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A Review on Pharmacology and Phytochemistry of *Commiphora wightii*

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ABSTRACT

Herbal medicinal plants are the gift of nature to the human beings. The present review is an effort to give a detail literature survey and discovering the hidden Marvels of *Commiphora wightii* also its remarkable health benefits in human beings. Worldwide *Commiphora wightii* is also known as Guggul is known for its anti-inflammatory property. Along with these it has many pharmacological activities like in the treatment of Rheumatoid arthritis, fibrinolysis, weight management, Cardioprotective action, thyroid function regulation, antioxidant support and in metastasis Inhibition. It contains various chemical constituents like guggulsterones, guggulipid, commiphoric acid, Monoterpenoids, guggultetrols, Steroids, flavonoids, diterpenoids, sesquiterpenoids, triterpenes, lignans and various amino acids which contribute to various therapeutic property.

Keywords: Chemical constituents, *Commiphora wightii*, Guggul, Health benefits, Pharmacological activities.

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INTRODUCTION

The Burseraceae family includes *Commiphora wightii* (Arn.) Bhandari, often known as *C.mukul* Hook Ex Stocks. This plant is a low-growing shrub with thorny branches and light bark. It has smooth, serrated leaves that are arranged in groups of three. It differs from other species such as *Commiphora gileadensis*, *C. foliacea*, and *C. habessinica* because of this (1). Guggul has been used for countless years in traditional Indian medicine to treat a variety of ailments, including obesity, gout, arthritis, inflammation, and disorders related to lipid metabolism (2). A few of the names used to refer to it include Indian bdellium, guggul, guggal, guggula, and gugar (41). The oleogum resin obtained from *Commiphora mukul* is a crucial ingredient in pharmaceutical formulations and is often known as Indian bdellium in the business world. Guggul or bdellium within the ducts located in the soft under bark is a chemical known as guggulipid, guggulipid, or guggulipid that has been extracted from this resin (3). The Ayurvedic System of Medicine, also known as Guggulu, clearly outlines the therapeutic advantages of guggul. The dehydrated exudate of *C. mukul*, a plant that flourishes in the dry regions of the Gujarat and Rajasthan states in India, is where the oily resin is derived from (4). Due to overharvesting in a sizeable area of its native habitat, *C. wightii* has experienced widespread use in traditional medicine. As a result, this plant species has been listed as an endangered species by the IUCN (42). The recent restrictions on the export of gum the Indian government as a result of its increased market worth in the context of global commerce (3).

The Guggul purifying procedure, Guggul Shodhana, is covered in Ayurvedic literature. Raw guggul ingestion may cause skin rashes, menstrual cycle disruption, diarrhea, headaches, mild nausea, and in situations of large doses, probable liver poisoning, according to Ayurvedic writings (19). Ayurvedic principles recommend a variety of purifying techniques (known as shodhan vidhi) using a variety of substances (dravyas) to address the possible negative effects of unprocessed guggul. These procedures not only lessen the negative effects but also increase the possibilities for healing. Guggul must go through purifying processes before being added to formulations, according to Ayurvedic literature (43). Based on estimates, the yearly requirement for guggul is approximately 1000 metric tons. However, the utilization of this medicinal substance in different preparations within the Indian system of medicine amounts to nearly 2300 metric tons. Moreover, around 500-1000 metric tons of guggul's oleo resin are imported from Pakistan each year. Given these circumstances, it is logical to focus on the preservation and cultivation of this threatened species, along with an investigation into effective harvesting and post-harvesting techniques (5).



Figure 1: Plant of *Commiphora wightii*(55)

Scientific Classification

Table 1: Scientific classification of *Commiphora wightii*

Kingdom	Plantae
Subkingdom	Tracheophyta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Eudicots
Subclass	Rosids
Order	Sapindales
Family	Burseraceae
Genus	Commiphora
Species	Mukul or wightii

Origin and distribution

There are 165 species in the *Commiphora* genus, which is native to Africa and Asia. It is widely distributed throughout tropical areas, including Northern Africa, Madagascar, Central Asia, Australia, the Pacific Islands, India, Bangladesh, and Pakistan. There are four species in this genus that may be found in India: *C. wightii*, *C. agollochoa*, *C. stocksiana*, and *C. berryi*. Notably, *Commiphora wightii* is where real guggul gum is sourced. Several Indian states, notably Tamil Nadu and Karnataka, are home to this specific species. Rajasthan, Assam, Maharashtra, and Gujarat (5)(6).

