A Review on a Pharmacological Activity of Cedrus Deodara

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Introduction

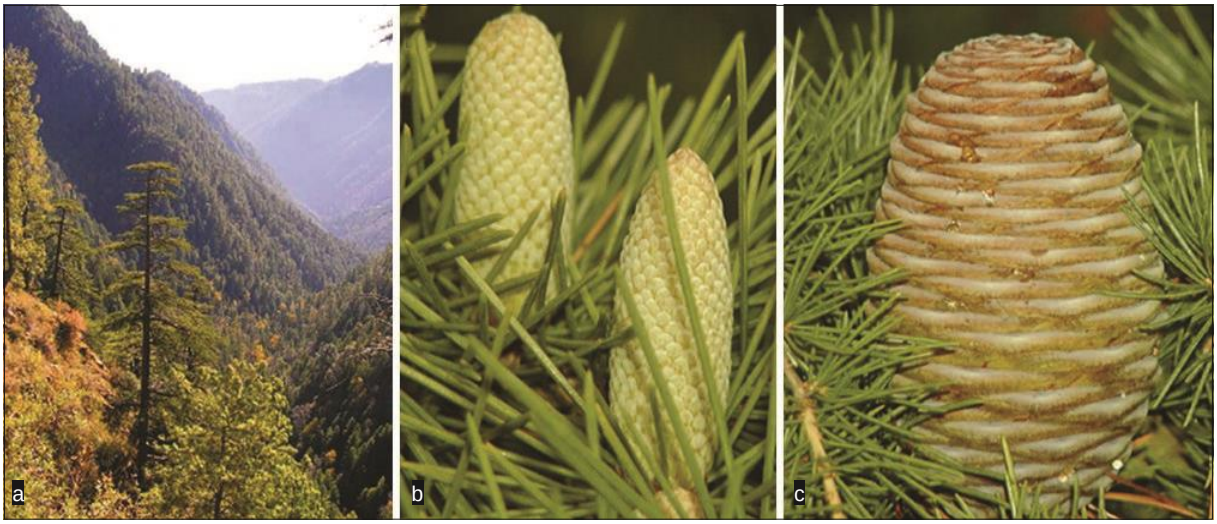
Plants significantly influence humankind in all spheres, including the environment, economy, industry, spirituality, history, and aesthetics. They are widely used for health maintenance over the globe and are regarded as the powerful source of many significant modern pharmaceuticals because their phyto constituents are used as the chemical components in drug production. Plant-based goods go by many different trade names, including natural health products, plant food supplements, herbal medications, botanical drugs, botanicals, phytomedicines, traditional medicines, herbal medicines, and traditional herbal medical products. [4] Due to their considerable secondary metabolite systems, which include saponins, tannins, alkaloids, phenols, flavonoids, fixed oils, and triterpenoids among others, about 15,000 different plant species are employed in medicinal procedures in India. Cedrus deodara, often known as Himalayan Cedar in English and Devdaar in Hindi, is one such widely used medicinal plant. Devdaru, a Sanskrit word, means "the forest of the Gods" and is also translated as "a celestial tree." It is also known in India as "the pearl of Kashmir" due to its abundance in the Kashmir valley. It belongs to the family Pinaceae, the biggest conifer family with more than 230 species and a significant commercial importance, and is a significant species of cedar. [1-2]

Due to the abundance of essential oils in every one of its sections, it is a significant aromatic plant. Each component of the plant has the characteristics of being bitter, hot, oleaginous, and somewhat smelly. The plant has a very long history of use in many ethnobotanical rituals and practises among various civilizations throughout the world, including those in India, Pakistan, China, and Korea, among others. Inflammations, dyspepsia, sleeplessness, cough, fever, urine discharges, bronchitis, itching, elephantiasis, tuberculous glands, leucoderma, opthalmia, and piles are just a few of the illnesses it is used to treat. The heartwood of Cedrus deodara is traditionally used to strengthen the brain, balance the central nervous system, and enhance cerebral function. Also used as an expectorant and carminative, wood. The plant is a rich source of commercial lumber in the Western Himalaya region in addition to its medicinal benefits. Its wood is of exceptional quality, and it has durability and resistance to rot. The factory produces a lot of building materials and serves as a fuel supply. [3-5]

