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A Review on Ethnobotanical, Phytochemical and Pharmacological Potentials of *Cedrus deodara*

Farwa Nadeem[1]*, Talha Khalid[1], Muhammad Idrees Jilani[2] and Shafiqur Rahman[3]

[1]Department of Chemistry, University of Agriculture, Faisalabad-38040-Pakistan, [2]Department of Chemistry, University of Sahiwal, Sahiwal, Pakistan and [3]Department of Pharmaceutical Sciences, South Dakota State University 1055 Campanile Avenue, Avera Health and Science Center, Brookings, SD 57007, USA

Abstract

Cedrus deodara is a bluish or greenish grey needled plant having pyramidal shape and number of branches with approximate width of about 20-30 feet and length of about 40-50 feet. This plant is most commonly used for ornamental purposes on walkways but best suited as yard quite away from avenues and strolls. Cedrus plant is known to have four well-known species having evergreen, coniferous, monoecious and oleoresin rich taller trees. The essential oil of *Cedrus deodara* constitutes (+)-allohimachalol, (+)-himachalol, α-dihydroturmerone, α-himalchenes, β-himalchenes, trans-atlantones, cis-atlantones and p-methyl acetophenone as a major chemical constituent. The essential oil of this plant is known to have number of applications in ayurvedic system of medicines owing to its anti-helmintic, carminative, diuretic, diaphoretic and astringent potentials. In addition to many pharmacological potential of *Cedrus deodara*, this plant also has some beneficial effects in neurological or psychiatric disorders including epilepsy and anxiety along with severe depressive behavior. Plant extracts from various parts are used to treat skin diseases, severe ulcers, dysentery, diarrhea, fever and urinary scatters. It is also found effective in strangury, wounds, skin infections, syphilis and leprosy.

Key words: *Cedrus deodara*, coniferous plant, essential oil, diaphoretic potentials, syphilis, leprosy, helmintic activities

Full length article **Corresponding Author*, e-mail: farwa668@gmail.com

1. Botany

1.1 Introduction

Nature always stands as a golden mark to exemplify the outstanding phenomenon of excessive production of essential oils from aromatic or scented plants. These plants are indeed indispensible for human being owing to their wide ranging applications and excellent therapeutic potentials. Infact, mother-nature has provided us a complete store-house of remedies in order to cure all sorts of ailments that prove to be catastrophic for human races. According to estimation, a major portion of the world's population utilizes medicinal plants either in parts or as whole plant. Rapidly growing numbers of health care consumers are turning to plant based natural medicines due to their cost effectiveness and seeking natural alternatives with relatively fewer side effects as evident by existing literature [1].

Some additional medicinal uses of curative plants are recognized as a way to learn more about the potential future perspective of medicinal plants. Medicinal remedies that have been derived from plants by getting information through traditional knowledge and finding literature are now being handed down generation after generation. Various pharmaceutical industries are now looking for some other natural alternative resources that are environmentally benign and potentially viable in nature. Now-a-days, scientists are working to explore potential anti-biotic, anti-oxidant, anti-microbial, anti-diabatic and crop protecting agents for sustenance of all life forms on earth. Medicinal plants generally provides a great source of a wide variety of natural bioactive compounds including phenolics, nitrogenous compounds, terpenoids, vitamins and various other secondary plant metabolites that are rich in valuable bioactivities e.g., anti-oxidants, anti-tumor, anti-inflammatory, anti-mutagenic, anti-bacterial, anti-carcinogenic and anti-viral activities [1].

Medicinal plants have long been the area of great interest and a hot topic of current scientific investigations for biochemists, chemists and pharmaceutics. These researches play a very important role in discovering the new natural resources and developing potential drugs for treatment of various unknown diseases that are supposed to

have more effectiveness and no side actions unlike most other synthetically produced modern drugs. Nevertheless, these plants also have number of non-medicinal uses including use as food flavors, ornamental articles, spices and herbs for dishes and as fumigants to avoid various dangerous elements. In accordance with the World Health Organization (WHO), approximately four billion people constituting eight percent population of the world uses herbal based natural drugs for majority of primary health care problems. Most of the currently existing pharmaceutical companies are doing extensive evaluation of plant material now-a-days for exploration of new compounds and to resolve the many hidden mysteries of nature [1].