Plant description

The guggul plant resembles a woody shrub or a small tree in appearance. Its development is gradual, and it will take it around 8 to 10 years to reach a height of 3 to 3.5 meters. The plant has papery, thin bark and thorns on its branches. These branches have sharp spines at the ends and are tangled and twisted. The older stem areas' bark peels off in long pieces. The leaves are either simple or trifoliate, with oval, irregularly toothed-edged leaflets that range in size from 1 to 5 cm in length to 0.5 to 2.5 cm in width. The plant is gynodioecious, with female flowers on some specimens and bisexual and male blooms on others. The individual blooms have four tiny petals and range in hue from red to pink. The fruit is ovoid and spherical, up to 1 cm long, and becomes crimson as it ripens. The golden monocarps of the ripe fruit divide into two distinct celled stones. The beneath bark, which likewise peels in thin, papery layers, is revealed when the ash-colored bark flakes off to show it. The shrub loses its leaves in the winter, and the peak gum extraction season for guggul reserves takes place in April and May (37, 38, and 39).

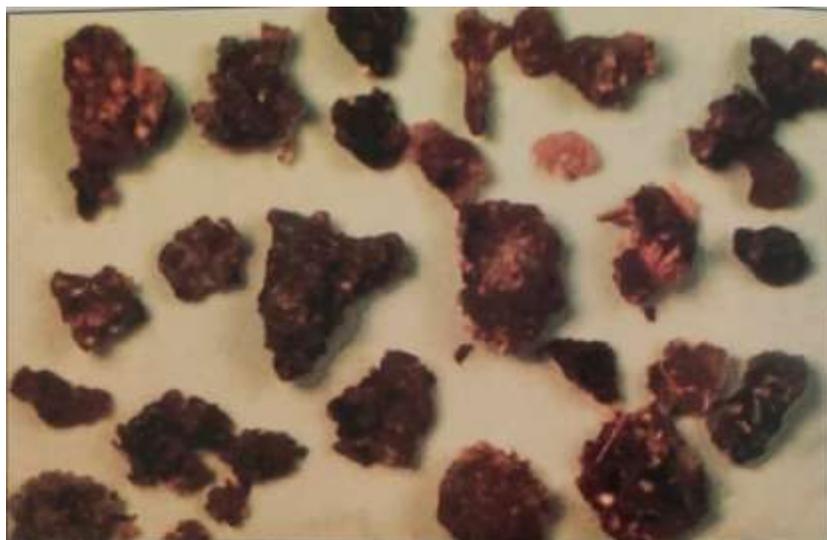


Figure 2: *Commiphora wightii* : oleogumresin(55).

Vernacular names of Guggul (7),(35),(36).

Language	Names
Bengali (also known as Bangla ,spoken in Bengal region of South Asia)	Guggulu, Guggul, Guggal, ranghan turb, Makal, Guggal
Canarese (also called as kannada language, spoken in state of Karnataka in southern India)	Guggulu
Dakshini (also known as Deccani Urdu, Dakni, Dakhani spoken in Deccan region of India)	Gugul, Guggul, Mukul, Ranghan turb
Gujarati (also known as Gujerati,Gujerathi. It is an official language of Gujarat)	Gugul, Gugal, Bhesaghgala, Guggul, Gugara, Mukul, Ranghanturb, Bhisoguggul
Hindi (also known as Hindustani language. It is an official language in Indian states which includes Madhya Pradesh, Jharkhand, Uttarakhand, Chhattisgarh)	Gugala, Guggal, Guggul, guggulu, Gugava, gugavik, Kukul, Rranghanturb, Gogil, Bhasagugul.
Kannad (Spoken in Coastal / Karavali kannada, southern kannada, Central kannada,Mumbai Karnataka kannada, Hyderabad Karnataka kannada.)	Kanthgal, Kangah, Guggul, Ivadol-guggala, Idbol
Marathi (also known as Mahratti, Maharashtri.It is most widely spoken by the people of India.)	Gugal, Guggal, Guggul, hansaguggul, kantguggul, Mahaishsguggul
Sindhi (It was spoken by Sindhi people belonging to India and Pakistan)	Gugaru
English (It was spoken in many countries including England, china, Australia, Canada, Ireland)	Gum giggulu, Indian bdellium, Indian bdellium, salativee, Bdelium, Guggulu, Borassus, Flabelliformis
Tamil (It was spoken by India, Sri Lanka, Malaysia and Singapore)	Kukkil, Gukkal, Guggal, Gugal, Gukkula, Maishskshi, maisachhi, Kungiliyam
Telugu (It was spoken in the regions of Andhra Pradesh and Telangana)	Meshakshi, Gukkal, Guggal, Guggal, Gugal, Gukkula, maishakshim, Mahishaksh-Gugilamu, Cheetu mahishashi
Arabic (There are many countries who speak Arabic language which includes Algeria, Bahrain, Egypt, Iraq and many other countries)	Mukulyahuda, Mulkarjak, Mushkilerarjak, Mogla, Mogal, Mokhit, Aphalatana, Mukal, Ahlatan, Mogal, Arzagiaglatam.
Persian (It was an official language of Iran)	Baijahundan, Boejahudan
Parsi (It was spoken in Gujarat and Maharashtra)	Boejahudon, Buejahudan, Boe, jhoodan, Vorojahudan
Sinhali (Sinhali is an Indo-Aryan language, which was spoken in Sri Lanka)	Rata dummula, Guggulu, tatayy, Jauya
Unani (Unani means Greek language)	Afaletana, Mikal

