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Research Article

ANTIDIABETIC POTENTIAL OF *SCHLEICHERA OLEOSA* (LOUR.) OKEN: A COMPREHENSIVE REVIEW OF PHYTOCHEMISTRY AND PHARMACOLOGICAL EVIDENCE

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Abstract

Diabetes mellitus, a chronic metabolic disorder, has emerged as a global health burden, prompting a surge in research on plant-based therapeutics. Schleichera oleosa (Lour.) Oken, a traditionally valued medicinal plant, has gained attention for its potential antidiabetic properties attributed to its rich phytochemical composition. This review aims to comprehensively evaluate the antidiabetic activity of Schleichera oleosa by examining its phytochemical constituents, underlying mechanisms of action, and findings from both in vitro and in vivo studies. An extensive literature search was performed using databases such as PubMed, Google Scholar, ScienceDirect, and Google. Studies indicate that *Schleichera oleosa* contains bioactive compounds such as flavonoids, tannins, triterpenoids, and phenolics, particularly quercetin, which contributes to its hypoglycemic effect. The plant exhibits antidiabetic activity via mechanisms such as inhibition of α-amylase and α-glucosidase, antioxidant defense enhancement, and pancreatic β-cell protection. Both *in vitro* and *in vivo* models have shown promising results in blood glucose regulation and oxidative stress reduction. *Schleichera oleosa* holds significant promise as a natural antidiabetic agent. Further clinical investigations and standardization of its bioactive compounds are warranted to validate its therapeutic potential and facilitate its integration into evidence-based herbal medicine.

Keywords: Diabetes Mellitus, Schleichera Oleosa, Quercetin, Oxidative Stress, Antidiabetic Agent

1. Introduction

In the current healthcare landscape, traditional medicine is witnessing a resurgence due to growing concerns about the side effects, resistance, and high costs associated with synthetic drugs. Herbal therapies derived from traditional knowledge systems like Ayurveda, Traditional Chinese Medicine, and Unani are being increasingly recognized for their efficacy and lower toxicity profiles. Studies have shown that phytochemicals present in medicinal plants, such as flavonoids, alkaloids, and tannins, exert significant therapeutic effects including anti-inflammatory, antidiabetic, and antimicrobial properties[1,2]. Moreover, traditional treatments are often more accessible in rural or underserved regions and are aligned with cultural preferences, leading to better patient adherence[3]. Synthetic

drugs, although fast-acting and well-characterized pharmacologically, are often associated with adverse effects, drug interactions, and increased antimicrobial resistance, which raise public health concerns[4]. The World Health Organization has also emphasized the importance of integrating traditional medicine into national healthcare strategies while ensuring scientific validation and standardization[5]. Despite the promising impact of traditional remedies, rigorous clinical trials and quality control are essential to ensure safety and efficacy. Thus, while synthetic drugs remain crucial in acute and emergency care, traditional treatments provide a complementary approach, particularly in chronic and lifestyle-related diseases.

Schleichera oleosa (Lour.) Oken, belonging to the family Sapindaceae, is a deciduous tree widely distributed in India, Southeast Asia, and parts of the Indian subcontinent. Traditionally, various parts of the plant are used for treating skin diseases, wounds, diabetes, and inflammation. The seeds yield an oil (kusum oil) known for its therapeutic value, especially in hair and skin care. Phytochemical investigations have revealed the presence of bioactive compounds such as flavonoids, tannins, sterols, triterpenoids, and quercetin, which contribute to its medicinal properties[6-8].

2. Methodology

A comprehensive literature review was conducted to evaluate the antidiabetic potential, phytochemical constituents, and mechanisms of action of Schleichera oleosa (Lour.) Oken, with a particular focus on in vitro and in vivo studies. Four major scientific databases and search engines—PubMed, Google Scholar, ScienceDirect, and Google—were utilized to retrieve relevant studies published up to 2025. The keywords used for the search included: "*Schleichera oleosa* (Lour.) Oken", "antidiabetic", "phytochemical constituents", "mode of action", "in-vitro studies", and "in-vivo studies". Boolean operators such as "AND" and "OR" were applied to refine the search results and ensure comprehensive coverage. A total of 45 articles were initially retrieved. Following a detailed screening process, 32 articles were selected for inclusion in this review based on their relevance, scientific rigor, and publication status in peer-reviewed journals. 13 articles were excluded due to being conference abstracts, unpublished manuscripts, or lacking complete data.

2.1 Inclusion Criteria

Inclusion criteria comprised original research articles and reviews that:

- Specifically addressed Schleichera oleosa and its antidiabetic activity.
- Contained in vitro or in vivo study results.
- Provided identifiable phytochemical profiles or mechanisms of action.

2.2 Excluded studies

Excluded studies were:

- Non-peer-reviewed conference proceedings.
- Unpublished or inaccessible documents.
- Studies not directly relevant to antidiabetic evaluation.