Cedrus deodara is a potential medicinal plant that belongs to division "Pinophyta", kingdom "Plantae", class "Pinopsida", order "Pinales", family "Pinaceae", genus "Cedrus" and species "deodara". In Latin, it is named as "Cedrus deodara", in English it is called "deodar", in Himalaya it is known as "cedar", in India it is famous as "devdaar", "diar" and "diyar", in Sanskrit, it is named as "devdaru", "amara" and "devahvaya" and in Gujarati it is termed as "devdaar". It is commonly known as "deodar" in Marathi, "devadaru", "devadaram" and "devataram" in Malayalam, "bhadradaaru", "daevadaaru" and "gunduguragi" in Kannada, "devadaru" and "ewadar" in Marathi, "burada deodar" and "deodar" in Urdu, "than sin" and "than-sin" in Tibetan, "devadaram", "tevataram" and "tunu maram" in Tamil and "devadaru" in Nepali [1].

Cedrus deodara is an evergreen coniferous plant that can attain the height of 85 m with almost rough, black and furrowed bark having spreading branches, dimorphic shoots, 2-5 and 5-8 cm needled leaves like Triquetrous, sharp and pointed monoecious flowers. Some trees or branches of this plant habitually bear the unisexual flowers. All of its parts are bitter, hot, slightly pungent and oleaginous in nature. *Cedrus deodara* is basically a tropical and subtropical plant having worldwide distribution while genus is composed of trees that are sometimes cultivated either for their usefulness to traditional cultures or for ornamental purposes. Cedrus is known to have four species *Cedrus deodara*, *Cedrus libani*, *Cedrus brevifolia* and *Cedrus atlantica* [1].

Some major chemical constituents of essential oil of various Cedrus species include the sesquiterpene such as β-himachalene (43%) and α-himachalene (12.5%). Some other associated compounds along with sesquiterpenes are various alcohol moieties (like centdarol, himachalol, isocentdarol, allohimachalol and himadarol). Through spectroscopic analysis, some compounds were also isolated from pine needles of *Cedrus deodara* that are identified as 9-hydroxy-dodecanoic acid, ethyl stearate, ethyl laurate, 3-β-hydroxy-oleanolic acid methyl ester, shikimic acid, β-sitosterol, methyl coniferin, β-glucoside and ferulic acid. Various species of Cedrus are known to show anti-bacterial, anti-fungal, insecticidal, mollusicidal, anti-tubercular, anxiolytic, anti-convulsant, neuroleptic, anti-diabetic, anti-oxidant, diuretic, anti-urolithiatic, anti-secretory, anti-spasmodic, anti-ulcer, anti-inflammatory, anti-arthritic and wound healing properties. Furthermore, pharmacological activities on the cells of this plant include immunomodulatory, cytotoxic, anti-malarial and mast cell stabilizing and lipoxygenase inhibitory activities along with anti-allergic effects [1].

1.2 Vegetation

New shoots of *Cedrus deodara* tends to appear in early April and late March while older leaves are shed in the hot months of May and June. Nevertheless, leaf persistence varies with growth vigour and age of plant. Male flowers dominate in the month of June and reach towards ripening stage while pollens are shed in the middle of September and October in accordance with the locality and time of ripening of female flowers for proper pollination. The cones or female flower appears in the month of August and are inconspicuous and partially hidden by leaf rosette. The younger fertilized cones show no growth until they become large enough to become visible during the early month of May, the season of spring. They achieve maximum size at the end of June and July with pale bluish green coloration. Fully ripened stage appears at the end of September, October and November. However, cones may or may not fall until the early parts of December at relatively higher elevations. Hence, the time in between first appearance of female flowers and ripening of female cones is about 12.5 to 13.5 months. Furthermore, periodicity of good seed years is about one in three consecutive years [2].

1.3 Foliage Type

Cedrus deodara is a plant that is known to have simple type of leaves with spiral leaf arrangement. Entire leaf margins have filiform or needle like leaves with parallel leaf venation. They are evergreen leaves with needled appearance at leaf margins with approximate length of leaf blade almost less than 2 inches. Its leaves are silver to greenish in coloration.

