Review Article

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KOSHAMRA (*SCHLEICHERA OLEOSA* (LOUR.) OKEN): AN INTEGRATIVE REVIEW OF ITS AYURVEDIC, PHYTOCHEMICAL, PHARMACOLOGICAL AND ETHNOMEDICINAL INSIGHTS

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ABSTRACT

Schleichera oleosa (Lour.) Oken, known as Koshamra, is a medium-sized tree belonging to the family Sapindaceae and traditionally has been used in Ayurveda for its therapeutic benefits. The different parts of the plant are used in the management of various ailments like skin diseases, diarrhea, rheumatism, wound healing and hair related conditions. The objective of the present review is to analyse the phytochemical profile, pharmacological properties, ethnomedicine and safety profile of the plant. A comprehensive review of classical Ayurvedic text, electronic databases such as PubMed, Web of science, Scopus was conducted. The phytochemical investigations have identified the various bioactive compounds such as quercetin, lupeol, stigmasterol, betulinic acid, triterpenoids, taraxerone which contribute to a broad spectrum of activities, including antioxidant, anti-inflammatory, anti-microbial, antidiabetic, anti-cancer and hepatoprotective activities. The pharmacological studies support the traditional uses, but comprehensive clinical validations remain limited. The research further should be done to elucidate the mechanism of action, standardized doses and assess potential toxicological risks. The limited research and its underutilization pave a need to increase its awareness and propagate its ethnomedicinal significance. Thus, *Schleichera oleosa* (Lour.) Oken holds a significant source of novel therapeutic agents and further research on standardization, clinical evaluation should be undertaken.

Keywords: *Schleichera oleosa* (Lour.) Oken, Koshamra, Ayurveda, Ethnomedicine, Phytochemical

INTRODUCTION

In today's era, Ayurvedic drugs are increasingly being recognized as a form of traditional medicine. Traditional medicines are being widely used, with 90% of WHO Member States have reported its utilization[1]. *Schleichera oleosa* (Lour.) Oken, previously known as *Schleichera trijuga* Wild known as Koshamra in Ayurveda, belongs to the family Sapindaceae. Schleichera is a monotypic genus of plants in the Sapindaceae family[2]. The Sapindaceae family also known as soapberry family comprising around 145 genera and some 1,900 species[3]. It is widely distributed across the Indian subcontinent and Southeast Asia, thriving in dry, deciduous forests and hilly regions. As per the IUCN status, the plant is classified under the category of least concern. It is commonly known as Lakshavriksha or Krimivriksha due to presence of lac known as 'Kerria lacca'. The species is valued for its versatile applications ranging from timber and oil production to traditional medicinal uses.

In Ayurveda, Koshamra is used for its Vranahara (anti-ulcer), kusthaghna (skin disorder), Shothhara (anti-oedema) and Rakta shodhaka (blood purifier) properties [4,5]. The plant exhibits Kashaya (astringent taste), Tikta (bitter taste) and Amla rasa (sour), Laghu (light attribute) Guna, Ushna (hot potency) Virya and Katu (pungent metabolic effect) Vipaka [5,6] which helps in balancing Vata and Kapha dosha. The fixed oil extracted from seeds known as Kusum taila is used topically in different preparations like lepas (external pastes) and tailas (medicated oil).

In traditional ethnomedicine, *Schleichera oleosa* (Lour.) Oken has being utilized for its therapeutic, cosmetic, agricultural, and environmental purposes by indigenous communities across India and Southeast Asia. The leaves are used for treating piles, jaundice, rheumatic disease, eczema, ulcers and ringworm. The bark is used for skin ailments, rheumatoid arthritis, joint pain and headache. The flowers have purgative and febrifugal properties. The fruit is used for treating diabetes and relieve chest complaints and eye problems[7]. The seeds have fixed oil which known as 'Macassor oil' used in hair growth[8] and used by tribal healers as a remedy for joint pain, rheumatism and scalp conditions.

The scientific investigations have validated various bioactive classes of compounds like triterpenoids, phenolic compounds, fatty acid esters and hydrocarbons. These constituents exhibit various array of pharmacological activities like anti-microbial, anti-inflammatory, anti-ulcer, antioxidant, anti-cancer, analgesic and anti-diabetic activities, supporting its traditional uses.

