A Review on Phytochemical and Pharmacological Properties of *Gymnema Sylvestre*

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Abstract

Gymnema sylvestre, also known as "gurmar," is a well-known herb in Ayurvedic medicine for its unique ability to help regulate blood sugar levels. This herb, a large woody climber native to the dry forests of India, contains bioactive compounds called triterpene saponins, with gymnemic acid being the main phyto constituent responsible for its anti-diabetic and anti-sweet properties. In addition to gymnemic acid, researchers have identified other bioactive constituents in *Gymnema sylvestre* that contribute to its various pharmacological effects. These effects include antidiabetic, antioxidant, antimicrobial, anti-inflammatory, immune-modulatory, and cytotoxic activities. *Gymnema* extracts are commonly used in dietary supplements to support blood sugar levels, body weight management, and cholesterol and triglyceride levels, as well as to reduce cravings for sugary foods. The herb's anti-sweet properties are attributed to triterpene saponins such as gymnemic acids, gymnema saponins, and a

polypeptide known as 'gurmarin.' This review highlights the traditional uses of *Gymnema sylvestre* in herbal medicine and its transition to modern medications, providing an overview of the herb's phytochemistry and its various pharmacological activities.

Keywords: *Gymnema sylvestre*, Phyto chemicals, Antidiabetic, Antioxidant

Introduction

The use of naturopathic remedies for treating diseases has a rich history dating back to ancient times and is increasingly gaining popularity in modern times. In India alone, there are approximately 45,000 plant species, with thousands of them holding pharmacological significance (Yusuf et al., 2022). Among these plants, many have been recognized for their medicinal properties, making them valuable resources for developing natural treatments. Diabetes mellitus stands out as a significant global health concern today (Kurya et al., 2022), affecting around 10% of the world's population. The increasing prevalence of this condition has made it a focus for healthcare providers and researchers worldwide. Recent assessments by the World Health Organization (WHO) reveal that herbal medicines are now being used by 80% of the population as their primary healthcare choice. WHO identifies over 21,000 plant species with the potential to treat various ailments, underscoring the value of medicinal plants (Rafieian-Kopaei, 2012). Treatment using these plants is often seen as safe and with minimal to no side effects, making them a preferred option for many.

Gymnema sylvestre, also known as "gurmar," is a well-known Ayurvedic herb appreciated for its ability to control sugar levels. Belonging to the Asclepiadaceae family, this plant is utilized in traditional medicine and dietary supplements for its multitude of health benefits. It thrives in dry forests at altitudes up to 600 meters and can be found in tropical forests across central and western India, as well as regions like Banda, Konkan, Western Ghats, Deccan, and beyond in the country (Laha et al., 2019). The antidiabetic properties of gymnema were discovered through the isolation and purification of the active compound, gymnemic acid, found in its leaves. This herb is valued for its therapeutic effects in treating conditions such as diabetes mellitus, arthritis, anemia, osteoporosis, hypercholesterolemia, cardiopathy, asthma, microbial infections, indigestion, and its anti-inflammatory properties (Khan et al., 2019). *Gymnema sylvestre* extract is incorporated into dietary supplements to aid in weight loss and lower cholesterol and triglyceride levels, showing promise for modern dietary and pharmacological applications (Devangan et al., 2021). Gymnemic acid, a crucial component of *Gymnema sylvestre*, acts by suppressing sweetness and reducing sugar cravings through the blocking of sugar receptors on the tongue. Various herbal preparations of this herb are utilized in nutritional supplements, beverages, tea

bags, health tablets, and confectioneries, highlighting its versatility and widespread use in different forms (Raghavendra et al., 2018).

Phytochemical Constituents

Gymnema sylvestre leaves are packed with bioactive compounds, particularly triterpene saponins, which fall into the categories of oleanane and dammarene classes (Tiwari et al., 2014). Notable components within the oleanane saponins group include gymnemic acids and gymnema saponins, while the dammarene class comprises gymnemasides. Additionally, the leaves boast a medley of other substances such as resins, chlorophyll, albumin, tartaric acid, formic acid, carbohydrates, butyric acid, anthraquinone derivatives, organic acids, parabin, inositole alkaloids, calcium oxalate, lignin, and cellulose. Recent research has identified a novel flavonol glycoside called kaempferol 3-O-beta-D-glucopyranosyl-(1-->4)-alpha-L-rhamnopyranosyl-(1-->6) beta-D-galactopyranoside in the plant's aerial parts (Liu et al., 2004). Moreover, *Gymnema sylvestre* is also enriched with anthraquinones, flavones, hentriacontane, pentatriacontane, phytin resins, dquercitol, chlorophylls, and various acids like tartaric, formic, and butyric acid. The plant extract has demonstrated the presence of alkaloids as well (Fabia et al., 2013).