Description of the Plant

A 65-meter-tall, 4-meter-wide tree, Cedrus deodara is a sizable evergreen. The stem is branching, and irregularly spaced, slightly ascending or descending branches emerge from it. The stem is clothed in grayish-brown to dark brown bark with vertical or diagonal fractures that are separated into oblong scales. The leaves are solitary, acicular, rigid, and silvery or silver-blue in colour, measuring 25–37 cm long. On normal shoots, they are grouped spirally, while on short halted shoots, they are placed in pseudowhorls. Male flowers are solitary, upright, catkin-like, pale green to purple, oblong to ovoid, 2.5-4.6 cm long, and 1-1.5 cm in diameter. When fully grown, they stand between 5 and 7.5 cm tall and become yellow from pollen. The female flowers are single, upright, and born at the ends of branchlets that have been halted. The female flowers are rectangular to ovoid in shape, 1.2-2 cm long, 0.6 cm wide, and have a pale glaucous green hue when they are in bloom. The female cones have a

persistent woody central shaft and are spirally structured with many fan-shaped scales or megasporophyll when they are fully mature. The female cones are 7.5–12 cm long and 5-8.7 cm in diameter. The mature cones are reddish-brown in colour. A pair of winged seeds measuring 2.5–3.7 cm long and 2–2.5 cm wide are carried by each scale. [6-7]



Cedrus deodara (a) tree in natural habitat, (b) male cones, (c) female cones[8-10]

Classification

1. Kingdom: Plantae
2. Phylum: Tracheophyta
3. Division: Pinophyta
4. Class: Pinopsida
5. Order: Pinales
6. Family: Pinaceae
7. Genus: Cedrus
8. Species: Deodara[11]

Synonyms

1. Hindi- Devdaar, Diar, Diyar
2. English- Deodar, Himalaya cedar
3. Sanskrit- Devdaru, Amara, Devahvaya
4. Gujarati- Devdaar
5. Marathi- Deodar
6. Malayalam- Devadaru, Devadaram, Devataram
7. Kannada- Bhadradarru, Daevadaaru, Gunduguragi
8. Marathi- Devadaru, Ewadar

9. Urdu- Burada Deodar, Deodar
10. Tibetan- Than sin, Than-sin
11. Tamil- Devadaram, Tevataram, Tunumaram
12. Nepali- Devadaru [12-15]

Morphological Description

An evergreen tree that may grow to a height of 60 metres is the Cedrus deodara. It features branchlets and horizontal branches with thin, nodding ends. The leaves are acicular and glaucous green, 2.5–5 cm long, and have a needle-like structure. With vertical and diagonal lines, the bark is grey or reddish brown in tone. The wood is strong and fragrant, with a hue ranging from light yellowish-brown to brown, distinct yearly rings, and white medullary ray lines. The male and female cones grow on different branches, making it a bisexual plant. Female cones are born alone on the terminals of dwarf shoots, are cylindrical, range in size from 2.5 to 4.5 cm, and have barrel structures. The fruits have a dry or hard coating and are brown, oblong, and 3 to 6 inches long. A particularly popular landscaping tree is the deodar cedar. Deodar trees used for landscaping are frequently dressed up for the holidays in the US. [16-17]

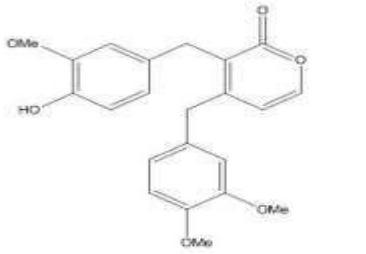
Characters	Description
Color	Yellowish-Brown
Odour	Aromatic
Taste	Astringent and Febrifuge
Size	Not Specific
Shape	Heavy

Geographical distribution:

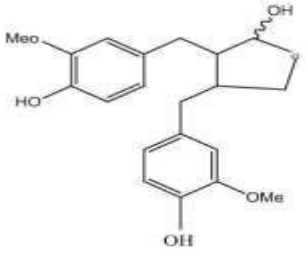
The Himalayas are the natural habitat of the deodar cedar. Deodar cedars have a lifespan of hundreds of years. With dendrochronological recordings of their yearly rings, scientists may gain an understanding of how climate change is impacting the ecosystems they reside in. To protect the nearby plants, the trees prevent erosion and save soil. Several animals, including crows and squirrels, can find shelter, food, and homes in them. At a height of 2,000-3,200 m, Cedrus deodara is extensively dispersed in the Western Himalayas and is abundant in nations such as China, Afghanistan, Pakistan, North-West India (Himachal Pradesh, Uttarakhand, and Kashmir), and Nepal. From Kashmir to Garhwal, there are several deodar woods to be found. [18-20]

Chemical constituents

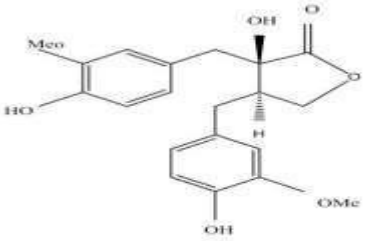
The main components of the oil are sesquiterpene, specifically -himachalene (12.5%) and -himachalene (43%). Sesquiterpene alcohols, such as himachalol, allohimachalol, himadarol, isocentdarol, and centdarol, relate to them. [22] Through spectroscopic analysis (Figure 2), some compounds were isolated from the pine needles of Cedrus deodara and are identified as 9-hydroxy-dodecanoic acid, ethyl laurate, ethyl stearate, 3-beta-hydroxy-oleanolic acid methylester, beta-sitosterol, shikimic acid, methyl coniferin, ferulic acid, and beta-glucoside. [21-23]



