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Review Article

Cedrus deodara (Himalayan cedar): An Integrative and Evidence-Based Review of Ethnomedicinal Uses, Phytochemistry and Pharmacological Activities

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ABSTRACT

The genus *Cedrus* (family Pinaceae) includes four species *Cedrus deodara* (Himalayan cedar), *Cedrus libani* (Lebanon cedar), *Cedrus atlantica* (Atlas cedar), and *Cedrus brevifolia* (Cyprus cedar). These species are distributed across the Himalayan region, the Mediterranean gulch, North Africa, and Cyprus, where they have been traditionally utilized for various medicinal, cultural, and economic purposes. Among them, *Cedrus deodara* is widely used in traditional medicinal systems such as Ayurveda, Siddha and Unani for treating various illnesses, including skin diseases, inflammatory conditions, joint pain, infections, ulcers, kidney stones, and respiratory disorders. Phytochemical studies have recognized many bioactive compounds in *Cedrus* species, particularly terpenoids, flavonoids, and phenolic compounds**.** The major phytochemical constituents contain α- and β-himachalene, himachalol, cedrol, atlantone, deodarin, taxifolin, and other sesquiterpenes**,** which donate to the medicinal properties of these plants. Pharmacological studies have demonstrated a wide-range of biological activities including antimicrobial, antioxidant, anti-inflammatory, analgesic, antidiabetic, anticancer, neuroprotective, and immunomodulatory effects thereby supporting their traditional uses. Though more studies focusing on bioactive compound isolation, mechanism of action, safety evaluation, and clinical authentication are necessary to fully explore the therapeutic potential of *Cedrus* species for drug development.

Keywords: Ethnomedicinal uses, Himalayan cedar, Medicinal plants, Terpenoids.

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INTRODUCTION

In this world, nature an excessive source of herbal plants that provide many medicinal properties to cure human illnesses and offer huge benefits to human health care. Most of the population depends on herbal medicine. Herbal medicinal plants play a very vital role in traditional system of medicine, including Ayurveda, homeopathy and Native American Indian medicine. The herbal medicines provide many important medicinal uses with little side effects (Khanduri and Sharma, 2002). Herbal plants are a good source of diverse bioactive compounds, including phenolic nitrogen-containing compounds, vitamin and terpenoids as well as various secondary metabolites that exhibit antioxidant, antitumor, antiviral and other pharmacological activities (Sharma *et al.*, 2018). The medicinal plants were used as therapeutic agents through ancient times in Indian and other known cultures of the past like Egyptian, Babylonian, Jewish, Chinese and more. Himalayans are the main source of the herbal medicinal plants. Around 15000 medicinal plants species present in the country 7000 plants used in Ayurveda, 700 in Unani, 600 in Siddha, 450 in homeopathy and 30 in modern medicines (Siwach *et al.*, 2013). The medicinal plants used for treating the disease through history of human life. The evidence speaks the use of herbal plants are cultivated as drug around 60,000 year ago. In India, China and Egypt around 5000 year ago and in Greece and central Asia around 2500 years ago. People cure their illness by using the herbal plants (Jamshidi-Kia *et al.*, 2017). According to the World Health Organization (WHO) around 4-5 billion people and 80 % of populace of the world uses the herbal medicinal plant to treat health care problems (Nadeem *et al.*, 2019).

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The Himalayan range has a rich legacy of awareness on plant-based therapy. Medicinal plants play an important role in living on top of the world. The medicinal plant is most important in the Himalayan region for peoples; it helps to treat illnesses that occur due to the weather and climate changes. The Himalayan state of India also used the medicinal plant for medicine. The western Himalayan forests are difficult to ecologically balance due to the biodiversity; regular climate provides the ecosystem favour like water filtration, carbon sequestration and soil stability (Dwivedi *et al*., 2019). The Indian Himalayas are divided into three main regions: North-western Himalaya: It shelters the area of the Ladakh plateau and Gilgit district in Kashmir. Western Himalaya: It spreads crosswise through Jammu and Kashmir, Himachal Pradesh, Garhwal, and Kumaon Himalayas. Eastern Himalaya: This zone includes Darjeeling, Sikkim, and the northern part of Assam and Arunachal Pradesh. A Himalayan medicinal plant helps to improve the daily life of the people (Chhetri, 2014).

For a long time, biochemists, chemists, and pharmacological researchers have been very interested in and focused on medicinal plants. These researchers are crucial in finding new natural resources and creating promising medications for a range of unidentified illnesses that should be more effective and have fewer adverse effects than the majority of contemporary manufactured medications (Chhetri, 2014). Other therapeutic applications of healing plants are acknowledged as a means of discovering more about the potential prospects for medicinal plants in the future. Generation after generation are currently using medicinal medicines that were developed from plants using information gleaned from literature and traditional knowledge (Nadeem *et al*., 2019).

Nature is a rich source of the herbal medicinal plants. Many plants that have medicinal properties were used to treat their own illnesses through ancient times. One of the best herbal plant is *Cedrus deodara* which also has a medicinal property (Rahman *et al*., 2022). It has medicinal and non-medicinal uses such as fuel, ornamentals, food, species and wood for making houses, etc. *Cedrus deodara* is a large Himalayan evergreen coniferous tree native to the western Himalayas, commonly called as the Himalayan cedar, spread from the karakoram area to Nepal, Bhutan, and the northeastern Indian Himalayas. It belongs to the family Pinaceae (Sharma *et al*., 2016). Some species of *C. deodara* trees are located in western Himalayan forests in Uttarakhand and Himachal Pradesh, India, having a temperature climate and an altitude of 1700 to 2700 m.a.s.l. (meters above sea level) with neutral and acidic soil. This tree grows in both dry and moist conditions, and some species are unable to tolerate temperatures below -18°C (Pathak *et al*., 2023). *C. deodara* is tall, up to 85 m in heights, with rough black bark and spreading branches around the tree (Gillani *et al*., 2025). Through ancient time this plant has been used to treat diseases, either the whole plant or any part of the plant (Pathak *et al*., 2023). The growth of cedar depends on the climate changes. It is divided into two different age classes: "Young ages (<100 and Older age >100)" in the Indian western Himalaya lower temperature zone (Dhyani *et al*., 2022). It has many medicinal properties that mentioned the traditional medicinal system of India, China, Pakistan, etc. It is used in the treatment of various skin diseases, microbial infections, joint disorders, asthma, kidney stones, ulcers, brain disorders, and immunological disorders. In the current doubt, the allopathic medication shows the various side effects. The most important pivot consistently develops new remedies for treating diseases from herbs (Kalam *et al*., 2023).