Despite being traditionally utilized and prevailing scientific evidence, *Schleichera oleosa* (Lour.) Oken remains unexplored. Its integration into evidence-based medicine has been limited due to insufficient *in-vivo*, clinical and toxicological studies. The development of standardized formulations is still inadequate, and few herbal preparations are available in the market. This highlights the need for more scientific validations to explore its therapeutic potential.

This review aims to comprehensively analyze the phytochemical, pharmacological, ethnomedicinal and safety profile of *Schleichera oleosa* (Lour.) Oken, bridging classical knowledge with contemporary scientific research to highlight its relevance in both traditional and modern medicine.

A comprehensive literature review was conducted to compile the data related to *Schleichera oleosa* (Lour.) Oken and its medicinal, phytochemical, pharmacological, and traditional uses in the context of modern science, Ayurvedic textbook and Medicinal plant book.

Electronic databases such as PubMed, ScienceDirect, Scopus, and Web of Science were systematically searched along with classical Ayurvedic text like Brihatrayi (Charak, Sushruta Samhita & Ashtanga hridaya) and various Nighantus.

The search was performed using a combination of the following keywords "*Schleichera oleosa*", "Koshamra", "Sapindaceae", "medicinal plants", "Ayurvedic uses", "phytochemistry of *Schleichera oleosa*", "Kusum Taila", "pharmacological properties", "traditional medicine", "ethnobotany", and "bioactive compounds".

Botanical Description
Taxonomical Classification
Kingdom – Plantae
Phylum -Streptophyta
Class-Equisetopsida
Subclass-Magnoliidae
Order - Sapindales
Family -Sapindaceae
Genus - Schleichera
Species - *Schleichera oleosa* [9]

Vernacular names
Schleichera oleosa (Lour.) Oken is known by various names across different languages and regions. [10]

Languages
English - Ceylon Oak, Gum Lac tree, Honey tree, Macassar Oil tree
Sanskrit - Ghanaskandha, Lakshavriksha, Krimivriksha, Kshudraamra, Sukoshaka
Hindi- Kusum, Gausam, Kosum
Gond- Komur, Pusuku
Gujarat- Kossame
Telugu- Busi, Kodalipulusu, Madakapulusu, Posuku, Paparti
Tamil- Kolama, Konji, Konjivanji, Kumbadiri
Tulu-Sakate Uriya-Kusumo

Regions
Bombay- Assumar, Gosam, Kocham, Kosam, Kosamb
Konkani- Kassimb, Kossombo
Malyalam- Puvam
Marathi- Kohan, Kosimb,
North-west Provinces- Gosam
Punjab-Gausam, Jamoa, Kussumb
Burma- Gyo, Kobin, Kyet-mouk
Indo China- Dau truong, Dok phen, Kho som, Pongro
Portuguese- Carvalho de Ceylao
Sinhalese- Kon, Kong, Konghas

Geographical distribution
Schleichera oleosa (Lour.) Oken is a deciduous and semi-evergreen tree found in the lower Himalaya towards the North-west, Chota Nagpur and also in Central and Southern India, Ceylon and throughout Burma[8].

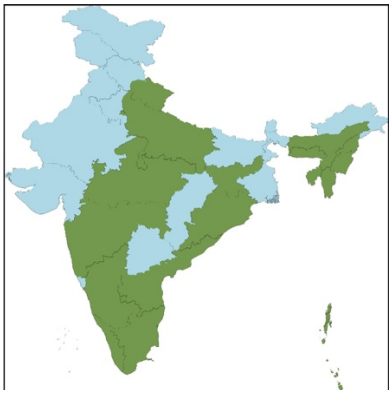

Figure 1: Map of distribution of *Schleichera oleosa* (Lour.) Oken[11]

Morphological characteristics
Schleichera oleosa (Lour.) Oken is a medium sized to large tree up to a height of 15-32 meters, with a spreading crown. The bark is pale brown to greyish brown, smooth and exfoliates in irregularly woody flakes. Leaves are paripinnately compound, alternate, 20-40 cm long, leaflets 2-4 pairs, elliptic, entire, glabrous, and subsessile with the apex usually rounded. The young leaves are reddish, turning green on maturity. Flowers are greenish yellow, either male or bisexual, fascicled in spike like lateral racemes and bloom from February to April. Fruits are ovoid,1-2 seeded and appear from May-July. Seeds are ellipsoid, smooth, compressed, brown, oily, enclosed in succulent aril and about 1.5cm long[12]