Pharmacological Properties:

- **Antidiabetic activity**

Numerous research studies have found that *G. sylvestre* utilizes various pathways to exert its anti-diabetic effects, some of which are comparable to those of oral hypoglycemic medications, while others are distinct (Leach et al., 2007). The key bioactive components accountable for these effects are triterpene saponins, specifically gymnemic acids, gymnema saponins, and the polypeptide gurmarin (Kang et al., 2012). According to a study by Baskaran et al. (1990), *G. sylvestre* has the potential to stimulate insulin release from the islets of Langerhans in the pancreas, thus aiding in glycaemic control. The research focused on the antioxidant properties of Gymnema leaf extracts, particularly their ability to combat oxidative stress in diabetic rats. Using ethanolic extracts, various antioxidant assays were carried out, including the thiobarbituric acid (TBA) assay, superoxide dismutase (SOD)-like activity assay, and the 2,2'-Azinobis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) assay as outlined by Vats et al. (2023). the antihyperglycemic properties of a crude saponin fraction and five triterpene glycosides (including gymnemic acids I–IV and gymnema saponin V) obtained from the methanolic extract of leaves were noted. It was observed that administering gymnemic acid IV at doses of 3.4/13.4 mg/kg led to a reduction in blood glucose levels ranging from 14.0–60.0% within 6 hours, surpassing the effects of glibenclamide (Sugihara et al. in 2020).

- **Effect on Body Weight**

Gymnema Sylvestre's ethanol extract was found to decrease body weight in Wister rats in a study by Shigematsu et al., (2001). Additionally, Fatani et al., (2015) reported significant weight reduction ($p < 0.001$) in Streptozotocin-induced diabetic Albino rats treated with the same extract. However, a separate study by Ahmed et al., (2010) showed that the ethanol extract of *Gymnema Sylvestre* caused an increase in body weight, as well as the weight of the liver and pancreas in alloxan-induced diabetic Wistar rats.

- **Anti-Inflammatory Activity**

In a study conducted on rats, the aqueous extract of *G. sylvestre* leaves was examined for its anti-inflammatory effects at doses of 200, 300, and 500 mg/kg using carrageenin-induced paw edema and cotton pellet methods. The liquid extract at 300 mg/kg reduced paw edema volume by 48.5% within 4 hours of administration, while the standard drug phenylbutazone reduced edema volume by 57.6% compared to the control. Additionally, doses of 200 mg/kg and 300 mg/kg of the aqueous extract showed significant reduction in granuloma weight compared to the control group (Malik et al., 2008).

- **Hypolipidemic Activity**

A key factor leading to atherosclerosis and associated conditions such as coronary artery disease is hyperlipidemia (Kaushik et al., 2011). *G. sylvestre* was found to significantly reduce cholesterol levels in a hypertension model. It also showed inhibitory effects on hormone-sensitive lipase activity in adipose tissue, leading to suppression of triglyceride release. When administered orally at doses of 400, 600, and 800 mg per kg of body weight once a day for 30 days, *G. sylvestre* demonstrated these effects (Mall et al., 2009).

- **Antibiotic and Antimicrobial Activity**

The concentrated ethanol extract from *G. sylvestre* leaves showed strong antimicrobial effects on Bacillus pumilis, B. subtilis, Pseudomonas aeruginosa, and *Staphylococcus aureus*, with no activity observed against Proteus vulgaris and *Escherichia coli* (Satdive et al., 2003). *Gymnema sylvestre* leaf extracts displayed promising potential as an herbal antibiotic remedy, proving effective in treating infections caused by various microbes (Saumendu et al., 2010). Research also delved into the antibacterial properties of *G. sylvestre* and gymnemic acid against *E. coli* and *B. cereus*, establishing a notable antimicrobial impact on these microorganisms (Yogisha and Raveesha, 2009). The antimicrobial potential of methanolic extracts from both aerial and root parts of *G. sylvestre* was evaluated. The findings revealed that the methanol extracts showed significant antimicrobial activity across a wide range of pathogens when tested under acidic conditions,

demonstrating their broad-spectrum effectiveness (Bhuvaneswari et al. 2011),

- **Hepatoprotective Activity**

The hepatoprotective properties of a hydro-alcoholic extract of *G. sylvestre* were investigated using freshly prepared rat hepatocytes. The extract, obtained through hot maceration, was tested at concentrations of 200, 400, 600, and 800 µg/mL. Results showed that concentrations of 200, 400, and 600 µg/mL exhibited significant antihepatotoxic effects against D-galactosamine-induced hepatotoxicity, while the 800 µg/mL concentration showed cytotoxicity. Treatments with the hydroalcoholic extract of *G. sylvestre* led to a dose-dependent restoration of the altered biochemical parameters towards normal levels ($P < 0.001$) in comparison to D-galactosamine treated groups (Srividya et al. 2010).

