

Phytochemical and Pharmacological Potential of Guggul (*Commiphora wightii*) Oleo-Gum-Resin: A Review of Its Traditional and Medicinal Applications

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Abstract: *Commiphora wightii* (Arnott) Bhandari (Burseraceae) is an important medicinal resin used in traditional medicine, Ayurveda. Guggul is an oleo-gum-resinous exudate obtained from the stem and branches of the plant through tapping, collection and drying. Historically, guggul has been utilized to treat inflammatory disorders, arthritis, obesity, lipid disorders, digestive ailments, scars and a number of other conditions. Phytochemical investigations have demonstrated the presence of volatile oils, monoterpenes, sesquiterpenes, diterpenes, triterpenes, steroids, flavonoids, lignans, guggulsterols, sugars and amino acids. Of these constituents, E-guggulsterone and Z-guggulsterone are compounds that have been especially studied scientifically. Experimental investigation shows anti-inflammatory, anti-oxidant, antimicrobial, hypolipidemic, anti-obesity, cardioprotective, hepatoprotective and antiproliferative properties of guggul and its constituents. Guggulsterones have also been studied regarding their interactions with nuclear receptors and inflammatory signaling pathways. Although there is some promising experimental evidence, there are varying clinical studies and guggul preparations are effective depending on the chemical constituents, dosage and standardization. Gastrointestinal, skin reactions, and potential drug interactions are also a concern for safety. *C. wightii* has also suffered from significant declines in population due to habitat loss and unsustainable collection of resin. In this review, botanical descriptions, collection and preparation of guggul resin, and traditional applications, along with phytochemistry, pharmacological activities, safety concerns and future research needs have been summarized.

Keywords: *Commiphora wightii*, guggul, guggulu, oleo-gum-resin, dried resin, guggulsterone, E-guggulsterone, Z-guggulsterone, Ayurveda, medicinal plant.

I. INTRODUCTION

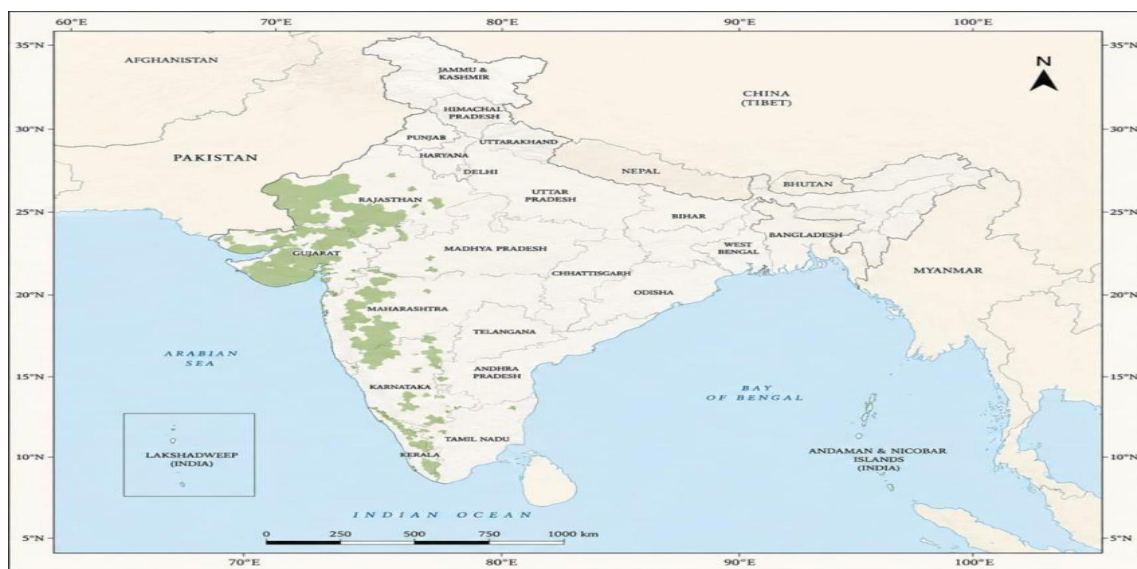
The role of medicinal plants in traditional medicine systems is crucial since ancient times and they are still an important source of bioactive compounds for the pharmaceutical industry in the process of drug discovery. Ayurveda is one of the ancient medicinal systems which have made extensive use of plant materials in order to prevent and treat a variety of disorders. *Commiphora wightii* (Arn.) Bhandari is an important medicinal plant that has great importance. Also known as Guggulu or Guggul and belongs to the Burseraceae family. It is a small thorny, bushy shrub or tree, mainly found in the dry and sub-humid areas of India and parts of Pakistan and Bangladesh. The oleo-gum resin from the branches and stem of the plant is the main medicinal part used and has long been used as a medicinal drug in Ayurvedic medicine (Soni et al., 2016). In India, *C. wightii* is mainly found in the arid regions of Rajasthan and Gujarat and in few pockets of arid regions of Haryana, Madhya Pradesh and Karnataka. It is well adapted to its abiotic environment, and is very