The *Cedrus* has 4 species: *C. deodara* (Roxb.) G. Don in Loud., *C. atlantica* (Endl.) Manetti ex Carriere, *C. libani* A. Rich., *C. brevifolia* (Hook. f.) Henry (Pijut, 2000) (Ginwal *et al*., 2020).

Cedrus atlantica (Endl.) Manetti ex Carriere occurs in the eastern and central part of the Atlas Mountains covering an area around 16,000 ha, and in the Rif Mountains it covers the total area around 145,000 ha. It occurs where the annual rainfall is 400-2100 mm/year and the average minimum temperature of the coldest month ranges between 8.5 and 2.7°C (Bouahmed *et al*., 2019).

Cedrus libani is today present in the Taurus Mountains of Turkey and also found in Syria and Lebanon. In the Past 5000 years it was cut and burnt out leaving only a very low population in Syria and Lebanon. *Cedrus libani* generally occurs between 800 and 2100 m elevation and in also found at higher elevation (2400 m) and lower elevations (500-600 m) (Boydak, 2003).

Cedrus brevifolia is located in the Troodos Mountains at 1700 m. a. s.l. 34°56′N, 32°50′E elevation (Binazzi *et al*., 2017). It differs from other species of the genus in its morphological and Eco physiological traits, characterized by shorter needles, shorter growth, and the highest drought tolerance among all cedar species (Eliades *et al*., 2011). Some details of cedar species are presented in Table 1.

All *cedar* species differ in needle length, characteristics of male strobili, number of leaves in pseudo-whorls, branch morphology and shape and size of cones. The size of the needles is different, like *C. deodara* has long needles (2-6 cm) shown in Figure 1, and Mediterranean has three other species which have short needles (around 3-3.5 cm), but the *C. brevifolia* length of the needles is very short (0.5-1.6 cm). The identification of *C. libani* and *C. atlantica* is very difficult due to the same shorter length of needles shown in Figures 2 and 3 but it is easy to identify *C. deodara* because of the long length of needles and in *C. atlantica* cone is present. The cones of *C. atlantica* and *C. brevifolia* are relatively short (up to 8-10 cm) Figures 3 and 4, while *C. deodara* cone size reaching 12-13 cm in length, presented in Figure 2 (Ohi-Toma *et al*., 2021).

METHODOLOGY

This review is based on a systematic collection and analysis of published literature on *Cedrus deodara* from scientific databases such as PubMed, ScienceDirect, Scopus, and Google Scholar. Relevant studies on ethnomedicinal uses, phytochemistry, and pharmacological activities were selected, critically evaluated, and synthesized to provide an evidence-based overview.

Ethnopharmacological uses

All the parts of the *Cedrus deodara* are very useful the Ayurvedic system of medicine to treat insomnia -like disorders and diseases like skin and blood. *C. deodara* is also suggested for both the acute and chronic inflammations. Oil and gum have lots of medicinal properties to treat inflammation, dyspepsia, cough, fever, bronchitis, itching, elephantiasis, leukoderma, ophthalmia, and tuberculous glands. The astringent activity is present in bark and useful for fever, diarrhea, or dysentery. Bark is extracted by the alcohol; it reduces the inflammation. Wood is bitter in taste, and it has carminative properties that are helpful for diuretic, lungs and urinary disease. *C. deodara* pine needles are a nutrient-rich food source. The medicinal plant has lots of vitamins, protein, and minerals. Medicinal plants have potential bioactivities that produce antioxidant, anti-inflammatory, anti-tumor, anti-mutagenic, anticarcinogenic, antibacterial, and antiviral properties (Sargar *et al*., 2024).

The traditional use of *Cedrus atlantica* (Endl.) Manetti ex Carriere is antiseptic, anti-inflammatory, and antimicrobial. It is also used for treating skin problems, like wounds and fungal infections. Traditionally, essential oil and resin are applied to wounds, cuts, and infections because of their antiseptic and antimicrobial properties. It inhibits growth and prevents infection with the help of terpenoid compounds present in the oil (Belkacem *et al*., 2021). It is used a healer to relieve inflammatory conditions and pain relief (Gruin *et al*., 2025).

Cedrus libani has been used as folk medicine for a long time in the Mediterranean and Middle East basically used for rheumatic disorders, gastrointestinal pain, respiratory and inflammatory conditions, skin, wound healing, and eczema. For rheumatic pain, leaves are traditionally used on the basis of anti-inflammatory and analgesic effects by testing (Elias *et al*., 2019). It traditionally widely cures the illness, including respiratory and inflammation, as well as relieves toothache (Nayal *et al*., 2023). Essential oil of *Cedrus* species, including *C. libani*, has shown anticancer, antibacterial, and a little bit antiviral activity which is used for infected wounds and skin (Saab *et al*., 2018). Cones Essential oil support traditionally significantly improves wound closure and reduces inflammation in excision and incision models (Tumen *et al*., 2011).

Cedrus brevifolia folk remedies for pain, swelling, and skin lesions. The strong antioxidant activity is seen the extract of bark, needle, and resin (Lyggitsou *et al*., 2024). The essential oil from needles has broad antimicrobial activity against bacteria and fungi for the use of wound disinfection and infection control. The bark and resin extract are used for the treatment of wounds and skin injuries by the hydrogel formulation; it has wound-healing potential (Charalambous *et al*., 2022).

The Cedar extract has potential medicinal use due to the anti-inflammatory and antioxidant activity present in the bark and needle (Douros *et al*., 2017).

Phytochemical constituents

Constituents of wood and wood oil

The sesquiterpene himachalol is extreme chief constituent of the wood. Centradol is the another sesquiterpene identified by the wood of the plant. Himachalol and another sesquiterpene i.e. β-himachalene is isolated by the wood oil of the plant (Chaudhuri *et al*., 2025). Some sesquiterpenoids are identified in heartwood of the plant including dewarol dewardiol, himadrol, and 4-glucoside isomeric, allohimachalol, other sesquiterpenoids like α- himachalenes, β-himachalenes, (+)-longborenol, allohimachalol also present in wood oil of the plant. Each and



Figure 1: *C. deodara* needle and cone.