- **Antioxidant activity**

Gymnema sylvestre is well-known for its powerful antioxidant properties, which are essential for its healing capabilities. With its rich content of bioactive substances like gymnemic acids, flavonoids, and saponins, this plant exhibits strong antioxidant effects. These compounds work by combating free radicals, thus averting oxidative stress and cell harm. The antioxidants found in *Gymnema sylvestre* are key in shielding the body from chronic conditions like diabetes, heart diseases, and specific types of cancer (Yeh et al., 2003). Research has indicated that the ethanolic extract of *Gymnema sylvestre* demonstrates notable antioxidant properties, as demonstrated by its ability to decrease lipid peroxidation and boost the activity of antioxidant enzymes such as superoxide dismutase (SOD) and glutathione peroxidase. These characteristics establish this species as a valuable natural solution for alleviating oxidative stress-related health concerns and supporting overall health. A key compound in GS, C-4 pearl dimethyledoleanes, also enhances its antioxidant activity. The IC50 values for various antioxidant assays including DPPH scavenging, superoxide radical scavenging, inhibition of in-vitro lipid peroxidation, and protein carbonyl formation were found to be 238, 140, 99, and 28 µg/mL, respectively (Sharma et al., 2009).

- **Anti-cancer and Cytotoxic Activity**

The bioactive constituent gymnemagenol has been found to possess an anticancer activity when studied in vitro on HeLa cancer cell lines (Jain et al., 2007). The cytotoxic effects of the saponins were evaluated using the MTT cell proliferation assay, revealing that gymnemagenol effectively inhibits the proliferation of HeLa cancer cells without harming normal cells in vitro (Khanna and Kannabiran, 2009). This suggests that herbal formulations containing gymnemagenol could

serve as a potential option for cancer therapy amidst the increasing rates of cancer worldwide.

The methanolic leaf extract of *Gymnema sylvestre* is recognized for its immunomodulatory properties and is a key component in traditional Indian medicine. The diverse range of biological and therapeutic effects exhibited by this plant, including immunomodulation, can be attributed to the presence of various phytochemicals in Gymnema. A study demonstrated a notable decrease in both primary and secondary antibody titers, as well as a suppression in the increase of CD3 and CD19 lymphocytes and cytokines such as IL-2 and IL-4. These findings suggest that the methanolic leaf extract of Gymnema sylvestre exhibits significant immune-suppressive activity (Ahirwal, et al., 2015).

Economic Importance

The rise in global interest in natural health remedies and dietary supplements has boosted the value of *G. sylvestre* in the health and wellness market. Its use in managing conditions like diabetes, obesity, and other metabolic disorders has driven up demand in both the pharmaceutical and nutraceutical industries. By incorporating the herb into a range of products such as capsules, tablets, teas, and functional foods, manufacturers are able to reach a health-conscious consumer base seeking natural solutions. From an economic standpoint, cultivating and producing *G. sylvestre* presents significant opportunities for agricultural communities, especially in regions where the plant is indigenous. The soaring demand for the herb can stimulate economic growth and provide sustainable livelihoods for farmers. Moreover, the establishment of standardized extraction and processing methods can add value and ensure consistent quality in *G. sylvestre* products, further elevating its commercial viability.

Conclusion

Gymnema sylvestre is a versatile plant with potential applications in both pharmaceuticals and dietary supplements, thanks to its bioactive phytochemicals. One of its key components, gymnemic acid, is known for its anti-diabetic, anti-sweet, and anti-hyperlipidemic properties. With many people in developing countries turning to herbal remedies for healthcare, *G. sylvestre* has the potential to be a valuable medicinal herb. The plant's pharmacological effects are dictated by its various phytochemicals for instance, dammarene saponins provide anti-sweet and anti-diabetic benefits, sterols help lower cholesterol, anthraquinones offer anti-inflammatory properties, and gurmarin suppresses sweetness. To fully unlock its therapeutic potential, it is essential to conduct rigorous scientific studies on isolated compounds like gymnemagenol and gurmarin. Moving forward, more research is needed to uncover additional active phytochemicals and their precise mechanisms of action for anti-diabetic and anti-sweet effects.

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