resilient to drought and extended periods of water stress. It can thrive in rocky, sandy, and gravelly soils with limited moisture availability, where the cultivation of many economically important crops is challenging. *C. wightii* is a plant species that is particularly resilient to dry and semi-dry environments, making it an ecologically important part of the desert and semi-desert ecosystems (Kulloli et al., 2014). The volatile oils, terpenoids, steroids, flavonoids, lignans, guggulipids, guggulsterols, guggultetrols and other active components are present in Guggulu resin. Of these constituents, guggulsterones, especially guggulsterone E and guggulsterone Z, are regarded as significant characteristic bioactive constituents and have been extensively studied scientifically. Various pharmacological activities such as anti-inflammatory, anti-obesity, hypolipidemic, antioxidant, antimicrobial, analgesic and anti-arthritis have been studied for these compounds. The phytochemical diversity of *C. wightii* makes it a promising candidate for exploring new therapeutic agents as well as elucidating the pharmacological basis of its traditional usage (Bhardwaj et al., 2019).

The above-mentioned properties of Guggulu have led to its use in the treatment of disorders associated with Vata and Medas as well as in arthritis, rheumatism, gout, obesity, disorders of lipid metabolism, inflammation, pain, digestive disorders, respiratory disorders, wounds and various skin ailments (Mohan et al., 2016). It is also used as a key component in some traditional and modern herbal medicines. The long history of use of Guggulu and many experimental studies of its various biological activities have resulted in the continued significance of Guggulu in Ayurvedic therapeutics and phytopharmacological studies. (Cunningham et al., 2018).

One of the significant use of Ayurvedic Guggulu is Shodhana (purification) process. Raw Guggulu is traditionally purified by different media like herbal decoctions, milk, water and other medicines prior to its use in medicine preparations. Traditionally, Shodhana helps to decrease undesirable effects and enhance therapeutic suitability of the resin. But, the exact chemical and pharmacological alterations that occur in this process are not fully understood. Thus, systematic study on phytochemical analysis and biological activity and safety of raw and purified Guggulu may provide useful information regarding the change in phytochemical composition, biological activity and safety (Sunita et al., 2023). Though it has a long history of medicinal uses and has been extensively studied from a pharmacological point of view, a few aspects of *C. wightii* remain to be explored scientifically, such as standardisation of its preparations, mechanism of action, effect of Shodhana on the phytochemical profile of *C. Wightii*, its safety and efficacy in clinical applications. Furthermore, sustainable use and conservation of the plant should be encouraged as it is a plant resource that is likely to be stressed by growing demand for Guggulu resin.



Natural distribution of *Commiphora wightii* in India neighboring regions (Reddy et al., 2012).



A thorough scientific appraisal of *C. wightii* may thus help to validate and scientifically reason the traditional ayurvedic formulation. In the present study, focus has been given on *Commiphora wightii* highlighting its phytochemical constituents and pharmacological properties which will provide scientific basis for traditional medicinal importance and in formulation of standardized safe and therapeutically useful herbal remedies (Sarup, et al., 2015).