Figure 2: *C. libani* needles.

Table 1: Species, common name, and their occurrence of cedar (Xiao *et al.*, 2022).

Species	Common name	Occurrence
Cedrus deodara (Roxb.) G. Don is loud.	Deodar or Himalayan cedar	Western Himalayan
Cedrus atlantica (Endl.) Manetti ex Carriere	Atlas cedar or Atlantic	Eastern and central regions of the Rif Mountains and Atlas Mountains in Morocco
Cedrus libani A. Rich.	Taurus Cedrus or Cedar of Lebanon	It is distributed across the Mount Lebanon range in Lebanon and Syria as well as the Southern Taurus mountains in Turkey within the Eastern Mediterranean region.
Cedrus brevifolia (Hook. f.)	Cyprus cedar	Cedar Valley near Paphos or the Troodos Mountains near Prodromos



Figure 3: *C. atlantica* cone and needle.



Figure 4: *C. brevifolia* cone and needle.

every phytochemical constituent shown Table 2 (Chaudhary *et al.*, 2011).

Flavonoids are likewise current in wood i.e. 4-dihydroflavonols name as cedrin (6-methyldihydromyrecetin), cedeodarin ((6-methyltaxifolin), dihydromyricetin, or in wood cedrinoside were identified and isolated (Saab *et al.*, 2018).

Stem bark

Flavonoids are present in the Stem and bark isolated from dihydroflavonol also called as deodarin and chemical name is (3,4, 5,6 tetrahydroxy-8-methyl- dihydroflavonol (Chaudhary *et al.*, 2011).

Needles and needle essential oil

The chief constituent is α-Pinene present in essential oil of needle. There are other some constituents are present like β-caryophyllene (10.9%), β-myrcene (5.3-7.4%), α-bisabolol (3.5-6.6%), myrcene (10.7%), limonene (6.6-16.0%) and benzaldehyde (19.4%), β-pinene (5.2-10.3%), and germacrene D (9.35%). Needle essential oil identified terpenoid components. It holds oxygenated monoterpenes (0.1-22.8%), monoterpene hydrocarbons (44.5-88.1%), and sesquiterpenes hydrocarbons (3.8-17.6%) (Sinha, 2019).

Approximately needles contain polysaccharides compounds identical arabinose, mannose, xylose and glucose (Zeng *et al.*, 2014).

Additional flavonoids isolated and identified from the needles of the plant including cedrusone A, cedrin, 2R, 3R-dihydromyrecetin, myricetin, quercetin, α-D-glucopyranoside and 2R, 3R-dihydroquercetin (Liu *et al.*, 2011).

Miscellaneous compounds

Some more compounds like butyl acetate (33.9%), dodecanoic acid (12.9%) follow the linalyl propionate (10.9%) and 4-allyloxy-2-methyl penta-en-2-ol (6.2%) stayed central representative essential oil of needles. Some structure represented in Table 3 (Chung *et al.*, 2014).

Phytochemical constituents of *Cedrus atlantica*

The needle oil categorized by high content of monoterpene hydrocarbon β-pinene (31.7%), myrcene (17.2%), α- pinene (34.1%), and limonene (5.2%), also encompass reasonable

quantity of β-caryophyllene (9.1%) caryophyllene oxide (10.3%) (Paoli *et al.*, 2011).

It primarily includes β- himachalane (24.25%), longifolene (12.2%), α-Cedrene (0.03%), -Cedrene (0.02%), δ-Cadinene (0.04%), -Pinene (3.73%), Sabinene (0.88%), 6-camphenol (4.54-3.16%), α- himachalane (13.76%) methyl-1,4 cyclohexadiene (9.06%) (El Hachlafi *et al.*, 2023; Jaouadi *et al.*, 2020).

All the phytochemical constituents shown below the Table 4 and also structure represented in Table 5. The essential oil composition of *C. atlantica* varies according to part of the plant, the wingless seeds are rich in α-pinene (46.16%), Bornyl acetate (10.18%) and Manool (25.47%) (Zrira and Ghanmi, 2016).

In aerial parts it mainly contains α-himachalane (35.34%), β- himachalane (13.62%), γ- himachalane (12.6%), cedrol (10.32%), iso-cedranol (5.52%) and sawdust oil characterized predominantly by α-(E)- atlantone (19.3%), 8-cedren-13-ol (13.1%) and β- himachalane (15.1%) indicating a predominance of sesquiterpenes across different plant material (Bennouna *et al.*, 2020).

Phytochemical constituents of *Cedrus libani*

The phytochemical constituents of wood essential oil, cone and leaves ethanol extracts. The key compound of wood essential oil was himachalol (22.50%) β-himachalene (21.90%) and α-himachalene (29.40%). Ethanolic extract of leaves it contain high amount of Germacrene D (29.40%) Structure represented in Table 6. The compound is isolated form different part of plant are shown below the Table 7. The identical extract attained from cones basically contained β-myrcene (13.0%) and α-pinene (51.0%) (Loizzo *et al.*, 2008).

The composition of tar is the mixture of terpenes, with the β- himachalene (29.16), α-himachalene (5.28%), α-atlantone (28.7%), longifolene (6.66%), β- turmerone (5.12%) emerging the predominant constituents (Koc *et al.*, 2023).

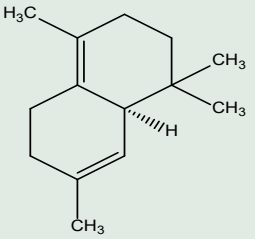
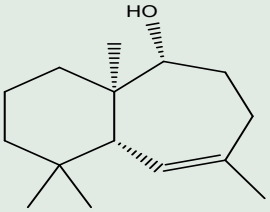
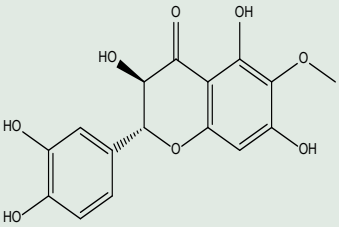
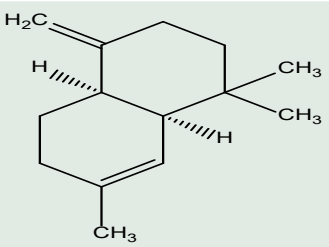
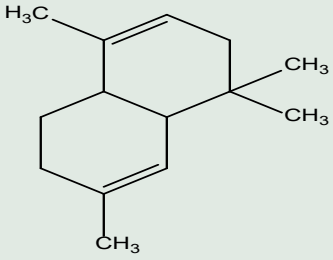
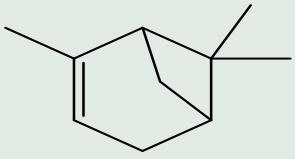
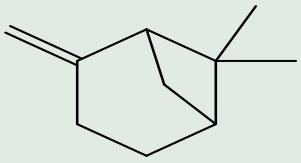
Phytochemical constituents of *Cedrus brevifolia*