Types of Guggul (7)

Guggul Type	Geographic Origin	Color Description	Medicinal Applications	Synonyms
Nadi Sameepottha	Near Sindhu River	-	-	-
Samudra	Near the ocean	-	-	-
Sameepottha				
Mahishaksha	-	Resembles Bhringa or Anjana color	Humans and elephants	Also Gajakeshara
Mahaneela	-	Intense blue color	Humans and elephants	Also Indravalli and Indraja
Kumuda	-	White like Kumuda flower	Suggested for horses	Also Mrinala and Kritanjana
Padma	-	Dark red like a ruby	Beneficial for horses	Also Devakusuma and Krishnapushpa
Hiranya	-	Gold color	No specified medicinal use	-
Kanaka	-	Most superior, recommended for medicinal use	Humans	Also Suvarna, Swarna, and Kanakeshara

Macroscopic Features

The translucent formations, also known as stalactic formations or vernacular formations, are tears. They come in a variety of sizes and hues, from reddish-yellow to brown. They frequently appear as resinous clusters, which have a propensity to darken over time. They exhibit a brittle snap when broken, presenting a surface with a rough or waxy texture and a clearly wet and unctuous look. These tears have an acidic, bitter, fragrant flavor and emanate a balsamic scent (34).

Shodhana process (Purification) of Guggul

Different techniques are involved in the Sodhana, or purifying, of Guggul, as described in our old writings. In the context of guggul purification, a number of ingredients are used as purifying agents, including gomutra (cow's urine), godugdha (cow's milk), triphala kasaya (decoction of three fruits), vasa kasaya or svarasa (decoction or juice of vasaka), and nirgundi svarasa (juice of nirgundi). The Ayurvedic Pharmacopoeia of India, Part II, Volume II, dated 2008, page 277, has documentation for this topic. Scientifically, Guggul is purified using these particular ingredients and procedures, in accordance with the prescriptions found in classical Ayurvedic books (7).

Guggul is a key component in several commercial polyherbal preparations with a primary focus on anti-inflammatory qualities (32). There haven't been many research looking at the Ayurvedic purification procedure and its possible effects on medicinal efficacy, with the exception of one that claims purification decreases the gastrointestinal irritancy of guggul (33).

Guggul that has not been purified yet goes through a number of procedures. The raw guggul is first carefully cleaned of any foreign substances, and then it is broken up into smaller pieces. The broken guggul is suspended inside a "dola yantra," an inert container, and is contained inside a cotton bag known as a "potli." This jar holds one of the purifying substances advised, such as water, milk, gomutra (cow urine), triphala kasaya (decoction of three fruits), vasapatra kasaya (decoction of *Adhatoda vasica* leaves), and vasapatra svarasa (aqueous extract of *Adhatoda vasica* leaves). Until the soluble parts of the guggul entirely dissolve inside the purifying solution, the guggul is heated while submerged in the fluid. The guggul's insoluble portion is taken out and thrown away. The guggul solution is continuously boiled till it turns into a mushy mass. The resultant mass is then dumped onto a wooden board that has been well smoothed down and is covered with castor oil or cow ghee. This mass is then allowed to dry in the sun. Purified guggul (suddha guggulu) is the name of the dried, finished product (43).

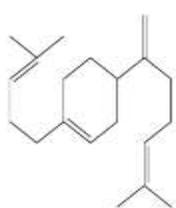
Phytoconstituents of Guggul

Through carefully conducted harvesting techniques, medicinal plants can be harvested for their therapeutic plant ingredients, or phytoconstituents. To achieve the finest quality and greatest