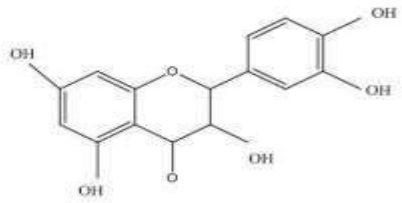
(-) Matairesinol



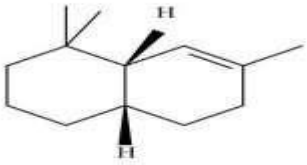
Dibenzylbutyrolactol



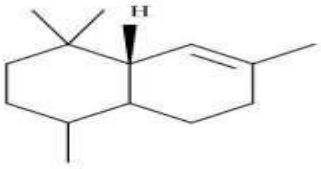
(-) Wikstromal



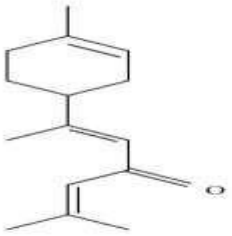
Taxifolin



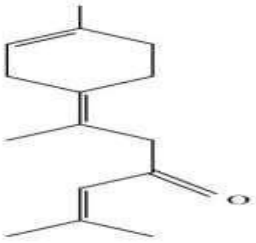
α-Himachalene



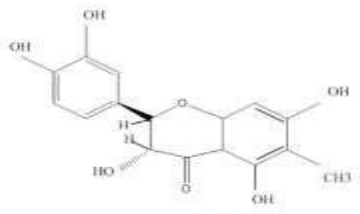
β-Himachalene



(E)– α-Atlantone



(E)–γ - Atlantone



Cedeodarin

Three chemicals with strong antioxidant activity were extracted in substantial amounts from dried plant heartwood powder and identified using spectroscopic techniques (1H NMR, 13C NMR, IR, and LCMS). These were identified as (4, 4', 9-trihydroxy-3, 3'-dimethoxy-9, 9'-epoxylignan), ()-matairesinol, ()nortrachelogenin, and a dibenzylbutyrolactollignan. This is the first account of these chemicals being found in plants. Two lignans were recovered from the butanol-soluble fraction of cedrus deodara wood purified with lead acetate. [23] The presence of flavanoids, alkaloids, tannins, and saponins in the leaf component is shown by phytochemical analysis. (-)-Wikstromal (7-79%), (-)-matairesinol (9-13%), and benzylbutyrolactol (7-11%) were the main components of an isolated "CD lignan combination" made up of lignans from the plant's stem wood. [24-25]

Ayurvedic Activity

The three bodily forces of Vata (space and air), Pitta (fire), and Kapha are the primary tenets of Ayurveda, according to the Tridosha hypothesis (water and earth). Cedrus deodara is a revered plant that is used as a medicine in the Ayurvedic system of medicine to cure a number of ailments. There are several synonyms for it, including Kilima, Macika, Suradaru, Pitadru, Surahva, Tridashahva, Badradaru, Pitadaru, Amaradaru, Suradruma, Badakashta, Amarakashta, Amaradaru, Amarahva, Daru, and Sarala. The plant has a Kapha-Vata Hara, Dipana, Kasahara, and Dushta Vrana Shodhaka Karma. The decoction of the plant, together with many other plants, is used in the treatment of hiccups (Hikka), respiratory issues (Svasa), dysentery, and diarrhoea (Kaphaja Atisara), whilst the paste of the plant, along with many other plants, is used to cure same conditions. Hemiplegia can be treated using it (Urusthambha). It is prescribed in the Sushruta Samhita for the treatment of wounds, inflammation, eye and nose issues, goitre and graves illnesses, fever, diarrhoea, and urinary difficulties. It is used to cure urethritis, eye problems, fever, cough, and hiccups in Asthanga Hrudaya. [26-27]

Traditional Uses- Because medicinal plants are more readily available and have superior health effects without having any serious side effects, the rural people has a strong understanding of plants and uses them more frequently than allopathic medications. For instance, the rural populace of various regions throughout the world, including Nepal, India, Pakistan, and Sri Lanka, among others, employs Cedrus deodara in numerous folkloric traditions to treat a wide range of human maladies. Western Nepal's Karnali region residents utilise the leaves' essential oil to relieve rheumatic discomfort. The bark and wood vapours are employed as a snake deterrent in Kumaun, Uttarakhand, while the inhabitants of Nanda Devi National Park utilise a bark decoction to treat fever and diarrhoea. The herb is utilised as part of a skin treatment regimen in Sri Lanka. In some parts of Pakistan, wood oil is used to treat a variety of skin conditions. Some examples of conventional use for cedrus deodar include:

1. Treat urinary disorders
2. Treat bacterial infections
3. Treat fungal diseases
4. Treat ulcer
5. Treat diabtes

6. Treat helminthiasis
7. Treat itching,burns[28-30]

Pharmacological Activity- Pharmacological properties are given below:

1. Antiurolithiatic Activity:

Rats are being used to test the antiurolithiatic activity of a petroleum ether extract of C. deodara heartwood. Increased salt and chloride elimination was noted as evidence of the petroleum ether extract of C. deodara's diuretic action. Rats are pre-treated with the extract to halt the decrease in urine production and pH that was first brought on by sodium oxalate, a substance that causes urolithiasis. Comparing urine samples from rats given the extract to those given sodium oxalate, where the amount of crystals was greatest, revealed that the extract-treated animals had less crystals in their urine. Also, as compared to a normal rat, treatment with sodium oxalate caused a decrease in the clearance of urea, creatinine, uric acid, sodium, potassium, and chloride as well as an increase in the blood levels of these substances, which indicates incorrect kidney function. Treatment with extracts was able to heal this problem. In the kidneys of rats given the extract, there was also a decrease in lipid peroxide levels and calcium oxalate crystals. The extract has a protective effect, as evidenced by the histological analysis of the rat kidney. [31-35]

2. Antioxidant Activity:

The brain and nervous system are particularly vulnerable to free radical damage than other tissues because they contain large concentrations of lipid and iron, two substances known to play key roles in the production of free radical species. The antioxidant properties of C. deodara were also well-reported. Cedrus deodara's antioxidant ingredients were discovered using two different procedures. Dried C. deodara heartwood powder was fractionated and purified after being defatted with petroleum ether and then extracted with chloroform. [36] On the free radical 1, 1-diphenyl-2-picrylhydrazyl (DPPH), the chloroform extract shown significant antioxidant activity. After that, silica gel column chromatography was used to separate and purify this fraction. Spectroscopic techniques were used to identify three compounds with strong antioxidant activity in considerable quantities (1H NMR, 13C NMR, IR, and MS). These were identified as (4, 4', 9-trihydroxy-3, 3'dimethoxy-9, 9'-epoxylignan), (-)-matairesinol, (-)-nortrachelogenin, and dibenzylbutyrolactollignan. [37]

3. Anti-diabetic and hypoglycemic:

Cedrus deoodara was tested against alloxan-induced diabetic rat models for its anti-diabetic and hypoglycemia effects by Podder et al. According to the study, heartwood petroleum ether extract, when administered at a dosage of 400 mg/kg body weight, showed effects similar to those of the common medication glibenclamide and significantly reduced glucose tolerance test results. The blood glucose level was significantly reduced at the dosages of 200 and 400 mg/kg body weight, however. An in-vivo investigation was conducted by Pradhan et al. to determine the impact of petroleum ether extract on the body weight of alloxan-induced diabetic rat models. The study found that administering extract dosages of 200 mg/kg and 400 mg/kg on days 14 and 21 significantly reduced body weight, and that administering extract doses of 100 mg/kg on day 21 demonstrated activity against body weight. [38-40]

4. Antihyperlipidemic activity:

C. deodara extracts in acetone and ethanol demonstrated antihyperlipidemic action in newborn rats with monosodium glutamate-induced obesity. Monosodium glutamate-induced obesity in rats was reported to result in an increase in body weight and a reduction in body temperature. As compared to monosodium glutamate control, rats given 200 mg/kg of ethanol and acetone extracts showed substantial weight reductions in the heart, liver, spleen, and kidney in addition to body weight reductions of 6.54% and 6.73%, respectively. Rats treated with 100 mg/kg and 200 mg/kg of ethanol extract, respectively, showed a substantial increase in locomotor activity compared to the control group. Additionally, it was found that when compared to the rats in the vehicle control group, the monosodium glutamate-treated rats had significantly higher levels of blood sugar, total cholesterol, triglycerides, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL), as well as lower levels of HDL. A drop in blood glucose, total cholesterol, triglyceride, LDL, and VLDL coupled with an increase in HDL level were seen after treatment with ethanolic and acetone extracts, indicating that the plant's extracts may have antihyperlipidemic and antiobesity properties. [41-45] In alloxan-induced diabetic rats, the hydroalcoholic extract of C. deodara and Embelia ribes was tested for its anti-diabetic and hypolipidemic effects. The studies showed that treatment with hydroalcoholic extracts at doses of 250 mg/kg and 500 mg/kg led to a substantial increase in serum insulin levels as well as a reduction in blood sugar, total cholesterol, and serum triglycerides. In addition, HDL cholesterol dramatically rises after extract therapy. [46]