Cedrus brevifolia also known as Cyprus cedar. It is one of the four species of the *Cedrus* Genus and different from other with same genus. It has less evidence-based data as compared to other species due to lack of wide study. Some study shows the crude extract of the bark contain the phenolic compound with anti-oxidant and anti-inflammatory activity. The methanol

Table 2: Compound detected and recognize from various part of the plant of *Cedrus deodara*.

Part of plant	Nature of the compound detected	Compound tag	References
Wood	Sesquiterpene, Dihydroflavonols	Himachalol, Isocentradol (4β, 7β- dihydroxyhimachal-2-one) Atlantone, deodardione and atlantone-2, 3-diol. Cedeodarin (6-methyltaxifolin), centradol (2β, 7β-dihydroxyhimachal-3-ene), dihydromyricetin, himaphenolone cedrin (6-methyldihydromyecetin), cedrinoside	(Chaudhary *et al.*, 2011)
Wood oil	Sesquiterpene	β-himachalene, allohimachalol, (+)-longborenol, Himachalol, α-himachalene	(Saab *et al.*, 2018)
Stem bark	Dihydroflavonol	Dihydroflavonol named deodarin (3, 4, 5, 6-tetrahydroxy-8-methyl dihydroflavonol)	(Chaudhary *et al.*, 2011)
Needle essential oil	Terpenoids	α-myrcene, α-himachalene, α-humulene, β-humulene, α-Pinene, γ-muurolene, β-himachalene, δ-cadinene, γ-amorphene, dl-limonene, β-copaene, α-muurolene, linalyl propionate, β-caryophyllene, β-pinene, germacrene D, dodecanoic acid, caryophyllene oxide, myrcene.	(Sinha, 2019)
Needle	Flavonoids	Myricetin, Quercetin 3R-dihydroquercetin, 2R, 3R-dihydromyricetin, Cedrusone A,	(Sinha, 2019)
Needle essential oil	Terpenes	β-myrcene, α-bisabolol, β-pinene, limonene, α-Pinene,	(Sinha, 2019)
Needle	Polysaccharides	Specific units of glucose, mannose, arabinose, and xylose.	(Zeng *et al.*, 2014)
Needles	Flavonoid glycosides	Myrecetin-3-O-(6-O-E-p-coumaroyl) -α-D-glucopyranoside, cedrin.	(Zeng *et al.*, 2014)
Heartwood	Sesquiterpenoids	Allohimachalol, himadrol, dewarol dewardiol, dewarenol.	(Chaudhary *et al.*, 2011)
Petroleum ether extract of needle	Miscellaneous	4-allyloxy-2-methylpenta-en-2-ol, ethyl ester of dodecanoic acid, 2,2-dimethylpentanal, benzoic acid, α-pinene, caryophyllene, butyl acetate, oxide, butyl ester of 5-oxohexanethioic acid	(Chung *et al.*, 2014)

Table 3: **Molecular structure of *Cedrus deodara*.**

Structure name	Molecular structure
α- himachalene	
Allohimachalol	
Cedeodarin (6-methyltaxifolin)	
β- himachalene	
γ-himachalene	
α-Pinene	
β- pinene	

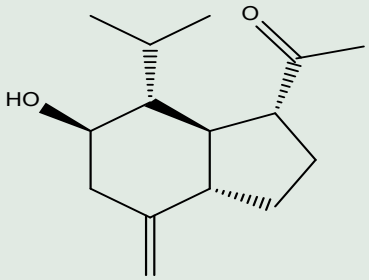
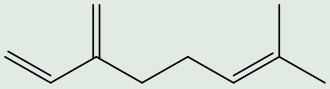
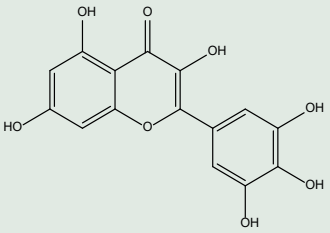
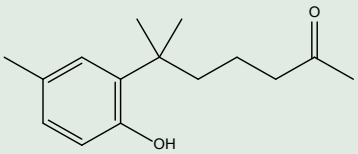
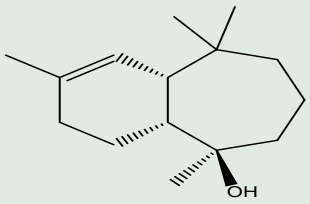
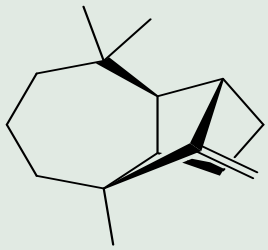
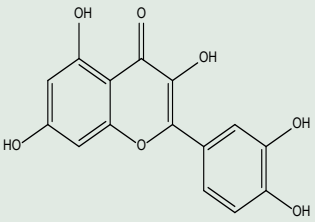
Structure name	Molecular structure
Sesquiterpene	
Myrcene	
Myricetin	
Himaphenolone	
Himachalol	
(+)- Longifolene	
Quercetin	

Table 4: Compound detected and recognize from various part of the plant of *Cedrus libani*.