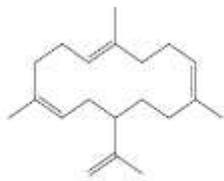
medicinal advantages, it is therefore crucial to collect these herbs using the right methods(8). Diterpenoids, triterpenoids, steroids, long-chain aliphatic tetrols, carbohydrates, ferulates, lignans, carbohydrates, and a variety of inorganic ions are among the many substances that make up guggul. Sesamin and numerous other unknown substances are also present in trace concentrations. The dried oleo-gum resin exudates collected from the *Commiphora* bark's cracks and fissures are a complex mixture of several substances. Numerous studies on the phytochemistry of *Commiphora mukul* have shown that it contains a variety of substances, including gums (32%), oleo-gum resin (38%), and essential oils (1%). The commercial product also contains additional chemicals (5%), foreign organic matter (4%), and minerals (20%). A complex blend of substances, including steroids, lignans, ferulates, terpenes, tannins, cembrenoids, and flavones, are present in dried oleo-gum resin(9). The current agreement recognizes that the bioactive component of gum guggul, responsible for its pharmacological actions, is guggulsterone (32). The two guggulsterone isomers Z and E, which are found in the ketonic fraction, have considerable anti-inflammatory and hypolipidemic qualities (Figure 1) (33).

Volatile oil content and its specific terpenoidal constituents.

Monoterpenoids: The gum resin obtained from *C. wightii* yields approximately 0.4% of essential oil through steam distillation. The main constituents of this essential oil include myrcene, dimyrcene, and polymyrcene (45). In addition, the oil contains d-limonene, linalol, β -pinene, eugenol, cineole, β -terpineol, d- α -phellandrene, methylheptanone, bornyl acetate, (\pm)geraniol. Additionally, the oil contains various other compounds that have not been identified yet (46).



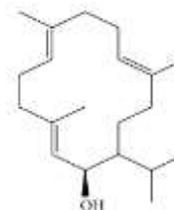
1. Camphorene



2. Cambrene A



3. Cambrene



4. Mukulol

Figure 1

Figure 2

Sesquiterpenes: In relation to sesquiterpenoids, the gum resin of guggul was identified to possess bicyclic sesquiterpene which is known as cadinen.

Diterpenoids: It contains a variety of cambrenoids, including Cambrene A, Camphorene, and Cambrene. One of the most fundamental tetraenes is cembrene-A, which was created by cyclizing carbons C-1 to C-14 from geranylgeranyl pyrophosphate. The hexane-soluble part of the guggul-

derived methanol extract was used as the starting point for a guided isolation procedure based on bioassays that led to the discovery of novel chemicals (31).

Triterpenoids: It includes Polypodane type of triterpenes include myrrhanol A, myrrhanone A, myrrhanone B, myrrhanone A acetate.