5. Anti-malarial activity:

The bioactivity of C. deodara essential oil against Culex quinuefasciatus and Aedes aegypti adults was assessed. The plant's wood chips were utilised to extract the essential oil. The plant's crushed wood chips were processed via a device of the Clevenger type to extract the essential oil. Adults of A. aegypti were insensitive to the oil of C. deodara after 1 hour of exposure and within the control range, but the reported LC50 for C. quinuefasciatus was 2.48%, indicating minimal efficacy. Against these two mosquitoes, the plant has only moderate activity. [47]

6. Anti-cancer:

Shietal used CK-8 tests to examine the anti-cancer activity of the total ligans found in Cedrus deodara pine needles against the A549 cell line. The study showed that CTL's inhibitory effects were dose-dependent. Inhibitory effects of CTL were also seen in HeLa, HepG2, MKN28, and HT-29 cell lines. Using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) test, Chauhan et al. investigated the anti-cancerous properties of Cedrus deodara as well as many other significant plants in BHK-21 cells. The findings demonstrated that diverse plant extracts significantly slowed cell development at varying doses. [48-50]

7. Anticonvulsant activity:

A substance isolated from the heartwood of C. deodara called 3, 4-bis (3,4-dimethoxyphenyl) furan-2,5-dione (BDFD) has been shown to have anticonvulsant properties. According to the findings of their investigation, BDFD protected albino rats against convulsions caused by 6-

Hz, pilocarpine, and pentylenetetrazole (PTZ) in a dose-dependent manner. Also, in PTZ-, 6-Hz-, and pilocarpine-induced seizures, 100 mg/kg of BDFD showed therapeutic benefits on motor coordination. Also, it was noted that BDFD therapy increased the levels of GABA in the test-rat brains. All of these findings point to BDFD's anticonvulsant properties. [51]

8. Antispasmodic Activity:

Himachal is a significant component of plant wood that has antispasmodic properties. The pharmacological studies of himachal against various agonists (acetylcholine, histamine, serotonin, nicotine, and barium chloride) and on various isolated smooth muscles (rat uterus, guinea pig ileum, rabbit jejunum, and guinea pig seminal vesicle) revealed spasmolytic activity comparable to that of papaverine. It is more efficient than papaverine at blocking barium chloride's ability to cause spasm in the guinea pig ileum, but less so in the jejunum of rabbits, and it has no calming effects on its own. In the conscious immobilised cat, intragastric treatment of himachalol or papaverine (100 mg/kg) resulted in the similar rate of inhibition of carbachol-induced intestinal spasm, lasting for roughly 2 hours, although himachalol had a considerably earlier beginning of action than papaverine. Papaverine was less effective than himachalol at preventing the guinea pig seminal vesicle's contraction in response to epinephrine, while himachalol had no spasmolytic impact on the animal's bronchial muscle. The cat experienced a dose-dependent drop in blood pressure and an increase in femoral blood flow after receiving an intravenous injection of himachalol (3–10 mg/kg). [52-55]

9. Larvicidal activity:

Against the diamondback moth, Plutella xylostella, the essential oil of C. deodara displayed larvicidal action. It was noted that the pentane fraction of the essential oil, which had an LC50 value of 287 g/mL, was the most efficient in larvicidal activity against diamondback moth P. xylostella second instars when derived via hydrodistillation of the plant's wood chips. Furthermore, it was claimed that fractions with himachalenes as opposed to allantone as an enrichment were more harmful. According to the data above, himachalenes and allantone most likely contributed to the larvicidal action. [56]

10. Anti depressant:

In an in-vivo investigation using experimental albino mouse models, Kumar et al. assessed the anti-depressant efficacy of Cedrus deodaran. In the forced swim test (FST), the compound 3,4-bis(3,4-dimethoxyphenyl) furan2,5-dione (BDFD), which was isolated from the plant's heart wood, demonstrated antidepressant activity at a dosage of 100 mg/kg i.p. However, in the tail suspension test (TST), the immobility time was not significantly reduced by the BDFD treatment, indicating the compound's atypical antidepressant action. [57-58]

11. Anti-inflammatory and anti-arthritic activity:

The plant's air dried stem bark's aqueous extract was tested for its potential to treat arthritis and inflammation. Using the method developed by Winter et colleagues in 1962, in carrageenaninduced inflammation. The mice received an injection of 0.05 ml of 1%

carrageenin suspension in the hind paw, and the outcomes of C. deodara were compared to those of conventional medications betamethasone and phenylbutazone. It was discovered that C. deodara was less efficient than usual. The granuloma pouch and cotton pellet methods were used to assess the anti-infammatory activity in additional detail. The same standards were applied, and the results suggest that betamethasone significantly reduces the amount of exudates as compared to control (40%). Nevertheless, C. deodara and phenylbutazone considerably reduce the amount of exudates by 20% and 30%, respectively. Nevertheless, Cedrus deodara's anti-inflammatory properties did not significantly decrease tuberculin rxn. The rat paw edoema caused by compound 48/80 and nystatin were significantly inhibited by the volatile oil of the plant's wood (50 and 100 mg/kg, p.o.). [59-61]