II. REVIEW METHODOLOGY

An extensive literature search was conducted to gather, review and synthesize the scientific data related to the botanical features, traditional and medicinal uses, phytochemical constituents and reported biological activities of *Commiphora wightii*. Literature search was conducted to collect reliable and relevant information from scientific literature such as original research articles, review papers, pharmaceutical studies, phytochemical studies, ethnomedicinal reports and relevant patent documents in a wide scientific literature.

A wide search of the existing literature was conducted by searching through various well-known electronic databases and scholarly information sources. Google Scholar, Web of Science, SciFinder, Scopus, ScienceDirect, PubMed, SciELO, SpringerLink, Google Patents, Espacenet, BioMed Central (BMC), and MEDLINE were some of the major databases that were consulted. These databases were chosen because they provide a good coverage of medicinal plants, natural products, pharmacognosy, phytochemistry, pharmacology and therapeutic uses.

The main objective of the search was to identify publications that reported the botanical description, taxonomy, geographic distribution, morphological features, traditional applications, medicinal value, phytochemical composition, pharmacological activity and biological activity of *C. wightii*. Special attention was paid to the studies related to the major bioactive compounds of the plant such as steroidal compounds, terpenoids, essential oil and other secondary metabolites reported from various parts of the plant. Literature pertaining to the traditional use of *C. wightii* in different system of medicine was also taken into consideration to ensure its ethnopharmacological importance.

III. NATURAL DISTRIBUTION OF COMMIPHORA WIGHTII

BOTANICAL DESCRIPTION

Commiphora wightii (Arn.) Burseraceae is an important medicinal plant, known as Bhandari. Its valuable use is as source of oleo-gum-resin used in Ayurvedic, Unani and modern herbal medicine. Therefore, to identify, cultivate, conserve and sustainably use it, it is important to know its botanical features well.

Taxonomic Classification

The scientific classification of *C. wightii* is as follows:

Kingdom: Plantae

Division: Angiosperms

Class: Magnoliopsida

Order: Sapindales

Family: Burseraceae

Genus: *Commiphora*

Species: *Commiphora wightii*

The Burseraceae is a family of trees and shrubs, with many members that produce a resin, found primarily in the tropics and subtropics. Members of this family are characterized by aromatic resin canals and peeling bark. The resin of *C. wightii* is one of the most economically important species of this family for its medicinal use (Mahr et al., 2012).

The vernacular names of the plant are Mukul, Guggul, Gugal, Gogil (Hindi), Gukkal, Gukkulu, Maishakshi (Tamil), Guggala, Gulag, Mukul (Marathi), Gugal, Gugali, Gugar, Guggul, Mukul (Gujarat), Gugul, Mahisaksh, Maisakshi, Moqlearzaqi, Mukulearabi (Telugu), Aflatan, Moql (Arabic), Bhavabhishtha, Bhutahara, etc. (Sanskrit) (Bhardwaj, et al 2019).



IV. MORPHOLOGY

C. wightii is a woody shrub or a small tree that grows to a height of 2–3 metres. The branches are very numerous and have silvery, paper-like bark peelings. Branches are knotty and crooked, divaricate and typically terminating in a sharp spine.

Leaves: The leaves are rhomboid-ovate, 1–3 foliate, serrate-toothed in the upper part, smooth, and shining. The lateral leaflets, when present, are less than half the size of the terminal ones.

Flowers: The flowers are fascicled 2–3 in each, having very short pedicels. The calyx is campanulate, glandular and hairy, consisting of 4–5 triangular lobes, equal to the tube. The petals are broadly linear, brownish-red, with rounded apex, reflexed, 3 times longer than calyx. Stamens are 8–10 in number, alternately long and short, and half the length of the petals. The disc has 8–10 lobes with the alternate lobes being deeper, the shorter stamens are inserted in these alternate lobes. Ovary oblong-ovoid and attenuate to style (Sinha et al., 2012).

Fruits: The fruits are small, red in colour when ripe, and are ovoid drupes. Oleo-gum resin is produced by each plant, about 0.5 to 1 kg in January - March.