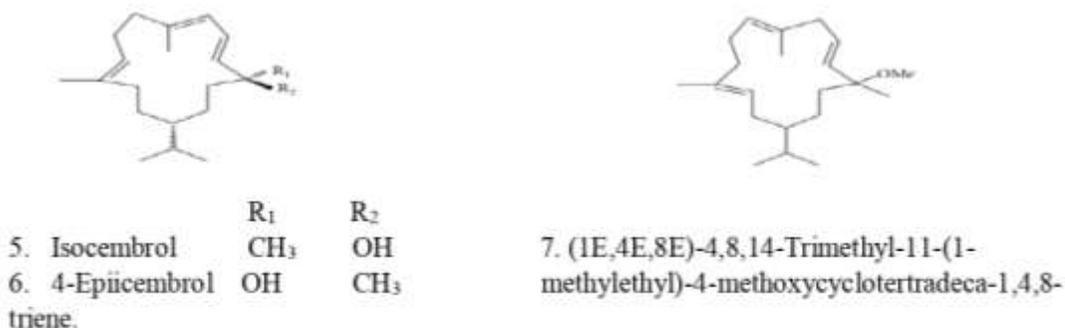
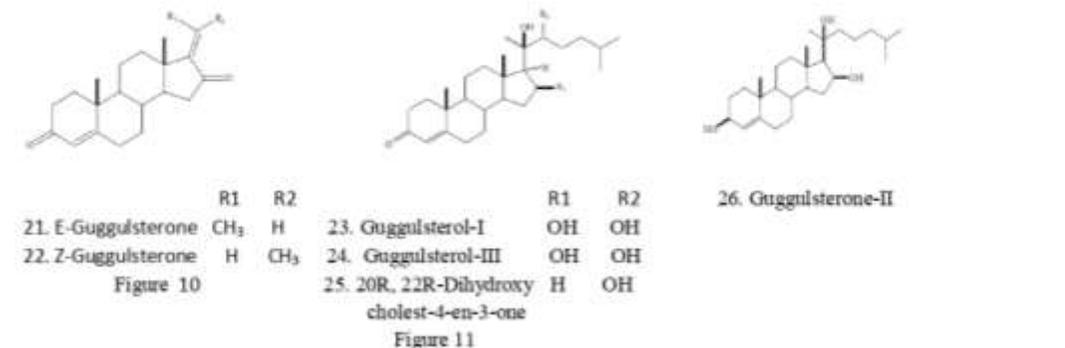
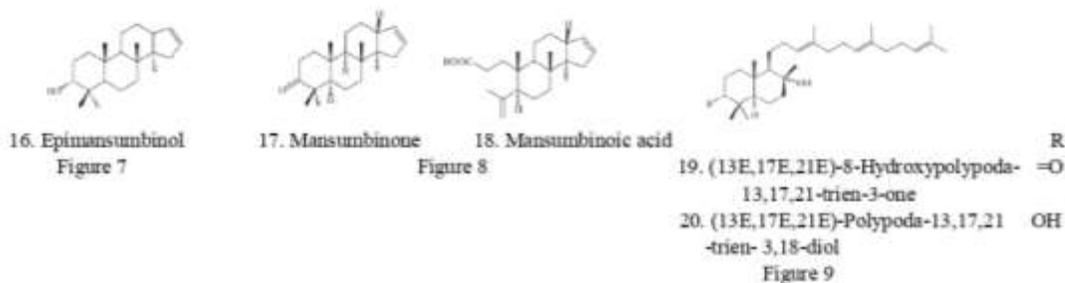
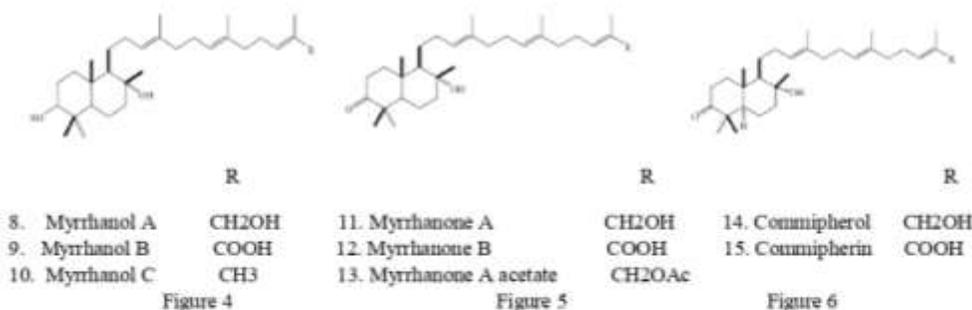


Figure 3



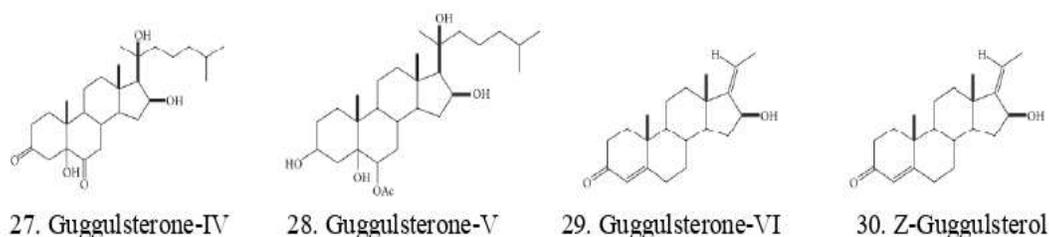


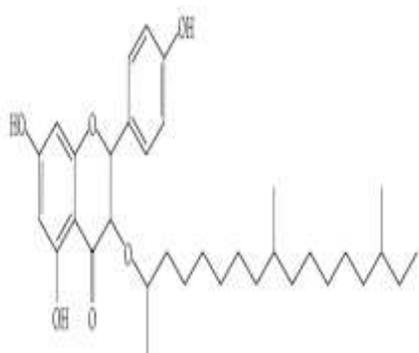
Figure 12

Steroids:

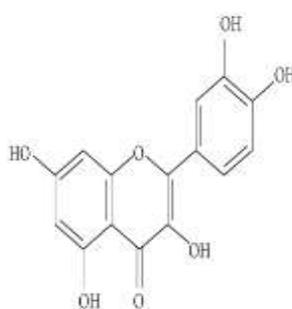
The gum resin has been reported to contain various isolated steroidal constituents. Among these, the principle components encompass E-guggulsterone (depicted in Figure 10), Z-guggulsterone (depicted in Figure 10), guggulsterol-1 (shown in Figure 11), guggulsterol-II (shown in Figure 12), guggulsterol-III (depicted in Figure 11) (33), guggulsterol-IV (depicted in Figure 12), guggulsterol-V (depicted in Figure 12) (32), and guggulsterol-VI (depicted in Figure 13) (47). Other compounds related with the steroids include Z-guggulsterone (depicted in Figure 12) (31).