12.Antifungal activity:

In addition to two previously known sesquiterpenes, atlantone and (E)-atlantone, two novel sesquiterpenes, (E)-(2S, 3S, 6R)-atlantone-2, 3-diol and (E)-(2S, 3S, 6S)-atlantone-2, 3, 6-triol, were isolated from C. deodara and shown to exhibit antifungal activity. Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Aspergillus parasiticus, and Aspergillus sydowii were reported to be inhibited by the use of n-hexane extract, chloroform extract, atlantone, and (E)—atlantone. A. parasiticus and A. sydowii were also resistant to (E)-(2S,3S,6R)-atlantone2,3-diol's limited antifungal activity, but (E)-(2S,3S,6S)-atlantone-2,3,6-triol and both extracts inhibited Trichophyton rubrum. [62]

13.Antiapoptotic activity:

In human leukaemia Molt-4 cells and HL-60 cells, AP9-cd, a standardised combination of lignans made up of (-)-wikstromal (75-79%), (-)-matairesinol (9-13%), and dibenzylbutyrolactol (7-11%), was discovered to have a function in inducing apoptosis and nitric oxide production. The combination reduced the number of Molt-4 cells that proliferated, increased the percentage of sub-G0 cells without a mitotic block, generated apoptotic bodies, and encouraged the growth of DNA ladders. In Molt-4 and HL-60 cells, AP9-cd also caused the production of nitric oxide, the development of peroxides, a decrease in the potential of the mitochondrial membrane as well as an increase in the activity of caspases-3, caspases-8, and caspases-9.

The study's findings showed that the leukaemia cell was destroyed as a result of the apoptotic pathway being initiated.[63]

14.Antiproliferative activity:

Three different Cedrus species' wood essential oils, including those from Cedrus atlantica, Cedrus libani, and Cedrus deodara, inhibited the growth of the K562 cell line with IC50 values of 23.38 1.7 g/mL, 59.37 2.67 g/mL, and 37.09 1.47 g/mL, respectively. The wood essential oils of C. libani, C. deodara, and C. atlantica also caused erythroid differentiation at concentrations of 15 2%, 20 2%, and 12 1.8%, respectively, in erythroid cells at 5 g/mL, 25 g/mL, and 10 g/mL. The findings imply that the wood essential oils of the three species of Cedrus are a powerful source of the active ingredients needed to make anticancer medications. [64-65]

The anticancer properties of flavonoids isolated and extracted from C. deodara needles were examined. The total flavonoid content of the needle of C. deodara was found to be up to 54.28%, with the main flavonoids myricetin, quercetin, kaempferol, and isorhamnetin having concentrations of 1.89, 2.01, 2.94, and 1.22 mg/g, respectively. The extract had an IC50 value of 114.12 g/mL and, according to the MTT experiment, inhibited the proliferation of HepG2 cells in a dose-dependent manner. The plant extract also inhibited the growth of human cervical carcinoma HeLa, stomach cancer MKN28, glioma SHG44, and lung carcinoma A549 rather than HepG2 cells. The amount of HepG2 cells in the G0/G1 stage of the cell cycle and the proportion of apoptotic HepG2 cells were both raised by the extract. [66]

15.Anti-leishmanial:

In an in-vitro test using certain parasites, Narayan et al. investigated the anti-leishmanial efficacy of Cedrus deodara leaf extract. According to the study, benzene solvent was used to extract the leaf, and the dose of 25 to 200 ug/ml showed impressive anti-leishmanial efficacy. [67]

16.Neuroprotective Activity:

Cedrin, a chemical extracted from C. deodara, is thought to have neuroprotective properties. Cedrin was found to increase cell survival in a concentration-dependent manner in PC12 cells damaged by treatment with A1-42. Malondialdehyde (MDA) and intracellular reactive oxygen species were increased in PC12 cells treated with A1-42, whereas SOD activity was decreased. Cedrin pre-treatment of the cells was able to correct this state, demonstrating its antioxidant properties against oxidative stress brought on by A1-42.

In PC12 cells, where A1-42 had first failed, Cedrin also enhanced mitochondrial membrane potential and the opening of the mitochondrial permeability transition pore. Eventually, cedrin improved mitochondrial dysfunction and prevented apoptosis, all of which suggested that cedrin had neuroprotective effects. It also lowered Bax expression, which was raised by A1- 42, and promoted Bcl-2 activity, which was downregulated by A1-42. [68-70]

17.Anthelmintic activity:

According to reports, C. deodara's leaf extract has anthelmintic properties. It was discovered that leaf extracts in petroleum ether, chloroform, ethyl acetate, and methanol had greater antiadult Pheretima posthuma action. Petroleum ether required the least amount of time to paralyse and kill the worms, followed by methanol, ethyl acetate, and chloroform, in that order. [71]