Gum resin: A pale to brown yellow aromatic gum resin is extracted from the bark of the plant. The resin tears are brittle, somewhat transparent with waxy surface. The gum exudes a thick resin which is aromatic, burns on fire and melts in sunlight. It is milky white when dissolved in water.



Guggul resin obtained from *Commiphora wightii*

V. MEDICINAL VALUES

In Ayurveda

The Guggulu has been used in Ayurveda for a long time. The earliest reference, where its medicinal and therapeutic properties are mentioned, is in the Atharvaveda. The detailed description of its actions, uses and indications and the varieties of guggul is given in many Ayurvedic texts such as charakasamhita (1000 B.C), sushrutasamhita (600 B.C) and Vagbhata (7th century A.D). Moreover, a number of medical lesions were recorded in between 12th and 14th century A.D., in which Guggulu was used for treating obesity, osteoarthritis, rheumatoid arthritis, gout, facial paralysis, sciatica, constipation, haemorrhoids, liver disorders, inflammation, cyst, cervical lymphadenitis, coronary thrombosis, anaemia, diabetes, urinary calculus, increased frequency and turbidity of urine and skin diseases (Shekhawat et al., 2020). It has a wide range of usefulness in indigenous medicine. Astringent, antiseptic and bitter, it is stomachic, carminative and astringent when taken internally. It is an oleo-resin that increases number of leucocytes and stimulates phagocytosis, like all oleo-resins. It has diaphoretic, expectorant, diuretic, uterine stimulant and emmenagogue properties. The resin is applied as a lotion to indolent ulcers, and as a gargle in caries, spongy gums, pyorrhea, chronic tonsillitis and ulcerated throat. The fumes from burnt guggulu are recommended for high fever, acute and chronic nasal catarrh, chronic laryngitis, chronic bronchitis and phthisis. It is used as an ingredient for ointment for ulcers (Kulhari et al., 2012).



Unani and Folk Medicine

The traditional uses of Guggul in Unani medicine include use for anti-inflammatory, stimulant and detoxifying properties. It is used in several formulations to treat chronic inflammatory diseases, respiratory and gastrointestinal diseases. Traditional practitioners have long relied on Guggul to relieve pain, swelling and inflammation from joint and muscle disorders, as a natural remedy (Ahmed et al., 2011).

Guggul is also traditionally recognized as a digestive stimulant and is thought to promote appetite, digestive secretions and normal digestion. In some traditional communities, low doses of guggul have been applied to treat indigestion, abdominal distention, and gastrointestinal pain (Ulrich et al., 2022). The resin has also traditionally been used as an expectorant in disorders of the respiratory system. It is thought to help to moisten and expel mucus from the respiratory tract and thus used for chronic cough, bronchitis and respiratory congestion. Guggul has also been described in traditional medicine for its antimicrobial activity and traditionally has been used in treatment of minor infections, wounds and skin disorders. It has been reported that the resin is used externally in traditional medicine for treating wounds and preventing microbial contamination (Asfaw et al., 2019).

In addition, in some traditional Indian medical practices, Guggul is considered a blood purifier. It is thought to have a cleansing effect, can circulate blood and aid in overall health. The traditional idea for this blood cleansing effect is coupled with the potential anti-inflammatory and detoxifying effects of Guggul. In summary, the various uses of Guggul in Unani and folk medicine underscore its historical and medicinal importance and suggest potential areas for further research. In conclusion, the multifaceted applications of Guggul in Unani and traditional medicine reveal its rich historical and therapeutic significance, offering avenues for continued scientific study and exploration of its medicinal properties.

Importance of Active Chemical and phytochemical Constituents of *C. wightii* (Guggul)

The oleo-gum-resin of *Commiphora wightii* (Guggul) is a source of various bioactive chemical constituents, which is mainly responsible for its medicinal importance. These compounds work synergistically and individually have a number of pharmacological effects. Guggulsterones E and Z: They are the main and best studied active ingredients. They are especially significant for their hypolipidemic properties, which help to regulate lipid metabolism and lower excess cholesterol levels. They are also known to be significant quality markers for the Guggul preparations.