Flavonoids:

A new antifungal flavone, named muscanone (illustrated in Figure 13), was isolated from an alcoholic extract of the trunk of *Commiphora wightii* using a silica gel-packed column. This compound was discovered alongside the known compound naringenin. Muscanone demonstrated Exhibited efficacy against *Candida albicans* in a microbial susceptibility test (30). The principle flavonoid compounds found in the flowers of *Commiphora mukul* were identified as follows: quercetin (depicted in Figure 14), Quercetin-3-O - α - L-rhamnoside (depicted in Figure 14) (48)



31. Muscanone



32. Quercetin

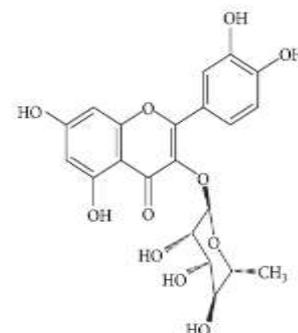
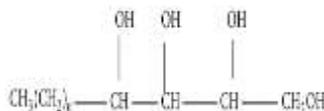
33. Quercetin-3-O - α - L-rhamnoside

Figure 13

Figure 14

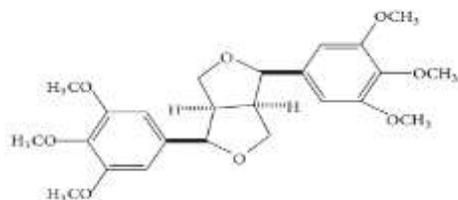
Guggulterols: A crystalline material was extracted from the saponified gum resin and recognized as a combination of octadecan-1,2,3,4-tetrol (depicted in Figure 15) Nonadecan-1,2,3,4-tetrol (depicted in Figure 15) Eicosan-1,2,3,4-tetrol (depicted in Figure 15) (49).



34. Octadecan-1,2,3,4-tetrol n= 13
 35. Eicosan-1,2,3,4-tetrol n=15
 36. Nonadecan-1,2,3,4-tetrol n=14

Figure 15

Lignans: lignans, namely sesamin (29) also Diayangambin (27) have been documented in the alcoholic solution of Guggul (28).



37. Diayangambin

Figure 16

Amino acids: *Commiphora mukul* was subjected to alcohol extraction, and the resulting extract, after solvent removal, was divided between water and ether phase. The aqueous fraction underwent chromatography, revealing the presence of diverse amino acids. The identified amino acids encompassed histidine, arginine, serine, threonine, proline, tyrosine, tryptophan, isoleucine (26).

Traditional Uses of Guggul (22,23,24,25)

Aspect	Details
Historical Utilization	Guggul has a rich history of use in Ayurveda. It is mentioned in the Atharvaveda. Detailed explanations of its effects, applications, and forms are found in texts like Charaka Samhita (1000 B.C.), Vagbhata (7th century A.D.) Sushruta Samhita (600 B.C.) Medical manuscripts from the 12th to 14th centuries also document its use.
Conditions Addressed	Guggul is used for various conditions including obesity, rheumatoid arthritis, Osteoarthritis, gout, sciatica, facial paralysis, hemorrhoids, inflammation, cysts, cervical lymphadenitis, constipation, coronary thrombosis, liver disorders, anemia, diabetes, skin ailments, UTI
Utility in Traditional Medicine	Guggul serves as an astringent, antiseptic, bitter, stomachic, and carminative when ingested. It increases white blood cell count and phagocytosis. It's diaphoretic, expectorant, diuretic, uterine stimulant, and emmenagogue. Topically, it's used for ulcers and as a gargle. Vapors aid in respiratory issues
Topical Application	Guggul resin is applied topically for sluggish ulcers and used as a gargle for oral conditions like inflamed gums, Decay, tonsillitis and pyorrhea.
Inhalation Use	Inhaling vapors from burning guggul is recommended for hay nasal catarrh, fever, laryngitis, phthisis (persistent cough) and bronchitis
Ointment Ingredient	Guggul is included in ointments for ulcers.