Classical Ayurvedic Literature
The Rasapanchaka (Ayurvedic properties) of the plant as compiled from several nighantus (lexicons) indicates that the Apakwa phala (unripe fruit) possess Amla rasa (sour taste), Guru guna (heavy attribute) and Ushna virya (hot in potency) and has Grahi (absorb liquid from stools) property while pakwa phala (Ripe fruit) is characterized by Laghu guna (light attribute)[5]. Overall, the plant contains Kashaya (astringent), katu (pungent), Tikta Rasa (bitter), Guru (heavy in attribute) guna, Katu (pungent metabolic effect) Vipaka and Ushna (hot potency) Virya[6]. The plant has Deepana (digestive stimulant), Pushtikara (nourishing), Krimihara (antihelminthic), Vranahara (anti-ulcer) and Raktashodhaka (blood purifier) property [4,13,14]. Its uses are indicated in Raktapitta (bleeding disorders), Kustha (skin diseases), Vrana (wound), Shotha (inflammatory disorders), and Krimi (microbial infestation) vikara[13]. In classical Ayurvedic Samhitas it is used in treatment of yonistrava [15] (Vaginal discharge), Vataj Vrddhi (Scrotal enlargement), nasa roga (treatment of nose disease) and Vishoupdrava (complications of poisoning) [16,17].

Ethnomedicinal Uses
Schleichera oleosa (Lour.) Oken has long been utilized in India for its varied roles in traditional healing practices. Table 1 summarize the common uses in folk and traditional medicine as reported in literature and previous studies.

Phytochemical Analysis
The phytochemical analysis of *Schleichera oleosa* (Lour.) Oken revealed the presence of diverse group of pharmacologically bioactive compounds belonging to different classes, reflecting its diverse therapeutic potential. Qualitative screenings have shown presence of secondary metabolites such as flavonoids, tannins, phenolic compound, saponins, alkaloids, steroids and terpenoids while advanced techniques (HPTLC, GC-MS, LC-MS) confirmed specific constituents. Table 2 summarizes the various phytoconstituents.

Table 1: Ethnobotanical uses of *Schleichera oleosa* (Lour.) Oken

Part used	Tribes/Region	Mode of Application / Preparation	Traditional Uses
Bark	Santals	Local application	Pain in back and loins[10].
	Cambodia	Maceration /infusion	Malaria[10]
	Madhya Pradesh	Decoction	Menorrhea[18]
Seed Oil	Nilgiris	Anointing	Bodyache[10]
	Bombay, Malabar and Coorg	-	Remove itching and skin diseases[10]
	Bombay	Local application	Rheumatism[10]
	Sambalpur, Central provinces	-	Headache[10]
	Andhra Pradesh	Local application	Hair oil [19]
Fruits	Nepal Himalayan region	-	Anti-helminthic [20]
Inflorescence	Bapat	-	Snake bite[10]
Powdered seeds	-	External application	Ulcers of animal and removing maggots[10]
	Singhbhum district Jharkhand	External application	On cuts to prevent pain and to cure white patches on the skin[21]
Leaves	Odisha	-	Piles, Jaundice, Rheumatism, Eczema, Ulcers[22]
		Dressing	Ringworm[22]
Root bark	Kotia Hills of Vizianagaram district, Andhra Pradesh,	Orally 2 spoonfuls daily	Extract is given and paste applied over the snakebite[23]