Guggul oleo-gum-resin has the following major characteristic constituents: guggulsterones. There are two main isomers, E-guggulsterone and Z-guggulsterone. These steroidal compounds are regarded as significant chemical markers and they are used for identification, standardization and quality evaluation of Guggul preparations. Their hypolipidemic, anti-inflammatory, antioxidant and metabolic properties have been explored (Sarup et al., 2022).

Major Phytochemical Constituents

Chemical class	Representative compounds	Reported significance
Steroidal compounds	E/Z-guggulsterone, guggulsterols	Lipid metabolism, inflammation
Monoterpenes	α -pinene, limonene, myrcene	Volatile/aromatic properties
Sesquiterpenes	Reported sesquiterpenes	Biological activity
Diterpenes	cembrene, cembrene-A, mukulol	Reported bioactivity
Triterpenes	myrrhanol, myrrhanone, commipherol	Pharmacological interest
Flavonoids	naringenin, quercetin derivatives	Antioxidant/biological activity
Lignans	sesamin, diayangambin	Pharmacological interest
Guggultetrols	guggultetrol-18, guggultetrol-20	Characteristic constituents
Sugars	L-arabinose, D-galactose, etc.	Structural/chemical constituents
Amino acids	Lysine, alanine, valine, etc.	Reported constituents



Essential oils: Volatile oil fraction of Guggul is mainly comprised of monoterpenes and sesquiterpenes. The volatile fraction has been reported to contain compounds like α -pinene, β -pinene, limonene and myrcene. The aromatic components in Guggul may account for some of its antimicrobial, antioxidant, and anti-inflammatory properties and are responsible for the aroma of the plant. Mainly composed of monoterpenes and sesquiterpenes, these compounds are responsible for Guggul's characteristic aroma. They are also responsible for its antimicrobial, anti-inflammatory and antioxidant properties and are responsible for its traditional application in incense and fumigation.

Sterols: Phytosterols and related sterol compounds are thought to affect cholesterol absorption and lipid metabolism, and may play a role in the potential cardioprotective activity of Guggul (Shen et al., 2012).

Terpenoids: The resin consists of monoterpenes, sesquiterpenes, diterpenes and triterpenes. The biological activity of Guggul may be attributed to these compounds, which are known to possess anti-inflammatory, antimicrobial, and antioxidant effects. Terpenoids are also important components of the volatile fraction of the resin these compounds have significant anti-inflammatory, antioxidant and antimicrobial properties. They are especially significant when it comes to the traditional applications of Guggul in arthritis, rheumatism and inflammatory disorders (Uzma et al., 2020).

Monoterpenoids: The gum resin of *Commiphora wightii* is extracted as a volatile essential oil which contributes about 0.4% of the resin by steam distilling. Several other volatile compounds have been reported in the essential oil in addition to the aforementioned major constituents, which are mostly monoterpenoids; myrcene, dimyrcene and polymyrcene are reported as the major components. These contain eugenol, d-limonene, α -pinene, ($\pm$)-linalool, cineole, α -terpineol, d- α -phellandrene, methylheptanone, bornyl acetate, and ($\pm$)-geraniol. There are also a number of other minor constituents present, but not fully identified.

These various volatile components give the gum resin its distinctive chemical composition and aromatic qualities. The essential oil rich in monoterpenoids has thus been given much attention in the phytochemical studies of *C. wightii*.

Diterpenoids: Gum resin of *Commiphora wightii* is composed of a few diterpenoid compounds such as cembrene-A, cembrene, and other diterpenoids of cembrene type. Cembrene-A is a simple tetraene that is produced by cyclization of geranylgeranyl pyrophosphate. The aerial parts as well as the resin of the plant are also found to contain a cembrane-type alcohol called Mukulol. It was confirmed in its structure by spectroscopic studies and mild dehydration leading to the formation of cembrene.