Part of plant	Nature of compound detected	Compound tag	Reference
Wood (heart wood) essential oil	Monoterpenes, sesquiterpenes, oxygenated sesquiterpenes	α-pinene, β- pinene, limonene, p-cymene, α-himachalene, β-himachalene, γ-himachalene, himachalol, atlantone derivatives.	(Loizzo *et al.*,2008)
Cone essential oil	Monoterpenes, sesquiterpenes	α-pinene, myrcene, β-pinene, β-phellandrene, germacrene D, caryophyllene	(Loizzo *et al.*,2008)
Leaves (needles)	Monoterpenes, sesquiterpenes	α-pinene, β-Caryophyllene, Germacrene D limonene.	(Loizzo *et al.*,2008)
Wood tar	Terpenes, Monoterpenoids, sesquiterpenoids, hydrocarbon, aziridines	m- cymene, α-himachalene, β- himachalene, γ-himachalene, α-atlantone, β-tumerone, longifolene, chamigran-9-one, 2-aziridinedicarboxylate	(Koc *et al.*, 2023)

and water extract of needle presented high reducing activity of anti-oxidant and anti-microbial properties against the bacteria and fungi (Tumen *et al.*, 2011).

Needle essential oil is the core compound of α- pinene (56.8%), limonene (7.8%), β- pinene (4.2%), myrcene (1.8%), Sabinene (0.2%), camphene (1.4%). The essential oil covers the high amount of the monoterpene hydrocarbon (76.6%) and less amount of the diterpenes (8.3%) and oxygenated monoterpenes (8.6%) and small amount of oxygenated sesquiterpene (0.6%) and sesquiterpene hydrocarbons (1.6%). Some molecular structure shown below the Table 8. They are presented in Table 9 and also structure represented in 9 (Boutos *et al.*, 2020). The main constituent of the resin is Myrcene (20.3%), β-phellandrene (7.0%) α-thujene (9.0%), they are not present in heartwood and sapwood. In cedar wood (heartwood and sapwood) the major constituents are α, β, γ- himachalene (17.3%), (15.0%), (22.0%) (E)-α-atlantone (4.2%), cedrol (3.0%), (3.0%) junipene (0.5%), limonene (5.8%), β-himachalene-oxide (10.5%) (1.9%) (Douros *et al.*, 2019).

The pharmacological potential of different portions of the *C. deodara* has been investigated through many experimental models. The leaf extract has shown immunomodulatory properties by stimulating immune responses, which was confirmed through immune cell activation assays (Narayan *et al.*, 2017). Needle essential oil has demonstrated significant antioxidant activity, exhibiting strong free radical scavenging effects as evidenced by DPPH and lipid peroxidation assays (Zeng *et al.*, 2012). The pharmacological activities shown above the Table 10.

Total flavonoids isolated from needles have shown anti-tumor potential by inhibiting tumor growth through apoptosis in *in vitro* tumor proliferation assays (Anand *et al.*, 2024). Bark essential oil possesses notable anticancer activity, where the apoptosis induced in human colon cancer cell lines by inhibiting the NF-κB signaling pathway (Bhagat *et al.*, 2020).

Additionally, wood volatile oil has been reported to exhibit anti-ulcer activity, effectively reducing ulcer index and gastric acidity in pylorus-ligated and ethanol-induced ulcer models in rats. Methanolic wood extract has also been found to promote wound healing, as indicated by increased wound contraction and enhanced collagen deposition in burn wound models in Wistar rats (Rastegari *et al.*, 2023).

Total flavonoids isolated from needles have shown anti-tumor potential by inhibiting tumor growth through apoptosis in *in vitro* tumor proliferation assays (Shi *et al.*, 2016).

Furthermore, ethanolic extracts have demonstrated antihyperlipidemic activity by significantly reducing levels of cholesterol, triglycerides, VLDL, and LDL in Monosodium Glutamate (MSG)-induced obese rat models (Patil *et al.*, 2011).

The branch extract has been shown cytotoxic effect against the cancer cells, mainly in MCF - 7 breast cell lines (Belkacem *et al.*, 2021). The cedar wood oil has been reported to exhibit neuroprotective and sedative effect, that producing the calming actions on the nervous system (Gonçalves, 2025). The essential oil has antifungal activity, it inhibited the fungal pathogen in agar diffusion assay and also has anti-inflammatory activity that inhibited the inflammatory mediators by the invitro enzyme inhibition assay experimental model (Belkacem *et al.*, 2021). Details presented above the Table 11. Needle ethanolic extract has antimicrobial activity against towards both the gram-positive and gram-negative bacteria by using disc diffusion method (Rabouj *et al.*, 2025). Essential oil has Dermatoprotective properties by reducing tyrosinase activity act as skin protection (El Hachlafi *et al.*, 2023).

Table 5: **Molecular structure of *Cedrus atlantica*.**

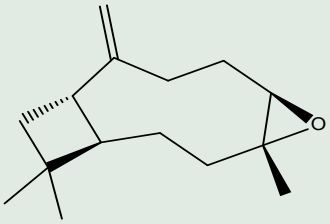
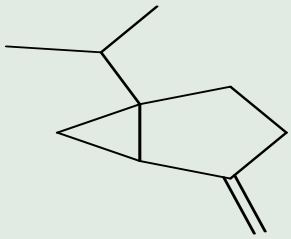
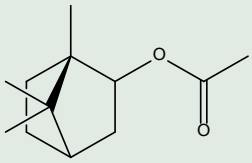
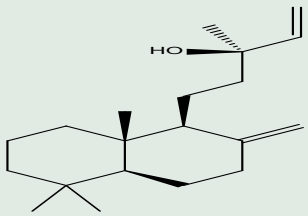
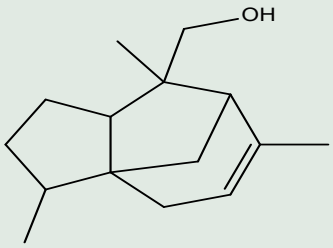
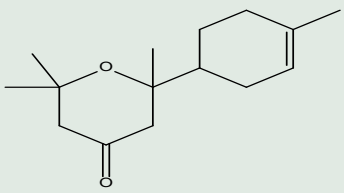
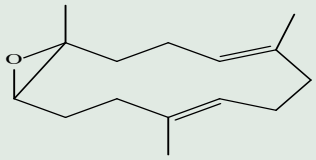
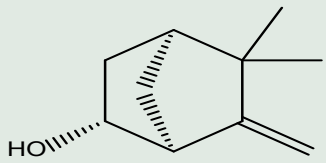
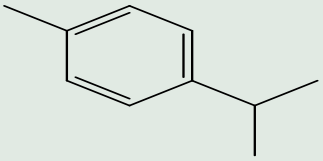
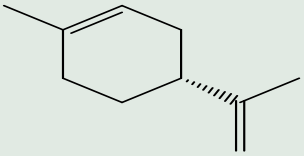
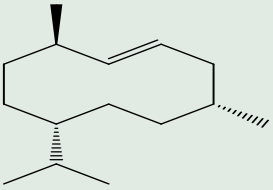
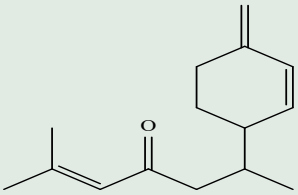
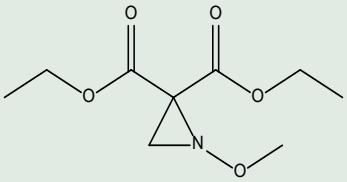
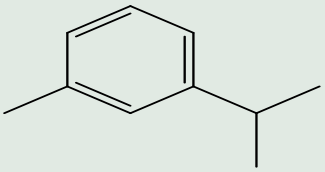
Structure name	Molecular structure
caryophyllene oxide	
Sabinene	
Bornyl acetate	
Manool	
8-Cedren-13-ol	
Deodarone	
Cedroxyde	
6-camphenol	