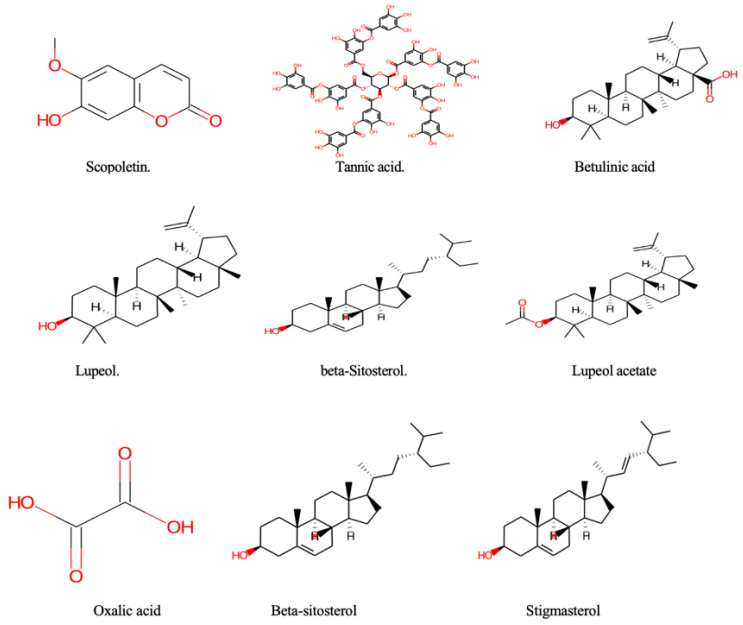

Figure 2: Bioactive compounds isolated from *Schleichera oleosa* (Lour.) Oken[32]

Table 2: Analysis of various phytoconstituents

Part	Type of extract used	Technique	Class	Major Subclass Identified
Bark	Ethanol	HPTLC	Polyphenol (Flavonoid)	Quercetin[24]
	Ethanol	HPLC	Triterpenoids	Lupeol, Lupeol acetate, Betulin, Betulinic acid[25]
	Methanol	GCMS	Alkane	2- Methyleicosane
			Glycoside	Scillarenin
		LCMS	Fatty acid	n-hexadecanoic acid, Oleic acid, Linoleic acid, Stearic acid
			Flavonoid	Kaempferol-3-O-rutinoside, Quercetin-3-O-glucoside
			Phenolic compound	2,4-Di-tert-butyl phenol, 2,6 Di-tert-butylphenol
			Fatty acid ester	2-hydroxy-1-ethyl ester, 9-Octadecenoic acid, Hexadecanoic acid, Methyl isostearate
			Triterpene	Squalene
			Sterol	y-sitosterol, stigmasterol
			Triterpenoids	Lupeol, Betulinic acid[26, 27]
Seeds	-	Not specified	Fatty acids	1-cyano-2-hydr oxymethylprop- 2-en-1-ol[28]
	Hexane	GCMS	Fatty acids	Linoleic acid (49.7%), eicosenoic acid (29.5%), palmitic acid (7.6%), linoleic acid (5.6%) and oleic acid[29] (2.8%)
Leaves	-	Not specified	Fatty acids	Oxalic, tartaric, arachidic Cyanogenetic glucoside[30]
	Methanol	NMR	Flavonoids, Sterols, Triterpenoids	5,7-dihydroxy-4′-methoxyflavone, Stigmasterol, Lupeol, Betulinic acid[31]

HPTLC-High performance Thin Liquid Chromatography, LCMS- Liquid chromatography mass spectrometry, GCMS- Gas Chromatography mass spectrometry, NMR- Nuclear Magnetic Resonance)

Table 3: Pharmacological profile of plant by various methods

Pharmacological activity	Part used	Extract/Fraction/ Plant parts dose	Type of assay, animal models or cell line	Method use	Result /Observed Parameters
Anti-microbial	Leaves	Methanolic and aqueous	*In-vitro*	Agar well diffusion	Inhibition of microbes like *S.aureus, E.coli* due to triterpenoids and tannin present that disrupt cell membrane[33].
	Leaves	Methanol	*In-vitro*	DPPH free radical scavenging assay	Inhibit free radicals by DPPH mechanism[34]
Analgesic activity	Bark	Ethanol	*In vivo*	Formalin induced pain in rodents	Pain reduction at dose of 400 mg/kg[35]
Cytotoxic/Anticancer activity	Seeds	Methanol	Cell line study	MCF-7 (breast cancer cells)	Moderate inhibition of cancer cell lines by suppressing expression of BRCA1 gene and induce apoptosis of cells[36].
Anti-diabetic Activity	Seed	Methanolic extract	*In-vivo*	Alloxan-induced diabetic rats	Reduction in blood glucose levels significantly[37]
	Leaves	Ethanol and aqueous extract	*In-vitro*	α– amylase and α-glucosidase inhibitory assay by Bernfeld and Apostolidis method	Polyphenols and Flavonoids presence in leaves inhibit α-amylase and α-glucosidase enzymes responsible for diabetes induction[38].
Hypolipidaemic Activity	Seed	Ethanol	*In-vivo*	Alloxan induce diabetic rats	Decrease in lipid profile markers such as Total Cholesterol, Triglycerides and LDL[37]
Antifungal	Seed oil	-	Clinical	Isolation of fungus Candida albicans from endophthalm itis patients	Seed oil possesses dose-dependent antifungal reduction mechanism[39]
Wound Healing Activity	Seed oil	-	*In- vivo*	Rat excision and incision wound model	Seed oil accelerated wound contraction and increase tensile strength thus helping in better collagen formation thereby healing wound[40].
Hepatoprotective Activity	Leaves	Methanolic extract	*In-vivo*	CCl4 induced liver toxicity in rats	Significant reduction in LFT markers such as serum SGOT, SGPT, ALP and regeneration of liver tissue[41].