2.3 Ecological Habitat and Morphological Features of Schleichera oleosa (Lour.) Oken

Schleichera oleosa (Lour.) Oken, commonly known as Kusum, is a deciduous tree belonging to the family Sapindaceae. It is native to the Indian subcontinent and Southeast Asia and thrives in dry deciduous forests, rocky hills, and mixed hardwood forests at altitudes ranging from 150 to 1200 meters. It prefers well-drained soils and tolerates both tropical and subtropical climates[9,10]. The tree grows up to 25 meters tall and has a straight bole with a broad crown. The bark is rough, greyish-brown, and exfoliates in irregular flakes. Leaves are alternate and pinnate, with 2–4 pairs of elliptical leaflets. Small, greenish-yellow flowers appear in terminal panicles during the dry season[11]. The fruit is a yellowish drupe, which turns brown on ripening and contains oil-rich seeds used for various purposes[12,13].

2.4 Antidiabetic Potential of Schleichera oleosa (Lour.) Oken: Phytochemical Constituents and Mechanisms of Action

Schleichera oleosa (Lour.) Oken, a medicinal tree of the Sapindaceae family, has demonstrated significant antidiabetic potential attributed to its rich phytochemical profile. Traditionally used in folk medicine for managing diabetes, its various parts—especially seeds, bark, and leaves—contain bioactive compounds such as quercetin, gallic acid, tannins, flavonoids, β-sitosterol, lupeol, and saponins[7,8,14–16]. Among these, quercetin, a flavonoid, acts as a potent α-glucosidase and α-amylase inhibitor, thereby slowing carbohydrate digestion and glucose absorption in the gut[17,18]. It also exhibits antioxidant and insulin-sensitizing properties by modulating GLUT4 expression and improving pancreatic β-cell function[19]. Gallic acid, a phenolic compound, enhances insulin secretion, reduces oxidative stress, and suppresses hepatic gluconeogenesis[20,21]. Tannins and flavonoids collectively exhibit glucose-lowering effects by inhibiting key carbohydrate-hydrolyzing enzymes and enhancing peripheral glucose uptake[22,23]. Lupeol, a triterpenoid, promotes β-cell regeneration and has insulin-mimetic activity, reducing fasting blood glucose and improving lipid profiles[24]. β-sitosterol has been shown to modulate lipid metabolism and enhance insulin receptor sensitivity[25]. *In vivo* studies using streptozotocin- and alloxan-induced diabetic models confirm that extracts of S. oleosa significantly reduce fasting blood glucose, glycosylated hemoglobin (HbA1c), and improve antioxidant enzyme levels[8,14,16]. The synergistic action of these phytochemicals contributes to glycemic control through multiple pathways: enzyme inhibition, improved insulin sensitivity, pancreatic protection, and oxidative stress reduction[23–26].

2.5 In Vitro Antidiabetic Activity of Schleichera oleosa (Lour.) Oken

Several *in vitro* studies from 2000 to 2025 have evaluated the antidiabetic potential of *Schleichera oleosa* through enzyme inhibition assays. Muthukrishnan and Sivakkumar (2017) demonstrated that ethanolic leaf extracts exhibited approximately 52.8 % αamylase inhibition at 4 mg/mL and 72.6 % αglucosidase inhibition at 50 mg/mL, attributed to high polyphenol and flavonoid content[27]. Sophy Jose and Sinha (2020) compared aqueous and methanolic leaf extracts and found dose-dependent αamylase inhibition, with methanolic extract showing up to 68.9 % inhibition at 100 µg and aqueous extract about 55.5 %, indicating potential as carbohydrate metabolism modulators[28]. Khandekar et al. (2015) reported chloroform extracts possessing significant enzyme inhibitory activity, correlating with presence of alkaloids, tannins, phenolics, flavonoids, saponins, and steroids[29]. Additionally, preliminary phytochemical studies (2023) confirmed abundant phenolics and flavonoids in hydrophilic extracts, correlating with enzyme inhibition effects[30]. These *in vitro* findings suggest that *S. oleosa* leaf extracts inhibit key carbohydrate-hydrolyzing enzymes, thereby reducing postprandial glucose absorption—similar to clinical αglucosidase inhibitors. These results highlight its promise as a natural agent to control hyperglycemia via enzyme modulation, warranting further isolation of active compounds and standardized bioassays. Some of the significant studies have been tabulated in Table1.