Investigation of the *Commiphora wightii* Market: Supporting Data and Approach

Since 1980, the Indian market has offered guggulipid, an alcoholic extract made from the oleoresin of *Commiphora wightii* and standardised by CDRI (The Central Drug Research Institute, Lucknow), as a hypolipidemic medication. This extract contains guggulsterones and guggulsterones, which are thought to be the cause of the hypolipidemic effects of guggul (19,20,21). 4 to 6 percent of guggulsterone may be found in guggulipid. Commercial considerations and the noted synergistic hypolipidemic effects of other components within the ethyl acetate extract were the main driving forces for the decision to use the ethyl acetate extract rather than individual guggulsterones (18). Despite the fact that there is evidence to support the marketing of guggul in the form of an ethyl acetate extract, traditional preparations like Yogaraj Guggul, Amritadi Guggul, Mahayogaraja Guggul, Gokshuradi Guggul, Kanchanara Guggul, Triphala Guggul, Kaishore Guggul, etc., are the most common types of guggul preparations offered in the market. Guggul is sold in mixtures with other medicinal plants or mineral medications by several Ayurvedic and herbal pharmaceutical businesses for a range of therapeutic purposes. Recently, some businesses began promoting guggul in the form of a refined extract as a single herb agent. Foreign markets, notably those in the USA and the Middle East, have a need for guggul. However, delivering guggul in a pure compound form is often necessary for successful marketing in these nations, accompanied by comprehensive chemical fingerprinting using cutting-edge methods like HPTLC, HPLC, GC-MS, etc.

Formulations of Guggul available in market (17)

Formulation	Benefits and Applications
Yogaraj Guggul	Alleviates excess Vata, especially in the musculoskeletal system. Supports detoxification, rejuvenation, and benefits joints, muscles, and nerves.
Kaishore Guggul	Balances Pitta, targets musculoskeletal disturbances. Detoxifies and rejuvenates while nourishing and strengthening. Focuses on deep-seated Pitta imbalances.
Punarnavadi Guggul	Clears excess Kapha from urinary system, kidneys, heart, and joints. Promotes fluid elimination, balances water element, supports circulation and joint movement.
Triphala Guggul	Combines Triphala's detoxifying properties with Guggul's cleansing actions. Supports weight management, digestion, and reduces toxin buildup.
Kanchanar Guggul	Addresses deep-seated Kapha imbalances, benefits thyroid and lymphatic system. Supports tissue detoxification and reduction of Kapha.
Gokshuradi Guggul	Benefits genitourinary tract, kidneys, bladder, urethra, and reproductive organs. Balances Vata, Pitta, Kapha. Supports urinary system detoxification.
Simhanad Guggul	Tailored for joint detoxification and rejuvenation. Balances Vata and Kapha. Detoxifies joints, improves mobility, and aids digestion.

Pharmacological activity of Guggul



Figure 17: *Commiphora wightii*

Rheumatoid arthritis (RA)

Aspect	Details
Condition	Rheumatoid Arthritis (RA)
Underlying Processes	Inflammatory cells invade synovial joints, leading to chronic synovitis and cartilage loss(14).
Key Players in RA Development	leukotrienes, adhesion proteins, Prostaglandins and MMP-9(14).
Role of Inflammatory Cytokines	Imbalance in cell signaling pathways results in the production of proinflammatory agents.
Regulation of Inflammation	Nuclear factor (NF)-kB regulates the action of various inflammatory agents
Inhibition by Guggulsterone	Guggulsterone inhibits NF-kB activation, reducing the expression of proinflammatory agents(50)
Comparative Study	Guggul gum's anti-inflammatory potency compared to phenylbutazone and ibuprofen in rabbit(16)
Experimental Model	Albino rabbits with simulated experimental arthritis similar to RA in humans(16)
Treatment Dosages	Guggul fraction A (ethyl acetate extract), ibuprofen, and phenylbutazone at specified doses(16)
Effectiveness	All three medications, including gum guggul, demonstrated good anti-inflammatory effects(16)
Immunomodulatory Cells and RA	Macrophages, T-cells, and fibroblast-like synoviocytes produce inflammatory cytokines in RA
Inhibition by Guggulsterone in FLS	Cis- and trans-guggulsterone reduce proliferative activity of FLS treated with IL-1b(14).
Impact on MMPs and Chemokine Synthesis	Inhibition leads to MMP deactivation and efficient control of chemokine synthesis(14).
NF-kB Activity Reduction	Binding activity of NF-kB is decreased, inhibiting chronic joint degradation in RA(50)

Anti-obesity agent

Aspect	Details
Condition	Obesity
Anti-Obesity Properties of Guggulsterone	Guggulsterone (cis- and trans-isomers) investigated using 3T3-L1 cells. Both isomers have anti-obesity qualities(15).
Induction of Apoptosis	Both cis- and trans-guggulsterone induce apoptosis in a dose-dependent manner. Cis-isomer is more effective(15).