Triterpenoids: The gum resin of *Commiphora wightii* has been mentioned to contain a wide range of triterpenoid compounds which include those in the polypodane-type and related triterpene classes. The resin contains a number of major compounds, including myrrhanol A, B, C; myrrhanone A, B; myrrhanone A acetate; commipherol, commipherin and epimansumbinol, an octanordammarane-type triterpenoid. These compounds are an important class of secondary metabolites found in the gum resin of the plant.

The resin was further phytochemical studied leading to the identification and isolation of two further triterpenoid compounds, mansumbinone and mansumbinoic acid. The occurrence of these compounds further confirms the structural diversity of the triterpenes present in *C. wightii*, and has helped in understanding its chemical composition.

Steroidal Compounds: Gum resin of *Commiphora wightii* is a rich source of steroidal metabolites which include E-guggulsterone and Z-guggulsterone as characteristic metabolites. The resin has also yielded several related compounds called guggulsterols (I-VI). Other steroidal metabolites reported from *C. wightii* are 20 α -hydroxy-4-pregnen-3-one, 20 β -hydroxy-4-pregnen-3-one and 16 β -hydroxy-4, 17(20)-Z-pregnadien-3-one. Steroid is also found in the resin, one of which is cholesterol. Other members of this family that have been described more recently are guggulsterone-M, dihydroguggulsterone-M and guggulsterol-Y. The lipid lowering, anti-inflammatory properties have been attributed to the steroidal fraction of guggulu, and its constituents have been gaining a lot of attention.

Flavonoids: Another group of secondary metabolites in *C. wightii* is flavonoids. The ethanolic extract of the trunk was subjected to phytochemical analysis, which resulted in the isolation of a flavone, muscanone, which has been reported as having antifungal activity, as well as the known flavonoid naringenin. Microbial sensitivity testing revealed that Muscanone has inhibitory activity against *Candida albicans*. It has also been demonstrated that the flowers of the plant



contain a number of flavonoid glycosides, such as quercetin, quercetin-3-O- β -D-glucuronide, quercetin-3-O- α -L-arabinoside, quercetin-3-O- β -D-galactoside, quercetin-3-O- α -L-rhamnoside, and pelargonidin-3,5-di-O-glucoside.

Guggultetrols: The gum resin has a unique class of long-chain aliphatic compounds, guggultetrols, that have been identified. Saponification of the resin yielded a crystalline fraction consisting primarily of octadecan-1,2,3,4-tetrol, nonadecan-1,2,3,4-tetrol and eicosan-1,2,3,4-tetrol, with smaller amounts of related homologues. The structural characteristics are four hydroxyl groups at consecutive carbon atoms in a long linear aliphatic chain, C-1, C-2, C-3, and C-4. The purified guggultetrol-18 and guggultetrol-20 were obtained by chemical derivatization and preparative gas-liquid chromatography.

Lignans: It has also been found that *C. wightii* contains lignans, which were identified in phytochemical studies. Sesamin and diayangambin have been described as some of the lignans that have been found in guggulu. Further, a furofuran lignan derivative, 5,5-tetrahydro-1H,3H-furo[3,4-c]furan-1,4-diylbis[7-(methoxy)-1,3-benzodioxole] was also found in the methanolic extract of the resin.

Carbohydrates and Sugars: The carbohydrate component of the gum resin is composed of a number of monosaccharides and uronic acid derivatives. The gum has been completely hydrolysable to L-arabinose, D-galactose, L-fructose (in trace amounts) and 4-O-methyl-D-glucuronic acid. Partial or graded hydrolysis led to the identification of one aldobiouronic acid, 6-O-(4-O-methyl- β -D-glucopyranosyluronic acid)-D-galactose.

Amino Acids: In addition to terpenoids, steroids, flavonoids and carbohydrates, the amino acid content of *C. wightii* has also been studied. Alcoholic extract of plant was concentrated and then divided into water-soluble and ether soluble fractions. The aqueous fraction was subjected to chromatographic analysis and various amino acids were identified. The constituents identified were cystine, histidine, lysine, aspartic acid, serine, glutamic acid, threonine, alanine, proline, tyrosine, tryptophan, valine, leucine and isoleucine.