1.4 Fruit

The fruit of *Cedrus deodara* is oval shape with approximate length of about three to six inches. The fruit cover is quite hard and dry with brownish shade. Fruit does not attract wildlife and can persist on trees for relatively longer period of time in comparison with other fruits.

1.5 Trunk and Branches

The branches, bark or trunk of this plant gradually droops as the tree grows and hence require continuous pruning for pedestrians and vehicular. Branches and trunks of this plant are not showy and known to exhibit clearance beneath the canopy. The branches should be grown with single leader having no thorns however needs little pruning for strong structural development. Trunks provide strong resistance against breakage and tree requires full sunlight for proper growth and development. This plant can bear slightly

alkaline, sandy and loamy or clay type soil nevertheless acidic contents are occasionally drained from soil. Surface roots are usually not problematic as they have long term resistance against potential pests [3].

2. Effect of Pests and Diseases

The deodar trees are harmed by excessive snow, intensive fire and overgrazing by goats. Among all wild animals, bears, porcupines and monkeys significantly harm the plants. *Rosa moschata* scrambles into the crowns of youthful trees of this species and smother them. Among parasitic growths, *Fomes annosus* and *Peridermium cedri* are damaging, bringing on its mortality and development of witches' sweepers on the trees. *Pestalotiopsis cryptomeriae* organism causes leaf scourge on youthful trees, though *Ploioderma cedri* causes foliar disease and untimely defoliation in ranches [4]. Wood of *Cedrus deodara* is reasonably hard, strong and impervious to assault by termites. There have been a few examinations on plants looking for adolescent hormone mimics particularly *Cedrus deodara* [5].

3. General Properties of Essential Oil of *Cedrus deodara*

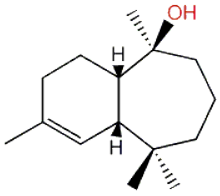
Some physical features like colour and odour of *Cedrus deodara* and more specifically chemical composition of various phytochemicals and essential oils of this plant are discussed in detail in this review along with the chemical structures of their potential bioactive compounds.

3.1 Color and Odour

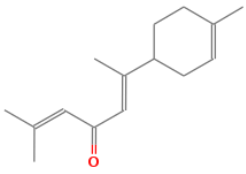
The oils of *Cedrus deodara* is yellow-brown to reddish brown, slightly viscous oil with an odour that is slightly dirty, somewhat crude and woody, and also sweet resinous. It is lighter than Cedar wood oil Atlas, somewhat urinic, with a limonene/citrus aspect. Cedar wood oil is familiar to aromatherapy practitioners, although its uses stretch way back in Ayurvedic system of medicines [6].

3.2 Chemistry of Oil

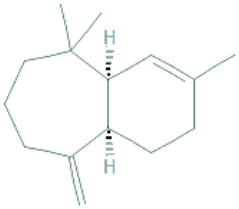
The plant, *Cedrus deodora* is known to have characteristic odour due to the presence of p-methyl-d-3-tetrahydroacetophenone nevertheless essential oil also constitutes numerous other components p-methyl acetophenone, cis-atlantones and trans-atlantones, α-himalchenes and β-himalchenes, α-dihydroturmerone as well as (+)-himachalol and (+)-allohimachalol along with various other chemical constituents. The essential oil of this plant is sold to aroma therapists usually as rectifier because unrectified oil is dirtier and more crudely resinous and urinic in nature.



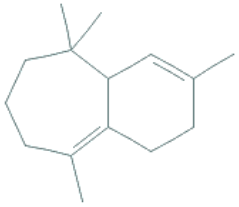
(A) Himachalol



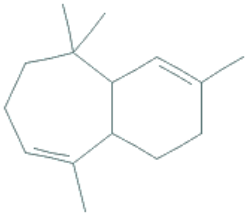
(B) (E)-α-atlantone



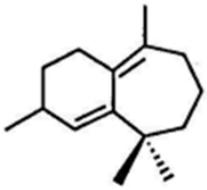
(C) α-himachalene



(D) β-himachalene



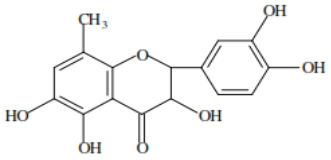
(E) γ-himachalene



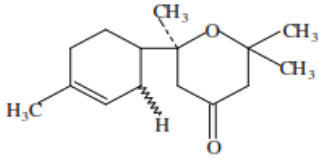
(F) δ-himachalene

Fig 1 Chemical structures of some highly valuable phytochemicals of *Cedrus deodara* (A) Himachalol (B) (E)-α-atlantone (C) α-himachalene (D) β-himachalene (E) γ-himachalene and (F) δ-himachalene