Table 6: **Molecular structure of *Cedrus libani*.**

Structure name	Molecular structure
p-cymene	
limonene	
germacrene D	
β-tumerone	
2-aziridinedicarboxylate	
m- cymene	

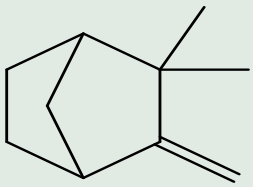
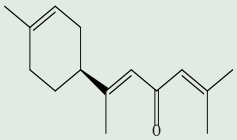
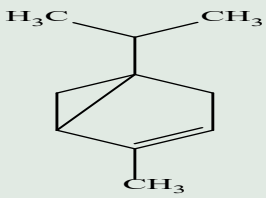
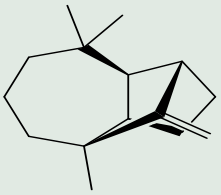
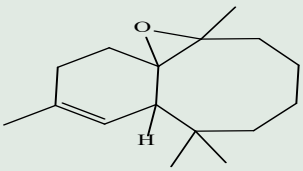
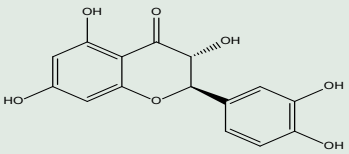
The cone essential oil has strong anticancer activity by inducing apoptosis and inhibiting the tumor cell proliferation, as demonstrated in human melanoma cell line studies (Mutlu *et al.*, 2026). The essential oil has both the antiviral, antimicrobial and spasmolytic activity due to its rich terpenoid composition which promotes smooth muscle relaxation (Saab *et al.*, 2018) and plant extract exhibit significant antioxidant activity mainly presence of phenolic and flavonoid compounds detected by DPPH and other free radical scavenging assays (Karrat *et al.*, 2022). Heartwood derived from the compound 2-himachalen-7-ol has cytotoxic and antiproliferative properties including synergistic anticancer effect used with cisplatin in human cancer cell lines (Elias *et al.*, 2019). The pharmacological activities presented Table 12.

Bark, branch, needle extract has anti-bacterial and strong radical scavenging and antioxidant capacity shown by particularly high

Table 7: Compound detected and recognize from various part of the plant of *Cedrus atlantica*.

Part of plant	Nature of compound detected	Compound tag	Reference
Needle oil	Monoterpene hydrocarbon	β-pinene, myrcene, α- pinene, and β-caryophyllene, limonene, caryophyllene oxide	(Paoli *et al.*, 2011)
Wood tar essential oil (GC-MS)	Sesquiterpene hydrocarbons, oxygenated hydrocarbons	α-Himachalene, methyl-1,4 cyclohexadiene, β-Himachalene, trans-Cadina-1(6),4-diene, and 6-camphenol, α-Cedrene, δ-Cadinene, γ-Cadinene, longifolene, Sabinene,	(El Hachlafi *et al.*, 2023) (Jaouadi *et al.*, 2020)
Wingless seeds	Monoterpene hydrocarbon, diterpene alcohol, oxygenated monoterpene (ester)	α-Pinene, Manool, Bornyl acetate	(Bennouna *et al.*, 2020)
Aerial parts	Sesquiterpene hydrocarbon, Oxygenated sesquiterpene (alcohol), Monoterpene hydrocarbon	α-Himachalane, β-Himachalane, γ-Himachalane, Cedrol, Iso-cedranol, α-Pinene	(Bennouna *et al.*, 2020)
Sawdust oil	Sesquiterpene hydrocarbon, Oxygenated sesquiterpene (ketone), Oxygenated sesquiterpene (alcohol), Oxygenated sesquiterpene (oxide)	8-Cedren-13-ol, α-Himachalane, β-Himachalane, α-(E)-Atlantone, Deodarone, Cedroxyde	(Bennouna *et al.*, 2020) (Zrira and Ghanmi, 2016)

Table 8: Molecular structure of *Cedrus brevifolia*.

Structure name	Molecular structure
Camphene	
(E)-α-atlantone	
α- Thujene	
Junipene	
β-himachalene-oxide	
Taxifolin	

activity in DPPH assay. Anti-bacterial activity against pathogen *E. coli* and *staphylococcus aureus* detected by MIC and MBC assay (Charalambous *et al.*, 2022). The hydrogel formulation make by the resin, sapwood, and heartwood extract has potential to enhance wound healing and tissue generation *in vivo* mouse model the concentration of resin extract is taken 5-10% (Lyggitsou *et al.*, 2024). Shown above the Table 13. The anti-inflammatory potential shown by lipoxygenase inhibitory activity present in the needle phenolic compound and needle flavonoid extract has strong anti-lipid peroxidation activity due to compounds such as taxifolin and coumaric acid derived in linoleic acid lipid peroxidase assay (Douros *et al.*, 2017).

DISCUSSION

The genus *Cedrus* (family Pinaceae) comprises four species: *Cedrus deodara* (Himalayan cedar), *Cedrus atlantica* (Atlas cedar), *Cedrus libani* (Cedar of Lebanon), and *Cedrus brevifolia* (Cyprus cedar). These species are distributed mainly in the Himalayan and Mediterranean regions. *C. deodara* is native to the western Himalayas of India, Pakistan, Nepal, and Afghanistan, whereas *C. atlantica* occurs in the Atlas Mountains of Morocco and Algeria. *C. libani* is distributed in the mountainous regions of

Lebanon, Turkey, and Syria, while *C. brevifolia* is endemic to the Troodos Mountains of Cyprus.