Together, these results indicate that the phytochemical content of *C. wightii* is very complex, containing from this plant steroidal compounds, flavonoids, guggultetrols, lignans, carbohydrates and amino acids along with the typical terpenoidal compounds. This wide chemical makeup forms the background to further explore the plant's pharmacological and therapeutic abilities.

VI. PHARMACOLOGICAL ACTIVITIES OF *COMMIPHORA WIGHTII* (GUGGUL)

Anti-Inflammatory and Antiarthritic Activity: In several experimental studies, Guggulu has been shown to have significant anti-inflammatory and antiarthritic activity. Aqueous-methanolic extract of guggulu was found to possess anti-inflammatory properties in mouse air-pouch granuloma model. The methanolic extract further inhibited nitric oxide levels in lipopolysaccharide activated mouse peritoneal macrophages. In another study, guggulu oil (petroleum ether extract) was used to inhibit inflammation in rats with Freund's adjuvant-induced arthritis, using a crystalline steroid isolated from the extract. It restricted the formation of primary lesions and reduced the severity of secondary lesions in comparison to untreated animals (Schrott et al., 2012).

Antioxidant Activity: Guggulu is also known to possess anti-inflammatory effects, which could help alleviate inflammation and support cardiovascular health. Guggulsterones are thought to be important contributors to this activity. In vitro studies showed that guggulsterone inhibited lipid peroxidation of low density lipoprotein (LDL) when stimulated with Fe^{2+} or stimulated rat peritoneal macrophages. Guggulsterone at 50 μM concentration, inhibited the production of thiobarbituric acid-reactive substances and lipid hydroperoxides. It did not, however, completely stop the formation of conjugated dienes, which are the early stages of the process of lipid oxidation (Mohan et al., 2016). Guggulsterone also blocked the lipid peroxidation in the liver microsomes in presence of Fe^{2+} and sodium ascorbate. It may, therefore, be correlated with the free-radical- scavenging and the metal-chelating properties. Moreover, alcoholic extract of *C. wightii* gum resin has demonstrated antihyperglycemic and antioxidant activities in streptozotocin-induced diabetic rats (Bellamkonda et al., 2011).

Antiatherosclerotic and Cardioprotective Activity: Oxidized LDL is known to promote the accumulation of cholesterol in the walls of the arteries and is important in the development and progression of atherosclerosis.



Guggulsterones, major constituents of guggulu with lipid-modulating properties, have been shown to inhibit in vitro oxidation of LDL. Both antioxidant and lipid-lowering effects indicate that guggulu could be potentially useful in atherosclerosis-related processes (Rawat et al., 2025).

Guggulsterones have also been found to exhibit cardioprotective activity in experimental models. Rats with isoproterenol induced myocardial injury showed changes in serum creatine phosphokinase and glutamate pyruvate transaminase along with changes in phospholipase, xanthine oxidase, lipid peroxide and glycogen, phospholipid and cholesterol levels. The administration of guggulsterone at 50 mg/kg dose significantly reversed these biochemical changes indicating a protection against myocardial damage (Chaudhary et al., 2012).

Antimicrobial Activity: Experimental studies have shown antimicrobial activity of extracts and volatile constituents of *C. wightii* (Sunita et al., 2023) reported that the volatile oil had fumigant activity towards *Rhyzopertha dominica*. The antibacterial activity of an ethanolic extract of *C. wightii* showed good activity against the multidrug resistant *Klebsiella pneumoniae* at 5 mg/mL. One compound (5-(1-methyl-1-aminoethyl)-5-methyl-2-octanone) extracted from methanolic guggulu gum showed a strong antibacterial effect on Gram-positive bacteria and a moderate effect on Gram-negative bacteria (Ulrich et al., 2022).

