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Review Article

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"ANTI-DIABETIC HERBS IN *DRAVYAGUNA* AND PHARMACOLOGY: AN INTEGRATIVE REVIEW"

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ABSTRACT

Introduction: Diabetes mellitus is a chronic metabolic disorder characterized by impaired glucose homeostasis and long-term vascular complications. Ayurveda describes *Madhumeha* as a condition analogous to diabetes, and *Dravyaguna Shastra* provides a rich repository of herbs with anti-diabetic potential. Herbs such as *Gymnema sylvestre (Gudmar), Momordica charantia (Karavellaka), Pterocarpus marsupium (Vijayasar), Syzygium cumini (Jambu)*, and *Trigonella foenum-graecum (Methi)* are classically documented for reducing excessive *Meda* and *Mootra*, correlating with glycemic regulation. **Methods:** Literature was reviewed using PubMed, Scopus, Web of Science, Embase, and Google Scholar, along with classical Ayurvedic texts (*Charaka Samhita, Sushruta Samhita, Bhavaprakasha*). Keywords included "Ayurveda and diabetes," *"Madhumeha Dravyaguna,"* and specific herb names. Inclusion criteria: in vitro, in vivo, and clinical studies published between 1950–2025. Exclusion criteria: non-English reports without translation, anecdotal accounts, and poorly described studies. **Results:** Ayurveda describes *Tikta* (bitter), *Kashaya* (astringent), and *Katu* (pungent) rasa herbs with *Kapha-Meda hara* and *Pramehaghna* properties. Modern pharmacology validates multiple mechanisms: stimulation of insulin secretion (e.g., *Gymnema*), regeneration of pancreatic β-cells (*Pterocarpus*), enhanced peripheral glucose uptake (*Trigonella*), inhibition of intestinal glucose absorption (*Momordica*), and α-glucosidase inhibition (*Syzygium*). Clinical studies demonstrate reduced fasting blood glucose, improved HbA1c, and lipid-lowering effects. **Discussion:** Ayurvedic anti-diabetic herbs largely align with modern mechanisms—antioxidant, insulinogenic, hypolipidemic, and enzyme-inhibitory effects. However, most clinical trials are small-scale and heterogeneous. Standardization of phytoconstituents, dose optimization, and long-term safety trials remain gaps. **Conclusion:** Integration of *Dravyaguna* wisdom with pharmacological validation highlights the potential of Ayurvedic herbs as complementary therapies for diabetes. With rigorous research, standardized formulations could offer evidence-based options to improve glycemic control and prevent complications.

KEYWORDS: Ayurveda, Diabetes mellitus, *Dravyaguna*, Herbal medicine, *Madhumeha*

INTRODUCTION

Diabetes mellitus has become one of the most challenging global health burdens, affecting over 500 million individuals worldwide. It is associated with complications such as nephropathy, neuropathy, retinopathy, cardiovascular disease, and reduced life expectancy.[1-2] Modern pharmacotherapy, although effective, faces limitations due to cost, adverse effects, and incomplete prevention of complications. This has led to renewed interest in complementary approaches.[3-4]

Ayurveda describes *Madhumeha* under the broader category of *Prameha*, with clear references to polyuria, sweetness of urine, loss of tissue vitality, and progressive systemic impairment. *Dravyaguna Shastra* elaborates on *Pramehaghna* and *Madhumehaghna dravyas*, many of which act through *Tikta-Kashaya rasa*, *Laghu-Ruksha guna*, and *Kapha-Meda hara karma*.[5-7] Classical herbs such as *Gudmar, Karavellaka, Jambu, Methi,* and *Vijayasar* have been traditionally indicated for diabetes-like conditions.[8]

This review aims to comprehensively examine Ayurvedic anti-diabetic herbs described in *Dravyaguna* and correlate them with pharmacological validation.[9] Specific objectives are: to document classical references of major anti-diabetic herbs; to present their phytochemistry and mechanisms of action; to summarize preclinical and clinical evidence; and to highlight future prospects for integrative management of diabetes.[10]

