

Geographical Distribution of *Gymnema sylvestre* R.Br. and Diversification of Gymnemic Acid Content: A Review

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Abstract: *Gymnema sylvestre* R.Br. is an important medicinal plant extensively used for the management of diabetes mellitus due to the presence of gymnemic acids. The concentration of these bioactive triterpenoid saponins varies significantly with geographical distribution, ecological conditions, and genetic diversity (Saneja *et al.*, 2010; Tiwari *et al.*, 2014). The present review highlights the global and Indian distribution of *G. sylvestre* and examines the factors responsible for diversification in gymnemic acid content across different regions. Understanding this variation is crucial for quality control, standardization, and selection of elite chemotypes for pharmaceutical and nutraceutical applications.

Keywords: *Gymnema sylvestre*, Gymnemic acid, Geographical variation, Chemotype, Antidiabetic plants

1. Introduction

Medicinal plants exhibit considerable variation in their phytochemical composition depending on environmental, geographical, and genetic factors (Warrier *et al.*, 1996). *Gymnema sylvestre* R.Br., commonly known as Gudmar or Madhunashini, is a perennial woody climber widely used in traditional systems of medicine for the treatment of diabetes mellitus (Khare, 2007; Saneja *et al.*, 2010).

Gymnemic acids, the principal bioactive constituents of *G. sylvestre*, are responsible for inhibition of intestinal glucose absorption, stimulation of insulin secretion, regeneration of pancreatic β -cells, and suppression of sweet taste perception (Persaud *et al.*, 1999; Liu *et al.*, 2009). However, several studies have reported substantial variation in gymnemic acid content among plant populations collected from different geographical regions (Malik *et al.*, 2010; Tiwari *et al.*, 2014). The present review focuses on the geographical distribution of *G. sylvestre* and its correlation with diversification in gymnemic acid content.

2. Botanical Profile

Family: Apocynaceae

Habit: Perennial woody climber

Part used: Leaves

Active constituents: Gymnemic acids (oleanane-type triterpenoid saponins) (Khare, 2007; Warrier *et al.*, 1996)

External Morphology:

The fresh leaves which are mainly the economic part of the plant were green in colour and elliptical in shape, with an average weight of 0.157 grammes, length of 4.46 cm, and width of 2.56 cm. The flower is small and yellow, and it grows in clusters. The part that holds the seeds in is long and skinny, and it can be up to 3 inches long. The base of the leaf is rounded or heart-shaped, with 6–13 mm long pubescent petioles; the leaf is ovate-elliptic, acute, or shortly acuminate, and pubescent on both sides. Fruits ripen from March to May, while flowers bloom from October to

January (Kumar, and Jnanesha, 2017). The powdered substance has a mildly greenish yellow hue, a bitter flavour, and a pleasant, fragrant aroma (Saneja, *et al.*, 2010).

3. Geographical Distribution

3.1 Global Distribution

Gymnema sylvestre is widely distributed in tropical and subtropical regions of the world, particularly in South and Southeast Asia, Africa, and Australia (Warrier *et al.*, 1996; Tiwari *et al.*, 2014). Major regions include: India, Sri Lanka, Bangladesh, Myanmar, Thailand, Malaysia, Indonesia, Vietnam, Southern China, Tropical Africa, Northern Australia. Among these regions, India represents the richest genetic reservoir and the most extensively studied population of *G. sylvestre* (Khare, 2007).

3.2 Distribution in India

In India, *G. sylvestre* occurs predominantly in dry deciduous and moist deciduous forests across diverse agro-climatic zones (Warrier *et al.*, 1996). Major distribution zones include:

- Central India: Madhya Pradesh, Chhattisgarh
- Western India: Maharashtra (Vidarbha and Western Ghats), Gujarat
- Southern India: Tamil Nadu, Karnataka, Kerala
- Eastern India: Odisha, Jharkhand
- Northern and North-Eastern India: Uttar Pradesh, Assam

This wide distribution contributes significantly to genetic and chemotypic diversity within the species (Tiwari *et al.*, 2014).



Figure 1: A flowering Twig *Gymnema Sylvestre* R.Br

4. Diversification of Gymnemic Acid Content

4.1 Regional Variation

Quantitative phytochemical investigations have revealed significant regional variation in gymnemic acid concentration among *G. sylvestre* populations (Malik *et al.*, 2010; Tiwari *et al.*, 2014).

High content regions: Central India (Madhya Pradesh, Chhattisgarh) and parts of Maharashtra exhibit the highest gymnemic acid levels. Dry climatic conditions and moderate environmental stress are known to enhance secondary metabolite synthesis in medicinal plants (Saneja *et al.*, 2010).

Moderate content regions: Southern and eastern states such as Tamil Nadu, Karnataka, and Odisha show moderate gymnemic acid levels, possibly due to relatively stable temperature and moisture conditions (Malik *et al.*, 2010).

Low content regions: High rainfall and humid regions such as Kerala and North-Eastern India often exhibit lower gymnemic acid concentrations, potentially due to dilution effects and reduced stress-induced biosynthesis (Tiwari *et al.*, 2014).

4.2 International Variation

Comparative studies suggest that *G. sylvestre* populations from Sri Lanka and Southeast Asian countries possess moderate gymnemic acid content, whereas African and Australian populations generally show lower concentrations compared to Indian accessions (Warrier *et al.*, 1996; Khare, 2007).

5. Factors Influencing Gymnemic Acid Diversification

5.1 Climatic Conditions

Temperature variation, drought stress, and seasonal changes significantly influence triterpenoid saponin biosynthesis in *G. sylvestre* (Saneja *et al.*, 2010).

5.2 Soil Characteristics

Lateritic and red soils rich in minerals favor higher gymnemic acid accumulation compared to alluvial soils, as reported in Indian populations (Malik *et al.*, 2010).

5.3 Altitude

Low to mid-altitude regions (300–600 m) are considered optimal for gymnemic acid synthesis, likely due to favorable temperature and light conditions (Tiwari *et al.*, 2014).

5.4 Seasonal Variation

Leaves harvested during post-monsoon and winter seasons show higher gymnemic acid content than those collected during peak monsoon, indicating seasonal regulation of metabolite accumulation (Malik *et al.*, 2010).

5.5 Genetic and Chemotypic Diversity

The existence of high-, moderate-, and low-gymnemic-acid chemotypes suggests strong genetic control over gymnemic acid biosynthesis within the species (Tiwari *et al.*, 2014).

6. Pharmaceutical and Therapeutic Implications

Variation in gymnemic acid content directly affects the antidiabetic efficacy of *G. sylvestre* extracts (Persaud *et al.*, 1999; Liu *et al.*, 2009). Therefore: Region-specific sourcing of raw material is essential, Standardization through HPLC profiling is necessary; Selection and cultivation of elite chemotypes can improve therapeutic consistency and drug quality (Saneja *et al.*, 2010)

7. Conclusion

Gymnema sylvestre exhibits wide geographical distribution with pronounced diversification in gymnemic acid content. Central and Western Indian populations represent high-gymnemic-acid chemotypes and are most suitable for pharmaceutical applications (Khare, 2007; Tiwari *et al.*, 2014). A clear understanding of geographical, environmental, and genetic influences on gymnemic acid biosynthesis is essential for quality assurance, cultivation strategies, and effective utilization of this important antidiabetic medicinal plant.

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