2.6 In Vivo Antidiabetic Activity of Schleichera oleosa (Lour.) Oken

Numerous *in vivo* studies from 2000 to 2025 have confirmed the antidiabetic efficacy of *Schleichera oleosa*, particularly in streptozotocin (STZ)- and alloxan-induced diabetic models. Coonick and coworkers (2008) demonstrated that high-dose (2 g/kg) ethanolic seed extracts significantly lowered blood glucose via pancreatic β-cell stimulation and enhanced lipid metabolism[32]. Goswami & Singh (2019) reported that ethanolic leaf extracts (100 and 200 mg/kg) effectively reduced fasting blood glucose in STZ rats and preserved body weight[14]. Muthukrishnan et al. (2022) showed that 200 and 400 mg/kg ethanolic extracts restored

β-cell architecture, improved HDL, and reduced LDL, VLDL, cholesterol, triglycerides, and hepatic enzymes[8] Awaluddin et al. (2022) confirmed that 200–600 mg/kg ethanolic leaf extract significantly decreased HbA1c in alloxan-induced rats[16]. Anjum et al. (2022) further validated hypoglycemic and antioxidant benefits in methanolic extracts at similar doses[15]. Additional studies illustrate improved oxidative stress markers—MDA, SGOT, SGPT—and enhanced liver antioxidant enzymes[32]. Histological analyses consistently show pancreatic islet regeneration . Collectively, these *in vivo* investigations highlight *S. oleosa*'s significant glycemic control, lipid regulation, β-cell protection, and enhanced antioxidant defense, underscoring its potential as a complementary antidiabetic therapy. Some of the studies have been mentioned below and also tabulated in Table 2.

2.7 Goswami S, Singh RP[14]

- **Model:** Streptozotocin-induced diabetic rats
- **Treatment:** Ethanolic extract (100 & 200 mg/kg) vs. glibenclamide
- **Findings:** Significant blood glucose reduction, body weight maintenance; presence of alkaloids, tannins, flavonoids, phenolics; quercetin identified.

2.8 Muthukrishnan S, Sivakkumar T, Anbiah V, et al[8]

- **Model:** Streptozotocin–nicotinamide diabetic rats, oral extract (200 & 400 mg/kg) for 28 days
- **Findings:** ↓ fasting blood glucose, cholesterol, triglycerides, LDL, VLDL; ↑ HDL, body weight; restored antioxidant and hepatic enzymes; βcell regeneration; isolation of polyphenol SMK/SO/01

2.9 Awaluddin A, Zulkifli AS, Burhan A, et al[32]

- **Model:** Alloxan-induced diabetic rats
- **Treatment:** Leaf extracts (various solvents)
- **Findings:** Significant HbA1c reduction in treated groups

2.10 Anjum N, Hossain MJ, Aktar F, et al[14]

- **Model:** Methanolic leaf extract tested *in vivo* (dosage unspecified)
- **Findings:** Significant hypoglycemic activity at 200 and 400 mg/kg, with antioxidant and potential enzyme-binding activity support

Table 1: In Vitro Antidiabetic Activity of Schleichera oleosa (Lour.) Oken

Extract Type	Enzyme Inhibited	Major findings	Ref.
Leaf ethanolic & aqueous	αAmylase, αGlucosidase	αAmylase inhibition: ~52.8% at 4 mg/mL (ethanolic extract) αGlucosidase inhibition: ~72.6% at 50 mg/mL Activity attributed to high flavonoid and polyphenol content	27
Leaf ethanol & aqueous	αAmylase,	αAmylase inhibition assay on leaf extracts Reported dose-dependent activity in ethanol and aqueous fractions	31
Leaf methanolic & aqueous	αAmylase,	Methanolic extract: 68.9% αamylase inhibition at 100 µg Aqueous extract: 55.5% inhibition at 100 µg	28

Table 2: In Vivo Antidiabetic Activity of Schleichera oleosa (Lour.) Oken

Year	Citation	Model	Dose & Duration	Key Outcomes
2019	Goswami & Singh	STZrats	100/200 mg/kg	↓ Glucose, maintained weight
2022	Muthukrishnan et al.	STZNA rats	200/400 mg/kg (28 d)	↓ Glucose & lipids, ↑ HDL & weight, βcell regeneration
2022	Awaluddin et al.	Alloxan rats	Leaf extract	↓ HbA1c
2022	Anjum et al.	Rodent model	200/400 mg/kg	Hypoglycemia + antioxidant effects

Between 2015 and 2025, multiple *in vivo* studies validate the antidiabetic potential of *Schleichera oleosa*. Extracts—especially ethanolic and methanolic—administered orally (100–400 mg/kg) consistently show:

- Glucose-lowering effects (fasting blood sugar and HbA1c)
- Improved lipid profile and antioxidant status
- β-cell regeneration in STZ models
- Isolation of bioactive polyphenols (e.g., SMK/SO/01)

3. Conclusion

The available scientific evidence strongly supports the antidiabetic potential of *Schleichera oleosa* (Lour.) Oken, primarily attributed to its diverse phytochemical constituents such as flavonoids, tannins, and triterpenoids. In vitro and in vivo studies demonstrate its ability to regulate blood glucose levels through multiple mechanisms, including inhibition of carbohydrate-hydrolyzing enzymes, antioxidant activity, and protection of pancreatic β-cells. Despite promising preclinical results, further research is needed to isolate and standardize its active compounds, elucidate precise molecular mechanisms, and validate efficacy and safety through well-designed clinical trials. Given its traditional use and pharmacological promise, *S. oleosa* has the potential to be developed as a complementary or alternative therapy for diabetes mellitus.

4. Conflict of Interest: None

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