Among these species, *C. deodara* is the most extensively utilized in traditional medicinal systems such as Ayurveda, Siddha, and Unani. Various parts of the plant are used for the treatment of skin diseases, wounds, inflammatory disorders, arthritis, asthma, ulcers, kidney stones, fever, and microbial infections. Similarly, *C. atlantica, C. libani*, and *C. brevifolia* have been traditionally employed for the management of respiratory ailments, rheumatism, pain, skin disorders, gastrointestinal complaints, wound healing, and infectious diseases.

Phytochemical investigations have revealed that all *Cedrus* species are rich sources of biologically active compounds, particularly sesquiterpenes, flavonoids, lignans, and phenolic constituents. Major compounds reported include α-himachalene, β-himachalene, himachalol, cedrol, atlantone, deodarin, taxifolin, and various phenolic derivatives. These constituents are considered responsible for the diverse biological activities exhibited by the genus.

Table 9: Compound detected and recognize from various part of the plant of *Cedrus brevifolia*.

Part of plant	Nature of compound detected	Compound tag	Reference
Needle essential oil	Oxygenated monoterpenes, Sesquiterpenes hydrocarbon, diterpenes. Monoterpene hydrocarbon, oxygenated sesquiterpenes.	α- pinene, β- pinene, limonene, camphene, Sabinene, myrcene	(Boutos *et al.*, 2020)
Resin	Nor- monoterpene hydrocarbon, monoterpene hydrocarbons, sesquiterpene hydrocarbon	Myrcene, α-thujene, β-phellandrene.	(Douros *et al.*, 2019)
Sapwood	Monoterpene hydrocarbon, sesquiterpene hydrocarbon, oxygenated sesquiterpenes	*nor*-thujane, α-pinene, limonene, α-longipinene, α, β, γ- himachalene, himachalol, cedrol, junipene.	(Douros *et al.*, 2019)
Bark	Flavonoids	Taxifolin (dihydroquercetin)	(Tumen *et al.*, 2011)
Heartwood	Nor-monoterpenes oxygenated, sesquiterpene hydrocarbons, oxygenated sesquiterpenes	α-longipinene, (E)-α-atlantone, himachalol, β-himachalene, γ- himachalene himachalene, β-himachalene-oxide	(Douros *et al.*, 2019)

Table 10: Pharmacological activities of *Cedrus deodara*.

Plant part	Pharmacological activity	Finding	Experimental model	Reference
Needle essential oil	Antioxidant	Strong free radical scavenging activity	DPPH, lipid peroxidation assay	(Zeng *et al.*, 2012)
Leaf extract	Immunomodulatory	Stimulated immune response	Immune cell activation assays	(Narayan *et al.*, 2017)
Bark essential oil	Anticancer	Induce apoptosis by inhibiting NF-$_k$B pathway	Human colon cancer cell line	(Bhagat *et al.*, 2020)
Wood volatile oil	Anti-ulcer	Reduces ulcer index and gastric acidity	Pylorus-ligated and ethanol-induced ulcer in rodent model	(Kumar *et al.*, 2011)
Total flavonoids from needles	Anti-tumor	Inhibition of tumor progression by triggering apoptosis	*In-vitro* tumor proliferation assay	(Shi *et al.*, 2016)
Ethanolic extract	Antihyperlipidemic	Reducing cholesterol, triglycerides, VLDL, LDL.	MGS-induced obese rat	(Patil *et al.*, 2011)
Methanolic wood extract	Wound healing	Increased wound contraction and collagen deposition	Burn wound model in wistar rat	(Rastegari *et al.*, 2023)

Table 11: **Pharmacological activities of *Cedrus atlantica*.**

Plant part	Pharmacological activity	Finding	Experimental model	Reference
Essential oil	Antifungal	Significant inhibition of fungal pathogen	Agar diffusion method	(Belkacem *et al.*, 2021)
Branch extract	Cytotoxic	Cytotoxic effect against cancer cell	MCF-7 breast cancer cell line	(Belkacem *et al.*, 2021
Needle extract	Anti-oxidant	Anti-oxidant potential and strong radical scavenging activity.	DPPH, FRAP, TAC assay	(Belkacem *et al.*, 2021
Needle ethanolic extract	Antimicrobial	Effective inhibition against gram positive and negative bacteria.	Disc diffusion assay	(Rabouj *et al.*, 2025)
Cedarwood oil	Neuroprotective and sedative	Sedative and calming effect on the nervous system	Experimental pharmacological models	(Gonçalves, 2025)
Essential oil	Dermatoprotective	Skin protective effect by reducing the tyrosinase activity	Tyrosinase inhibition assay	(El Hachlafi *et al.*, 2023)
Essential oil	Anti-inflammatory	Inhibition of inflammatory mediators	Invitro enzyme inhibition assay	(Gonçalves, 2025)

Table 12: **Pharmacological activities of *Cedrus libani*.**

Plant part	Pharmacological activity	Finding	Experimental model	Reference
Leaf extract	Anti-inflammatory	Indicating anti-inflammatory potential by inhibiting hemolysis	HRBC membrane stabilization assay	(Karrat *et al.*, 2022)
Essential oil and extract	Anti-oxidant	Significant antioxidant activity attributed to phenolic and flavonoids compounds	DPPH and free radical scavenging assays	(Karrat *et al.*, 2022)
Essential oil	Antiviral/ antimicrobial	Essential oil showed activity against microorganisms including bacteria and viruses	Biological activity screening	(Saab *et al.*, 2018)
Essential oil	Spasmolytic activity	Terpenoid rich oil showed Smooth muscle relaxing effects	Smooth muscle contraction assays	(Saab *et al.*, 2018)
Heartwood compound (2-himachalen-7-ol)	Cytotoxic and antiproliferative	Compound shows cytotoxicity and synergistic anticancer activity with cisplatin	Human cancer cell lines	(Elias *et al.*, 2019)
Cone essential oil	Anti-cancer	It has strong cytotoxic activity, induced apoptosis and inhibiting the tumor cell proliferation	Human melanoma cell line, MTT assay	(Mutlu *et al.*, 2026)

Table 13: Pharmacological activities of *Cedrus brevifolia*.