18. Analgesic activity:

By using a hot plate reaction time model and acetic acid-induced writhing response in mice, the oil of wood from C. deodara was examined for its analgesic potential. As a reference control for the investigation, morphine and aspirin were employed. At all levels of testing, the wood oil of C. deodara demonstrated substantial analgesic efficacy. [72]

Reference

1. Zaman T, Syed MS, Isfaq S, Khan MS. Biological activities of stem, leaves and essential oil of Cedrus deodara from district Poonch, Rawalakot Azad Kashmir, Pakistan. Turkish Journal of Agriculture-Food Science and Technology. 2018 Sep 9;6(9):1114-9.
2. Thakur S, Kaurav H, Chaudhary G. Nigella sativa (Kalonji): A Black Seed of Miracle. International Journal of Research and Review. 2021;8(4):342-357.
3. Kumari I, Kaurav H, Chaudhary G. Ethnobotanical Significance of PicrorhizaKurroa (Kutki), a Threatened Species. International Journal of Research and Review. 2021;8(4):363-75.
4. Kumari I, Kaurav H, Chaudhary G. Myristica fragrans (Jaiphal): A Significant Medicinal Herbal Plant. International Journal for Research in Applied Sciences and Biotechnology. 2021 Apr 7;8(2):213-24.
5. Choudhary S, Kaurav H, Chaudhary G. Vaibidang (Embeliaribes): A Potential Herbal Drug in Ayurveda with Anthelmintic Property. International Journal for Research in Applied Sciences and Biotechnology. 2021 Apr 16;8(2):237-43.
6. Metreveli M, Meskhidze A, Mepharishvili G, Gorgilade L, Koiava L. Antimicrobial Activity of the Himalayan Cedar (Cedrus Deodara Loud.) in Seasonal Dynamics. Bull. Georg. Natl. Acad. Sci. 2020;14(2).
7. Anthwal A, Gupta N, Sharma A, Anthwal S, Kim KH. Conserving biodiversity through traditional beliefs in sacred groves in Uttarakhand Himalaya, India. Resources, Conservation and Recycling. 2010 Sep 1;54(11):962-71.
8. Mahajan D, Bhat ZF, Kumar S. Pine needles (Cedrus deodara (Roxb.) Loud.) extract as a novel preservative in cheese. Food Packaging and Shelf Life. 2016 Mar 1;7(2016):20-25.
9. Patel SJ, Lambole V, Shah P, Shah DP. Pharmacological Activities of Cedrus deodara: An Overview. Pharma Science Monitor. 2013 Apr 16;4(3 Suppl 1):100-14.
10. Agrawal PK, Agarwal SK, Rastogi RP, Österdahal BG. Dihydroflavanonols from Cedrus deodara, A 13C NMR study. Planta medica. 1981 Sep;43(09):82-5.
11. Bisht A, Jain S, Misra A, Dwivedi J, Paliwal S, Sharma S. Cedrus deodara (Roxb. ex D. Don) G. Don: A review of traditional use, phytochemical composition and pharmacology. Journal of Ethnopharmacology. 2021 Jun 22:114361.
12. Viswanatha GL, Nandakumar K. Anxiolytic and Anticonvulsant activity of alcoholic extract of heart wood of Cedrus deodara roxb in rodents. Asian Journal of Pharmaceutical Research and Health Care. 2009;1(2):217-239.
13. Sharma I, Parashar B, Vatsa E, Chandel S, Sharma S. Phytochemical screening and anthelmintic activity of leaves of Cedrus deodara (Roxb.). World J. Pharm. Pharm. Sci. 2016 Jun 15;5(8):1618-28.