Lipolysis in Mature Adipocytes	Cis-isomer is more efficient in inducing apoptosis and lipolysis (fat breakdown) in mature adipocytes (15).
Combination of Guggulsterone and Genistein	Guggulsterone and genistein cause apoptosis individually and synergistically when combined(51).
Effects on Apoptotic Markers	Combination increases the expression of apoptotic markers such as procaspase-3 cleavage, Bax expression, cytochrome-c release, and PARP proteolytic cleavage(51).
Inhibition of Lipid Accumulation	Combination also blocks lipid buildup in maturing adipocytes(51).
Synergistic Effect with 1,25(OH)2D3	1,25(OH)2D3, a hormone metabolite of vitamin D, enhances anti-adipogenic (preventing fat cell production) and pro-apoptotic actions of guggulsterone in 3T3-L1 preadipocyte(13).

Fibrinolysis (12)

Aspect	Details
Condition	Prevention of excess of blood clotting
Fibrinolysis Enhancement by Guggul	Guggul encourages fibrinolysis, the process that breaks down fibrin in blood clots.
Antioxidant Properties of Guggul	Guggul functions as an antioxidant.
Role of Guggulsterones	Active ingredients in guggul, known as guggulsterones, improve fibrinolytic and platelet function, maintaining cardiovascular health.
Impact on Platelet Adhesiveness and Fibrinolysis	Research indicates that guggul can increase fibrinolytic activity while reducing platelet adhesive index.
Therapeutic Potential for Diseases	Guggul may have therapeutic advantages in treating diseases like COVID-19, where maintaining good fibrinolysis and preventing excessive blood clotting is crucial.

Cardioprotective agent

Aspect	Details
Condition	cardiac injury, lipid levels, LDL oxidation, and myocardial ischemia
Protection Against Cardiac Injury	Guggulsterone therapy (50mg/kg, oral) successfully restored cardiac damage induced by dl-isoproterenol hydrochloride injections in rats(10).
Reduction in Lipid Levels	Guggulsterone therapy resulted in a significant reduction in blood levels of VLDL, LDL, and lipid peroxides(11).
Comparison to Gemfibrozil	Guggulsterone's cardioprotective properties were compared to those of gemfibrozil and found to prevent oxidative damage to LDL and the production of free radicals(52).
Prevention of LDL Oxidation	Guggulsterone inhibits LDL oxidation, a critical step in atherosclerosis formation, by affecting enzymatic processes, free radicals, or catalytic copper ions(53).
Protection Against Myocardial Ischemia	Treatment with Commiphora mukul hydroalcoholic extract (containing guggulsterone) improved cardiac function, preserved myocardial integrity, and reduced lactate dehydrogenase levels in rats with induced myocardial ischemia(54).

Metastasis inhibition by Guggulsterones(56).

Aspect	Details
Condition	Metastasis
Metastasis Inhibition by Guggulsterone	Guggulsterone suppresses metastasis, a crucial step in cancer progression, by reducing the expression of genes controlled

NF-kB and Gene Expression Control	by NF-kB. NF-kB is a transcription factor linked to inflammation and controls the expression of genes involved in metastasis, such as MMP-9, VEGF and COX-2
Potential Therapeutic Use for Preventing Cancer Spread	Guggulsterone's ability to control key genes in metastasis suggests therapeutic potential for preventing the spread of cancer cells

Thyroid function.

Aspect	Details
Condition	Hypothyroidism
Thyroid Gland Stimulation by Guggulsterone	Guggulsterone activates the thyroid gland, leading to increased production of thyroid hormones T3 and T4(2).
Improvement in Hypothyroid Rats	Hypothyroid rats treated with guggulsterone (10mg/kg body weight) regained lost thyroid function and showed improved thyroid iodine absorption(2).
Effects on Thyroid Enzymes and Oxygen Consumption	Guggulsterone treatment raised thyroid peroxidase and protease activities and increased oxygen consumption in albino rats(2).
Lipid Peroxidation and Thyroid Function	Guggul treatment in mice improved the concentration of T3 and the T3/T4 ratio, while reducing lipid peroxidation in the liver(57)
Potential Implications for Thyroid-Related Diseases	Guggulsterone's effects on thyroid function suggest potential applications for individuals with thyroid-related diseases(2,57)

Other uses

Disorders	Details
Otitis Media (Middle Ear Inflammation)	Guggulsterone reduces inflammation in human middle ear epithelial cells induced by lipopolysaccharide (LPS) by inhibiting the production of pro-inflammatory molecules like COX-2 and TNF-a, and IkBa degradation(58)
Uveitis (Eye Inflammation)	Guggulsterone inhibits inducible nitric oxide synthase and NF-kB activation in cultured human primary non-pigment ciliary epithelial cells, effectively reducing endotoxin-induced uveal inflammation, suggesting potential use in treating ocular inflammation, especially uveiti(59). It also have some antimicrobial activity.

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