DPPH- 2,2-Diphenyl-1-Picrylhydrazyl, MCF- Michigan Cancer Foundation, LFT- Liver function test

Pharmacological Activities

The various *In-vitro*, *in-vivo* and cell line studies demonstrate the presence of different pharmacological activities in plant. Table 3 highlights the various pharmacological activities of plant.

Toxicological Profile and Safety

The toxicological assessments conducted demonstrates a safety margin within established limits for *Schleichera oleosa* (Lour.) Oken. Acute toxicity studies showed that the ethanolic extract of the leaves revealed no toxic symptoms or mortality at doses up to 5000 mg/kg with LD50 value exceeding this threshold. The sub chronic toxicity assessments demonstrated safety with no significant changes in parameters like hematology, biochemistry or histopathology, thereby confirming its non-toxic nature under prolonged exposure[42]. Furthermore, the ADMET analysis of the bark suggested that majority of its phytoconstituents are non-mutagenic[26].

Current Limitations and Research Gaps

The clinical trials are not validated as mostly *in vitro*, and few *in-vivo* models' study has been conducted. The data available on various ethnomedicinal uses has not yet been clinically validated. The toxicological evaluations are inadequate for high dose and long-term use of the drug for various pharmaceutical preparations.

DISCUSSION

The global increase in the use of herbal medicine reflects a shift towards natural and integrative approach to healthcare. *Schleichera oleosa* (Lour.) Oken possess diversity of functions due to its various ethnomedicinal and pharmacological uses. The cell-based assays, rodent and *in-vitro* models show that different plant parts exhibit biological activities acting through different mechanisms. Tribal and rural populations in India and Southeast Asia are using the plant as a folklore medicine in treating skin ailments, joint inflammation, bleeding disorders, gastrointestinal issues, ulcers and wound healing. The Ruksha (dryness) and Ushna (hot potency) properties present in *Schleichera oleosa* (Lour.) Oken indicate it's use in Kapha related skin diseases and Vata-induced joint pain. The Vrana ropaka (wound healing) Karma (properties) of Koshamra indicates it's modern anti-microbial and anti-inflammatory uses. The presence of Katu rasa (pungent taste) depict its detoxifying effect in body and helps in reducing inflammation. The analytical techniques like HPTLC, GCMS and LCMS findings help in profiling the plant chemical constituents.

The presence of different classes of compounds like flavonoids, tannins, saponins, phenolic, triterpenoids indicate it's use in anti-microbial, anti-inflammatory, antioxidant, anti-diabetic, hepatoprotective and wound healing activities[43,44]. The presence of subclasses like quercetin and lupeol in plant reflects its free radical scavenging property and role in inhibiting pro-inflammatory mediators[45,46]. Betulinic acid exhibits pro-apoptotic property against cancer cells and also inhibit cytokines[47]. Stigmasterol reduce oxidative stress and alleviates inflammation[48]. Although *Schleichera oleosa* (Lour) Oken shows different bioactivities, there is still a lack of research regarding its molecular mechanism of action, pre-clinical and clinical evaluations and safety profile. Further investigations are essential for establishing its efficacy and its safe integration into pharmaceutical formulations and potential applications in the food industry.

CONCLUSION

The *Schleichera oleosa* (Lour.) Oken is a plant bridging traditional knowledge with modern pharmacological principles. Its diverse array of phytoconstituents highlights potential in treatment of various disorders. The IUCN status is Least concern which ensures its easy availability thus making it a potential herb for formulations. Therefore, the pre-clinical and clinical trials are essential to validate its pharmacological effects along with toxicological assessments to ensure safety in humans. For its medicinal utility in contemporary science, future research must emphasize further standardization and quality control. While the traditional knowledge has laid the foundation, further exploration of this plant is indispensable for its therapeutic benefits and its effective integration into modern healthcare system.

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