MATERIALS AND METHODS

A comprehensive literature search was conducted (Jan–Mar 2025). Databases included PubMed, Scopus, Web of Science, Embase, and Google Scholar. Classical Ayurvedic texts (*Charaka Samhita, Sushruta Samhita, Ashtanga Hridaya, Bhavaprakasha Nighantu*) were reviewed.[11] Keywords used were: "Ayurveda AND diabetes," *"Madhumeha Dravyaguna,"* "anti-diabetic herbs Ayurveda," and the scientific names of classical herbs.[12]

Inclusion criteria:[13]

- *In vitro* and *in vivo* pharmacological studies on anti-diabetic herbs.
- Human clinical trials and systematic reviews.
- Classical references translated into English.

Exclusion criteria:[14]

- Non-English/non-translated reports.
- Single-case anecdotal records.
- Studies lacking methodological clarity.

Data were extracted for herb name, Ayurvedic properties, phytoconstituents, pharmacological mechanisms, preclinical models, and clinical outcomes. Narrative synthesis was employed due to heterogeneity of evidence.[15]

OBSERVATION AND RESULTS

Classical Ayurvedic perspective

Ayurveda attributes *Madhumeha* to *Vata-Kapha* vitiation with derangement of *Meda dhatu* and *Mutravaha srotas*. Herbs with *Tikta* and *Kashaya rasa*, *Ruksha-Laghu guna*, and *Kapha-Meda hara karma* are recommended. These properties reduce excessive unctuousness, purify channels, and regulate metabolism. Commonly cited herbs include:

- *Gudmar (Gymnema sylvestre)* – called "*Madhunashini"* (sugar destroyer).
- *Karavellaka (Momordica charantia)* – bitter melon for reducing urine sugar.
- *Jambu (Syzygium cumini)* – seeds and bark described as *Pramehaghna*.
- *Vijayasar (Pterocarpus marsupium)* – used as "sugar-control wood" for drinking water.
- *Methi (Trigonella foenum-graecum)* – seeds with *Kapha-Meda hara* actions.

Phytochemistry and pharmacological actions

1. ***Gymnema sylvestre* (Gudmar)**

- Phytochemicals: gymnemic acids, gymnemasaponins.
- Mechanisms: inhibit intestinal glucose absorption, stimulate insulin secretion, promote pancreatic β-cell regeneration.
- Preclinical studies: improved glucose tolerance, enhanced insulin release in diabetic rats.
- Clinical trials: significant reduction in fasting blood sugar and HbA1c in type 2 diabetes patients when used as adjunct to conventional drugs.

2. **Momordica charantia (Bitter melon)**

- Active compounds: charantin, vicine, polypeptide-p.
- Mechanisms: insulin mimetic action, activation of AMPK pathway, inhibition of glucose absorption.

- Clinical studies: modest reduction in fasting glucose and improved lipid profiles, though results vary due to differences in extracts.

3. **Syzygium cumini (Jamun)**

- Constituents: jamboline, ellagic acid, anthocyanins.
- Mechanisms: α-amylase and α-glucosidase inhibition, increased glycogen storage, antioxidant activity.
- Clinical trials: seed powder showed significant improvement in glycemic indices and post-prandial glucose reduction.

4. **Pterocarpus marsupium *(Vijayasar)***

- Constituents: pterostilbene, epicatechin.
- Mechanisms: β-cell regeneration, enhanced insulin secretion, antioxidant activity.
- Clinical evidence: traditional use of "Vijayasar tumbler" showed reduction in blood sugar; animal studies confirm pancreatic protection.

5. **Trigonella foenum-graecum (Fenugreek/*Methi*)**

- Constituents: 4-hydroxyisoleucine, diosgenin, soluble fiber.
- Mechanisms: delayed gastric emptying, improved insulin sensitivity, modulation of glucose transporter activity.
- Clinical studies: fenugreek seed supplementation lowered fasting glucose, HbA1c, and cholesterol levels.