Plant part	Pharmacological activity	Finding	Experimental model	Reference
Needle flavonoids extract	Anti-lipid peroxidase	It inhibits the lipid peroxidation with help of taxifolin and coumaric acid derivative compound	Linoleic acid lipid peroxidation assay	(Douros *et al.*, 2017)
Needle phenolic compound	Lipoxygenase inhibition	Strong lipoxygenase inhibitory activity also indicates the anti-inflammatory potential	LOX enzyme inhibition assay	(Douros *et al.*, 2017)
Hydrogel formulation of resin, sapwood and heartwood extract	Wound healing	Wound healing and tissue regeneration with the topical gel formulation contain 5-10% resin extract	*In vivo* mouse wound model	(Lyggitsou *et al.*, 2024)
Branch and needle extract	Anti-bacterial	Inhibition of *E. coli* and *staphylococcus aureus*	MBC and MIC assay	(Charalambous *et al.*, 2022)
Bark needle and branch extract	Radical scavenging activity	Strong antioxidant capacity showed by the bark extract	DPPH free radical scavenging	(Charalambous *et al.*, 2022)

Pharmacological studies have demonstrated a broad spectrum of therapeutic properties, including antioxidant, antimicrobial, anti-inflammatory, analgesic, antidiabetic, anticancer, neuroprotective, hepatoprotective, immunomodulatory, and wound-healing activities. The growing body of scientific evidence supports many of the traditional medicinal claims associated with *Cedrus* species. However, further research focusing on the isolation of novel bioactive compounds, elucidation of molecular mechanisms, standardization of extracts, safety assessment, and clinical validation is required to fully exploit their therapeutic potential and facilitate their development into evidence-based herbal medicines.

FUTURE DIRECTIONS

Future research on *Cedrus deodara* should focus on the isolation and characterization of novel bioactive compounds, elucidation of their molecular mechanisms, and standardization of plant extracts. Well-designed toxicity studies and clinical trials are needed to confirm safety and therapeutic efficacy. Additionally, the development of evidence-based herbal formulations and exploration of synergistic effects among its phytoconstituents may facilitate its translation into modern pharmaceutical applications.

CONCLUSION

The herbal medicated plants have played key role in humanity persistence. The great information about the medicinal plant how to use medicated plants for curing the illness and passed down from one generation to another generation and along with the modern times and techniques to find new medicinal properties safety and efficacy. The genus *Cedrus*, including *Cedrus deodara, Cedrus atlantica, Cedrus libani, and Cedrus brevifolia*, contains important medicinal plants with significant ethnomedicinal value. Among them, *Cedrus deodara* is widely used in traditional systems such as Ayurveda, Siddha and Unani for treating inflammatory disorders, skin diseases, respiratory problems, microbial infections, and rheumatic conditions.

Phytochemical studies reveal that *Cedrus* species contain diverse bioactive compounds including terpenoids, flavonoids, and phenolics, with major constituents such as himachalene derivatives, cedrol, himachalol, atlantone, and taxifolin**.** These compounds contribute to numerous pharmacological activities such as analgesic, antimicrobial, antioxidant, anticancer, anti-inflammatory, antidiabetic, neuroprotective or immunomodulatory effects.

Although extensive phytochemical and pharmacological studies exist, most findings are based on *in vitro* and preclinical research, and clinical validation remains limited. Future research should focus on bioassay-guided isolation of active compounds, mechanistic studies, extract adjustment, toxicity evaluation, and clinical trials**.** Overall, *Cedrus* species represent a promising source of natural therapeutic agents, and participating traditional knowledge with modern research may support the development of new plant-based medicines that helpful for cure the human illness.

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ABBREVIATIONS

DPPH: 2,2-Diphenyl-1-picrylhydrazyl; **FRAP:** Ferric reducing ability of plasma; **GC-MS:** Gas Chromatography–Mass Spectrometry; **HRBC:** Human red blood cells; **LOX:** Lipoxygenases; **LDL:** Low-density lipoprotein; **MBC:** Minimum bactericidal concentration; **MIC:** Minimum inhibitory concentration; **MTT:** Methyl thiazolyl tetrazolium; **MGS:** Monosodium glutamate; **MCF-7:** Michigan Cancer Foundation-7; **NF-κB:** Nuclear factor kappa-light-chain-enhancer of activated B cells; **TAC:** Total antioxidant capacity; **VLDL:** Very low-density lipoprotein.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Vandana Kumari conceptualized the review, conducted the primary literature search, synthesized the available evidence, and prepared the initial manuscript. Dr. Ashish Sarkar contributed to the identification and compilation of key phytochemical information. Ms. Rekha Gupta focused on the collection and organization of ethnomedicinal and traditional-use information. Siya contributed to the compilation and interpretation of pharmacological evidence. Ms. Preeti Shukla contributed to the collection and organization of information related to phytoconstituents and their reported activities. Aarti Thakur contributed to the preparation and organization of tables and graphical information. Ms. Ankusha Sharma contributed to the compilation of information on experimental and preclinical studies. Ms. Meenakshi Verma assisted with reference management, literature organization, and verification of cited information. Mr. Pushpender Sharma contributed to the preparation and formatting of figures, tables, and supporting structural information. Dr. Arijit Chaudhuri supervised the overall study, provided scientific direction, contributed to critical interpretation, and critically reviewed and revised the manuscript. Ms. Divya Sharma co-supervised the work, provided scientific guidance, contributed to critical evaluation of the literature, and reviewed and revised the manuscript. All authors reviewed and approved the final manuscript for publication.

SUMMARY

Cedrus deodara (Himalayan cedar) is an important medicinal conifer widely used in traditional medicine for the treatment of inflammatory disorders, infections, skin diseases, diabetes, and wound healing. Phytochemical investigations have revealed the presence of diverse bioactive constituents, including terpenoids, flavonoids, lignans, and phenolic compounds. Experimental studies have demonstrated a broad spectrum of pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, antidiabetic, anticancer, and wound-healing effects. The available evidence supports many of its traditional therapeutic applications; however, further standardization, toxicity evaluation, and clinical studies are required to fully establish its safety, efficacy, and potential for pharmaceutical development.

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