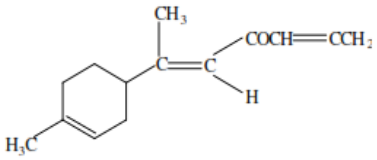
Recently, it has been confirmed by spectroscopic analysis that a new compound dihydroflavonol named "deodarin" which was isolated from oil of stem and bark of *Cedrus deodara* was 3,4,5,6 tetrahydroxy-8-methyldihydroflavonol [7].



(A) Deodarin



(B) Deodarone



(C) Atlantone

Fig 2 Structures of potential bioactive compounds of *Cedrus deodora* (A) Deodarin (B) Deodarone and (C) Atlantone

Essential oil of *Cedrus deodara* has found number of applications in Ayurvedic system of medicines [8]. It acts as an anti-helmintic medicine however decoction of its wood is considered to be diaphoretic, diuretic and carminative in nature. Bark of Cedrus possesses strong astringent potentials thus used to treat dysentery, diarrhea and fever while oil and oleoresin of wood are used for treatment of number of skin diseases and ulcers [6]. *Cedrus deodara* is one of the most important and traditional restorative plants that have extensively been utilized for the treatment of high fever, severe aspiratory protests, acute urinary scatters, chronic sickness, intensive mitigating and counteracting medicines of snake chomp and so forth [9]. Recently, some research groups [10] have summed up the uses of essential oil of *Cedrus deodara* in India as an anti-septic, diuretic, diaphoretic and depurative medicine so it is useful in skin diseases, leprosy, wounds, syphilis, ulcers, strangury and fever. Since applications of essential oil of this plant and various other parts are often confused, for completeness, it should be mentioned that the bark of the tree is often used as an astringent and febrifuge, also being employed in fever, and in cases of dysentery, urinary diseases and diarrhea at a dose of 0.7 to 2.8 grams per day [11]. Bark removes have long been a subject of Canadian patent (1967) to diminish urine and glucose levels in diabetics. The wood is known to have strong diuretic, diaphoretic and carminative potentials [12-13]. The glue of ground wood and water are used to dissipate migraine by applying to eye brows and sanctuaries [14]. Free radical searching action has been credited to particular mixes in chloroform concentrates of dried and defatted heartwood powder [15].

3.3 Some Important Uses of Cedar Wood Oil

Cedar wood is a strong disinfectant that is most commonly used to get rid of respiratory problems in many organisms and acts as an expectorant that effectively works in catarrhal conditions. In Ayurvedic system of medicines, leaves of cedar are used to treat some deleterious diseases such as tuberculosis. The decoction of heartwood is mostly given to patients suffering from severe chest infections, insomnia and diabetes. The essential oil of this plant is prescribed for syphilis and leprosy. Essential oil of *Cedrus deodora* is a strong medicinal remedy which when diluted can be used for massage on skin. It can also be used to treat colds, bronchial congestion, cystitis, wounds and ulcers. The leaves' tips are used to make tea that ultimately treats respiratory disorders like coughs and colds. However, cones can be used to relieve colic in babies and needles of this plant functions as a diuretic medicine. Topically, an infusion of leaves is found to be effective against different allergic reactions like athlete's foot and ringworm.

3.3.1 Vetinary Uses

In Indian provincial vetinary hone, both the steam refined wood oil and oleoresin have a background marked by use for ulcerous skin conditions and a dry refined oil arranged by ruinous refining has been utilized to treat mange in cows, a 20% weakening in castor oil being utilized for wild oxen and calves. Blended with ghee and now and again likewise together with oil of *Pinus roxburhii*, it has against helmintic properties when taken inside. "Pestoban" is an enrolled business item which is a blend of three plant extricates, two of which are known molluscicides: *Cedrus deodara* and *Azadirachta indica* and the potentiator *Embelia ribes*, which has no molluscocidal impact itself yet which makes the activity of the last two items 100 times more dynamic [16].