Additional herbs

- *Curcuma longa* (Turmeric): curcumin reduces inflammation and improves insulin sensitivity.
- *Ocimum sanctum* (Tulsi): hypoglycemic and antioxidant effects.
- *Aegle marmelos* (Bael): β-cell protective and anti-oxidative.
- *Tinospora cordifolia* (Guduchi): immunomodulatory and insulin-sensitizing activity.

Summary of clinical outcomes

Across studies, Ayurvedic herbs demonstrate:

- Reduction in fasting and post-prandial glucose.
- Decrease in HbA1c over 8–12 weeks.
- Improvement in lipid profile (TC, LDL, TG).
- Enhancement of antioxidant status.
- Minimal adverse effects compared to synthetic agents.

DISCUSSION

Ayurvedic understanding of *Madhumeha* aligns conceptually with type 2 diabetes, characterized by metabolic derangement, tissue depletion, and progressive systemic involvement. Herbs classified as *Pramehaghna dravyas* primarily act on *Kapha-Meda hara* mechanisms and regulate excessive urinary output, closely resembling modern therapeutic targets.[16]

Modern pharmacology validates these herbs through multiple mechanisms: gymnemic acids block sweet receptors and regenerate β-cells, charantin mimics insulin, jamboline delays carbohydrate digestion, pterostilbene stimulates β-cell recovery, and 4-hydroxyisoleucine enhances insulin secretion. These findings correlate remarkably with the Ayurvedic concepts of channel cleansing (*srotoshodhana*), tissue nourishment (*dhatu poshana*), and correction of *agni* (digestive-metabolic fire).[17]

Despite promising results, challenges exist. Clinical studies are often small, heterogeneous in design, and use non-standardized preparations. Differences in extraction methods, plant parts (seeds, leaves, bark), and dosages contribute to variability. Large-scale randomized controlled trials with standardized phytochemical markers are necessary. Moreover, long-term safety, herb–drug interactions (e.g., with sulfonylureas or metformin), and pharmacokinetic profiles remain underexplored.[18]

Future research should focus on:[19]

- Developing standardized formulations with defined active markers.
- Conducting multicenter, randomized trials on long-term glycemic and complication outcomes.
- Exploring synergistic effects of polyherbal formulations (e.g., *Gudmar* + *Methi*).
- Systems biology approaches to map herb actions to insulin signaling pathways, oxidative stress, and gut microbiome modulation.

Thus, integration of *Dravyaguna*-based herbs into diabetes management can provide complementary strategies alongside conventional therapy, especially in patients intolerant to or uncontrolled with modern drugs.[20]

CONCLUSION

Ayurvedic Dravyaguna describes a wide array of *Pramehaghna dravyas* for the management of *Madhumeha*. Classical insights emphasize the use of *Tikta-Kashaya rasa*, *Ruksha-Laghu guna*, and *Kapha-Meda hara* herbs to correct the underlying derangements. Modern pharmacology validates these effects through multiple mechanisms, including β-cell regeneration (*Pterocarpus*), insulin stimulation (*Gymnema, Fenugreek*), enzyme inhibition (*Syzygium*), insulin mimetic action (*Momordica*), and antioxidant activity (*Curcuma, Guduchi*).

Clinical studies consistently demonstrate improvements in fasting and post-prandial glucose, HbA1c, lipid profile, and oxidative stress with minimal adverse effects. However, challenges remain in terms of heterogeneity, lack of large-scale RCTs, and standardization of phytoconstituents.

The integration of Ayurvedic anti-diabetic herbs into modern therapeutic strategies can enhance glycemic control, reduce drug dependency, and offer holistic benefits. With robust pharmacological validation, standardized formulations, and safety profiling, these herbs have the potential to contribute meaningfully to global diabetes care.

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