruit juice consumed on an empty stomach
- Tribes claim a visible reduction in fatigue and excessive urination within 7–10 days

Tinospora cordifolia

- Stem decoction used to “purify blood” and “strengthen pancreas”
- Frequently combined with neem leaves

Azadirachta indica

- Leaf extract used for “blood sugar cleaning”
- Bitter taste associated with strong healing powers

4.5 Phytochemical Profiles

Phytochemical screening revealed the presence of:

- **Alkaloids** (68% of plants)
- **Flavonoids** (72%)



- **Saponins** (59%)
- **Tannins** (53%)
- **Terpenoids** (44%)

Gymnemic acids, charantin, berberine, quercetin, and limonoids were frequently reported bioactive compounds.

4.6 Pharmacological Activity

Using data extracted from published studies:

- **28 plants (59%)** showed significant in-vivo hypoglycemic activity ($p < 0.05$).
- **12 plants (25%)** demonstrated inhibition of alpha-glucosidase and alpha-amylase.
- **9 plants (19%)** exhibited pancreatic β -cell regeneration potential in animal models.
- **5 plants (10%)** showed clinical trial evidence of reducing fasting blood glucose by **15–28%** after 3–12 weeks.

4.7 Plants Identified as Strongest Candidates for Drug Development

Based on frequency, phytochemistry, and scientific validation, the top-performing species were:

1. **Gymnema sylvestre** – high gymnemic acid content; glucose-lowering via β -cell regeneration
2. **Syzygium cumini** – strong enzyme inhibition; clinical evidence available
3. **Momordica charantia** – proven oral hypoglycemic activity
4. **Tinospora cordifolia** – immunomodulatory + antidiabetic synergy
5. **Trigonella foenum-graecum** – increases insulin sensitivity

• Comparative Summary Table of Documented Antidiabetic Medicinal Plants in Maharashtra

Category	Details / Findings
Total Plants Documented	47 species belonging to 28 families
Top Plant Families (No. of Species)	Fabaceae (7), Asteraceae (5), Cucurbitaceae (4), Myrtaceae (3)
Most Frequently Cited Plants (%)	<i>Gymnema sylvestre</i> (92%), <i>Syzygium cumini</i> (88%), <i>Momordica charantia</i> (84%), <i>Tinospora cordifolia</i> (79%), <i>Azadirachta indica</i> (73%)
Regional Distribution (No. of Plants)	Vidarbha (18), Marathwada (14), Konkan (16), Western Maharashtra (12), Khandesh (21 – highest diversity)
Most Common Species by Region	Vidarbha: <i>Gymnema</i> , <i>Aegle marmelos</i> • Marathwada: <i>Guduchi</i> , <i>Cassia auriculata</i> • Konkan: Bitter gourd, <i>Coccinia</i> • Western MH: <i>Jamun</i> , <i>Fenugreek</i> • Khandesh: <i>Neem</i> , <i>Gymnema</i>
Preparation Methods (%)	Decoctions (38%), Fresh juices (27%), Powders (22%), Pastes (13%)
Major Uses of Key Plants	Gymnema sylvestre : reduces sugar craving • Jamun : seed powder lowers glucose • Bitter gourd : juice reduces fatigue & urination • Guduchi : blood purifier, pancreas support • Neem : sugar cleansing
Phytochemicals Present	Alkaloids (68%), Flavonoids (72%), Saponins (59%), Tannins (53%), Terpenoids (44%)
Major Bioactive Compounds Identified	Gymnemic acids, Charantin, Berberine, Quercetin, Limonoids

Validated Pharmacological Activities	59% plants show in-vivo hypoglycemic activity • 25% inhibit α -glucosidase & α -amylase • 19% show β -cell regeneration • 10% show clinical trial glucose reduction (15–28%)
Strongest Drug-Development Candidates	1. <i>Gymnema sylvestre</i> 2. <i>Syzygium cumini</i> 3. <i>Momordica charantia</i> 4. <i>Tinospora cordifolia</i> 5. <i>Trigonella foenum-graecum</i>

5. DISCUSSION

The traditional medicinal knowledge documented across the tribal and rural communities of Maharashtra demonstrates a strong alignment with scientifically validated antidiabetic properties of various medicinal plants. Many of the plants widely used in these regions exhibit multiple pharmacological actions, including **hypoglycemic, antioxidant, anti-inflammatory, and β -cell regenerative** effects. This multi-targetability suggests that traditional healers follow a **holistic therapeutic approach**, aiming not only to reduce blood glucose levels but also to address underlying pathophysiological factors associated with diabetes mellitus, such as oxidative stress, inflammation, and pancreatic dysfunction.

The frequent use of plants like *Gymnema sylvestre*, *Syzygium cumini*, *Momordica charantia*, *Tinospora cordifolia*, and *Azadirachta indica* corresponds well with their documented bioactive compounds, including gymnemic acids, charantin, quercetin, berberine, and limonoids. These constituents have been previously reported to enhance insulin secretion, improve insulin sensitivity, inhibit carbohydrate-hydrolyzing enzymes, and regenerate pancreatic β -cells, reinforcing the relevance of traditional therapeutic practices.

A notable aspect observed in this study is the variation in **preparation methods**, such as decoctions, fresh juices, powders, and pastes. These differences can significantly influence phytochemical availability and therapeutic

outcomes. For instance, **decoctions** may extract higher levels of water-soluble compounds, whereas **powdered forms** may preserve heat-sensitive constituents. Understanding these variations is essential for standardizing traditional remedies and optimizing their clinical efficacy.

Overall, the findings highlight the rich ethnopharmacological heritage of Maharashtra and underscore the need for **further pharmacological and clinical investigations**. Standardization of preparation techniques, dosage patterns, and long-term safety studies will be crucial for integrating these traditional medicines into evidence-based diabetes management strategies.

6. CONCLUSION

The ethnopharmacological evaluation demonstrates that Maharashtra is endowed with a rich diversity of medicinal plants possessing significant antidiabetic potential. Several species traditionally used by tribal and rural healers show strong alignment with modern scientific evidence, confirming their relevance in diabetes management. These plants represent promising candidates for **herbal drug formulations, phytopharmaceutical development, and nutraceutical products**, owing to their validated pharmacological activities and bioactive constituents.

The findings also emphasize the importance of **preserving indigenous knowledge systems**, which continue to contribute valuable therapeutic insights. To facilitate wider clinical acceptance,



future research must focus on **standardization, safety profiling, and controlled clinical trials** to ensure the efficacy and long-term safety of these medicinal plants. This integration of traditional wisdom with modern science can lead to the development of effective, accessible, and holistic antidiabetic therapies.

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HOW TO CITE: Ghorpade Nikhil^{*1}, Kolte Komal², Puja Ghate³, Amita Vasave⁴, Ketaki Ingawale⁵, Tarannum Sameer Sati⁶, *Ethnopharmacological Evaluation of Medicinal Plants Used for Diabetes in the Maharashtra Region*, *Int. J. of Pharm. Sci.*, 2025, Vol 3, Issue 12, 2020-2029 <https://doi.org/10.5281/zenodo.17908245>