3.3.2 Vascular Permeability

Operators that expansion vascular penetrability built the neighborhood blood supply, in this manner better empowering potential mending systems. Chandra and coworkers (1978) took a gander at the slender permeability of *Cedrus deodara* wood oil, catching up from the work of Jawahar Lal and companions (1976) who had reported that the oil was more effectual than benzyl benzoate or tetraethylthiuram monosulphide against sarcoptic mange in sheep [17]. Approximately a quarter century, Sharma and some other scientists (1997) took a gander at the genuine skin issue sarcoptic mange in sheep utilizing *Cedrus deodara* and benzyl benzoate. Twenty-four sheep partitioned into three gatherings (one as control) tainted with Sarcoptes bugs were independently treated on option days with the proper medications and the creatures observed for appearance of sores, aggregate erythrocytes leukocytes and hemoglobin fixation at regular intervals after treatment. It was found that the gathering treated with deodara oil reacted speedier to treatment, being free from parasites on the tenth day instead of the fourteenth day. Further, creatures treated with deodara had altogether higher erythrocyte and leukocyte numbers contrasted and control–creators presumed that *Cedrus deodara* was accordingly discovered more successful than benzyl benzoate in controlling mange in sheep.

3.3.3 Free Radical Searching Action of *Cedrus deodara*

Cedrus deodara has some dynamic parts that have free radical scrounger property. For the reason, defatted and removed powder of *Cedrus deodara* show cell reinforcement and radical searching movement on 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical. Three mixes which showed cancer preventing effects include (−)-matairesinol, (−)-nortrachelogenin and dibenzyl-butyrolactollignan (4,4',9-tivity trihydroxy-3,3'-dimethoxy-9,9'-epoxylignan). Later on they were recognized by utilizing GC-MS and NMR spectroscopic procedures. This

is the principal report of the event of these mixes in *Cedrus deodara* [18].

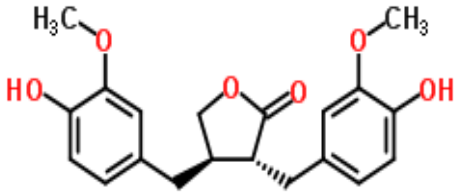


Fig 3 Free radical scavenger

3.3.4 Role in Pest Management

Plants and plant-determined materials assume a critical part in nuisance administration programs. Vital oil from wood chips of Himalayan Cedar, *Cedrus deodara* (Roxburgh) Don (Pinales: Pinaceae), was acquired by hydro-distillation and fractionated to pentane and acetonitrile from which himachalenes and atlantones enhanced portions were segregated. A sum of forty mixes was distinguished from these parts utilizing GC and GC-MS examinations. Crucial oils and divisions were assessed for insecticidal exercises against second instars of the diamondback moth, *Plutella xylostella* L., utilizing a leaf plunge technique. All examples indicated promising larvicidal action against hatchlings of *Plutella xylostella*. The pentane division was the most poisonous with a LC estimation of 287 g/ml. *Cedrus deodara* has the most potential to go about as larvicidal specialist [19].

3.3.5 Anti-Mosquito Effects

In some recent investigations, scientists [20] studied the potential anti-mosquito activity of essential oil of *Cedrus deodara*. Some other research groups [21] also determined the larvicidal activity of scented oils obtained by seeds of six different species of Cedrus such as *Cedrus libani* A. Rich. (Pinaceae) populations on *Culex pipiens* L. (Diptera: Culicidae). The essential oil of Cedrus was extracted from seeds through hydro-distillation process. Oils from each *Cedrus* population were compared with those of a standard larvicide such as temephos. Hence, overall results suggested that essential oil of *Cedrus libani* has potential to be used in the search for chemical components as new larvicide having better efficiency.