Anticancer and Antiproliferative Activity: Ferulates are one of the active constituents in guggulu that have shown cytotoxic activity in vitro. These compounds were found to inhibit the viability of MCF-7 breast cancer cell, PC-3 prostate cancer cell and P388 cell lines. An ethyl acetate fraction of the guggulu resulted in a significant degree of cytotoxicity and the presence of two compounds of ferulate with a unique chemical structure. The same fraction exhibited moderate free-radical-scavenging activity against DPPH radicals (Latha et al., 2021). The effects of Gugulipid have also been examined on prostate cancer cells. The viability of the androgen dependent LNCaP cells and their androgen independent C-81 variants were reduced by treatment with an IC₅₀ of ~1 µM after 24 hours of exposure. In other experimental research, guggulsterone was found to be anti-proliferative and induce apoptosis in prostate cancer cells (PC-3 cells) and the cells were greatly sensitive to the effect of guggulsterone, while normal prostate epithelial cells were comparatively resistant. These findings suggest that guggulsterone warrants further investigation as a potential candidate for cancer research; however, the available evidence is predominantly based on preclinical studies. (Latha et al., 2021).

Antifertility Activity: Oral treatment of guggulu in female rats (2 and 20mg/100g body weight) resulted in a decrease in the uterus, ovary and cervix weights, which was explained as anti-fertility activity. Simultaneously, an increase in the amount of glycogen and sialic acid was found in these reproductive tissues. The results indicated that guggulu may be anti-fertility in experimental animals.

Activity against Skin Disorders: Gugulipid has been studied for the treatment of nodulocystic acne. Gugulipid was found to be effective in a clinical trial of 21 patients, as much as tetracycline. Some better result was seen in those with oily skin which indicates that gugulipid can be used in the treatment of some types of acne (Ijaz et al., 2018).

Antihyperglycemic Activity: Experimental studies have shown that *C. wightii* has antihyperglycemic activity. The 60 consecutive days administration of an alcoholic extract at a dose of 200 mg/kg caused reduction in plasma Glucose levels in streptozotocin induced diabetic rats.

Guggulsterone has also been studied in high-fat diet induced diabetic rats. Glucose tolerance was seen to improve, with an increase in tissue glycogen content and stimulation of enzymes of glucose metabolism. Alterations in insulin secretion and expression of genes involved with carbohydrate and lipid metabolism were also found. These results indicate that guggulsterone might have dual glucose and lipid lowering properties, but more studies are needed to determine its therapeutic relevance in human diabetes.

VII. SAFETY AND TOXICITY

While guggulu has been traditionally employed in Ayurvedic medicine, its safety can vary based on dosage, preparation methods, duration of use and personal susceptibility. Unprocessed guggulu has been associated with



possible adverse effects in traditional Ayurvedic literature such as skin rash, gastrointestinal disturbances, headache, nausea and menstrual irregularity. High doses have also been reported to be hepatotoxic (Shah et al., 2012).

As a whole, guggul has been found to have a fairly good safety profile when used orally, both as a traditional remedy and in experimental applications; however, there is limited toxicity data available. Thus, correct dose, quality control and monitoring are crucial, especially when used for extended periods of time or at high doses.

Conclusion: *Commiphora wightii* has a high phytochemical content containing guggulsterones, terpenoids, steroids, flavonoids, and other bioactive substances and has been identified as an important medicinal plant. Traditional medicinal systems have utilized guggul in a variety of health conditions and experimental studies have shown various pharmacological activities such as anti-inflammatory, antioxidant, antimicrobial, anticancer, cardioprotective, and antihyperglycemic. But much of the evidence that is available comes from lab and animal research. Thus, clinical trials should be properly designed to determine its therapeutic effectiveness, safety and optimal dose.

Future Perspectives: In future, standardization and quality control of *C. wightii* extracts, identification of main bioactive compounds, and elucidation of its mechanisms of action should be investigated. Also, detailed toxicity, pharmacokinetic and chronic safety studies are needed. In addition, its traditional medicinal uses could be scientifically confirmed by further clinical trials which might also assist in the development of standardised guggul therapeutic products. It is also important to raise sustainable cultivation and conservation practices to ensure the protection of natural populations of this valuable medicinal plant.

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