3.3.6 Anti-Incendiary and Pain Relieving Effects

Cedrus deodara is a type of plant, native to western Himalayas in northern Pakistan, eastern Afghanistan, north-central India and southwestern areas more specifically western Nepal and Tibet. Wood of the *Cedrus deodara* has long been used in Ayurvedic medical practices in order to treat the rheumatoid arthritis and severe inflammations [22]. Some major chemical constituents present in various parts of this plant are alkaloids, glycosides, flavanoids, phenolic compounds, proteins and saponins. *Cedrus deodara* can effectively inhibit polyarthritis phase as measured by the paw swellings on injected limbs on complete adjuvant induced arthritis in rats [23]. In a different study, researchers [24] took a gander at the mitigating and pain relieving movement of orally regulated steam refined *Cedrus deodara* wood oil by finding an inhibitory impact on the instigation of rodent paw edema, both in exudative proliferative and perpetual periods of irritation in adjuvant joint rats, at measurements of 50 and 100 mg/kg body weight.

3.3.7 Neurological Effects

Cedrus deodara is traditionally used for the treatment of neurological disorders in India. In a recent experimental investigation, the compound 3,4-bis(3,4-dimethoxyphenyl)furan-2,5-dione (BDFD) was isolated from ethanolic extract of this plant and was evaluated for its anti-convulsant potentials. The experimental studies were carried out in albino mice (18–22 g) and rats (180–220 g), employing different models of convulsions. The N-methyl-d-aspartic acid (NMDA)-induced lethality test and estimation of brain gamma-amino-butyric acid (GABA) were carried out to investigate the mechanism of action of this compound. The BDFD gave dose-dependent protection against pentylenetetrazole (PTZ)-induced convulsions, pilocarpine-induced convulsions and 6-Hz-induced convulsions but it could not inhibit NMDA-induced lethality. Motor incoordination was displayed when the BDFD dose exceeded 400 mg/kg whereas the therapeutic dose was below 100 mg/kg in the PTZ, pilocarpine and 6-Hz models (39–90 mg/kg). Furthermore, brain GABA estimation revealed that this compound increases the GABA level. BDFD dose levels up to 150 mg/kg did not prevent NMDA-induced lethality, which proves its weak influence on the excitatory neurotransmitter glutamate. The findings of the experiments on various animal models clearly demonstrated that BDFD possesses anti-convulsant activity by enhancing inhibitory GABAminergic neurotransmission [25].

3.3.8 Depressive Behavior

Cedrus deodara has been used traditionally in Ayurveda for the treatment of disorders of central nervous system. The 3,4-bis(3,4-dimethoxyphenyl)furan-2,5-dione (BDFD) was isolated from *Cedrus deodara* and was shown to have anti-epileptic and anxiolytic activity. So, recently some scientists explored its anti-depressant effect in order to correlate the effect with serotonin and nor adrenaline levels of brain. Albino mice were used as experimental animal. Animals were divided into three groups; vehicle control, imipramine (30 mg/kg i.p.), BDFD (100 mg/kg i.p.). Tail suspension test (TST) and forced swim test (FST) was performed to evaluate anti-depressant effect of BDFD. The BDFD (100 mg/kg, i.p.) showed a significant decrease in immobility time when subjected to FST whereas immobility time was not significantly altered in TST. The BDFD treatment increased serotonin and noradrenaline levels in the brain which is indicative of BDFD having possible atypical anti-depressant action [26].

Summary

Cedrus deodara is a plant of western Himalayan having great commercial importance, high medicinal value and extensive therapeutic potentials thus abundantly used in

number of pharmaceutical formulations and remedies of Ayurvedic system of medicines. Pharmacological activities of *Cedrus deodara* have been reported in vivo and in vitro. Different parts of this plant possess strong immunomodulatory, anti-inflammatory, anti-cancer, anti-apoptotic, anti-bacterial as well as analgesic, anti-spasmodic, anti-oxidant, anti-malarial, anti-allergic, insecticidal, anti-hyperglycemic, anti-sarcoptic mange activity and anti-convulsant potentials thus used to treat number of diseases such as intensive fevers, pulmonary infections, flatulence, urinary disorders, kidney stones, rheumatism, insomnia, piles and diabetes. It has also been found useful as anti-dote for snake bite. In addition to many pharmacological potential of *Cedrus deodara*, this plant also has some beneficial effects in neurological or psychiatric disorders such as epilepsy and anxiety and depressive behavior. Furthermore, this plant is effective to treat phthisis, skin eruptions, bronchitis and blennorrhagia. It is also used for bruises, skin infections, joint injuries, dysentery and diarrhea along with older disease of tuberculosis.

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