14. Zeng WC, Zhang Z, Jia LR. Antioxidant activity and characterization of antioxidant polysaccharides from pine needle (Cedrus deodara). Carbohydrate polymers. 2014 Aug 8;108(2014):58-64.
15. Khanduri VP, Sharma CM. Pollen production, microsporangium dehiscence and pollen flow in Himalayan cedar (Cedrus deodara Roxb. ex D. Don). Annals of Botany. 2002 May 1;89(5):587-93.
16. Khanduri VP, Sharma CM. Cyclic pollen production in Cedrus deodara. Sexual plant reproduction. 2009 Jun;22(2):53-61.
17. Afzal S, Afzal N, Awan MR, Khan TS, Gilani A, Khanum R, Tariq S. Ethno-botanical studies from Northern Pakistan. J Ayub Med Coll Abbottabad. 2009 Mar 1;21(1):52-7.
18. Hanif M, Khalid AN, Sarwer S. Additions to the Ectomycorrhizae Associated with Himalayan Cedar (Cedrus deodara) using rDNA-ITS. International journal of agriculture & biology. 2012 Feb 1;14(1):101-6.
19. Manandhar NP. Ethnobotany of Jumla District, Nepal. International Journal of Crude Drug Research. 1986 Jan 1;24(2):81-9.
20. Singh PL, Tripathi K, Yadav RB, Yadav KN. Devdaru (Cedrus deodara (Roxb.) Loud): A critical review on the medicinal plant. Int J Ayurveda Pharm Res 2014;2:1-10.
21. Mukherjee PK: Exploring botanicals in Indian systems of medicine- regulatory perspectives. Clinical Research and Regulatory Affairs. 2003; 20:249-264.
22. Gulati BC: Cultivation and utilization of aromatic plant. In: Atal CK, Kapur BM. Regional research laboratory, Jammu-Tawi, India, 1977; 640-652.
23. Kar K, Puri VN, Patnaik GK, Sur RN, Dhawan BN, Kulshrestha DK, Rastogi RP: Spasmolytic constituents of Cedrus deodara (Roxb.) Loud: Pharmacological evaluation of himachalol. J Pharm Sci. 1975; 64: 258–262.
24. Agarwal PK, Rastogi RP: Lignans from Cedrus deodara. Phytochemistry. 1982; 21: 1459-1461.
25. Shafaghat A: Phytochemical Investigation of Quranic Fruits and Plants. Journal of Medicinal Plants. 2010; 9: 61-66.
26. Singh SK, Shanmugavel M, Kampasi H, Singh R, Mondhe DM, Rao JM, Adwankar MK, Saxena AK, Qazi GN: Chemically standardized isolates from Cedrus deodara stem wood having anticancer activity. Planta medica. 2007; 73:519-526
27. M. Makhaik, S.N. Naik, D.K. Tewary, J. Sci. Ind. Res., 2005, 64, 129-133.
28. Naik HR, Jhadav V. An Ayurvedic Review on Medicinal Inportant of Devdaru Plant. National Journal of Research in Ayurved Science. 2020;8(4):1-4
29. Singh PL, Tripathi K, Yadav RB, Yadav KN. Devadaru (Cedrus deodara (Roxb.) Loud.): a critical review on the medicinal plant. Int J Ayurveda Pharm Res. 2014;2(1):1-10.
30. Mehra A, Bajpai O, Joshi H. Diversity, utilization and sacred values of Ethno-medicinal plants of Kumaun Himalaya. Tropical Plant Research. 2014;1(3): 80–86.

31. Rana CS, Sharma A, Kumar N, Dangwal LR, Tiwari JK. Ethnopharmacology of Some Important Medicinal Plants of Nanda Devi National Park (NDNP) Uttarakhand, India. Nature and Science. 2010;8(11):9-14.
32. Gamage DG, Dharmadasa RM, Abeysinghe DC, Wijesekara RG, Prathapasinghe GA, Someya T. Emerging Herbal Cosmetic Production in Sri Lanka: Identifying Possible Interventions for the Development of the Herbal Cosmetic Industry. Scientifica. 2021 Mar 10;2021:1-12.
33. Khan N, Ahmed M, Ahmed A, Shaukat SS, Wahab M, Ajaib M, Siddiqui MF, Nasir M. Important medicinal plants of chitral.
34. .B. Halliwell, J.M.C. Gutteridge, Free Radicals in Biology and Medicine. Clarendon Press. Oxford, 96-98, 1989
35. Singh P, Khosa RL, Mishra G. Evaluation of antidiabetic activity of ethanolic extract of Cedrus deodara (Pinaceae) stem bark in streptozotocin induced diabetes in mice. Niger J Exp Clin Biosci2013;1:33-8.
36. Patil S, Prakash T, Kotresha D, Rao NR, Pandy N. Antihyperlipidemic potential of Cedrus deodara extracts in monosodium glutamate induced obesity in neonatal rats. Indian J Pharmacol2011;43:644-7.
37. M. Makhaik, S.N. Naik, D.K. Tewary, J. Sci. Ind. Res., 2005, 64, 129-133.
38. Singh SK, Shanmugavel M, Kampasi H, Singh R, Mondhe DM, Rao JM, et al. Chemically standardized isolates from Cedrus deodara stem wood having anticancer activity. Planta Med 2007;73:519-26.
39. Dhayabaran D, Florance EJ, Nandakumar K, Shanmugarathinum A, Puratchikody A. Anticonvulsant activity of fraction isolated from ethanolic extract of heartwood of Cedrus deodara. J Nat Med 2014;68:310-
40. Kar, V.N. Puri, G.K. Patnaik, N. Rabindra, B.N. Sur Dhawan, D.K. Kulshrestha, R.P. Rastogi, J. Pharm. Sci., 1975, 64, 258-262.
41. Chaudhary A, Sharma P, Nadda G, Tewary DK, Singh B. Chemical composition and larvicidal activities of the Himalayan Cedar, Cedrus deodara essential oil and its fractions against the diamond black moth, Plutellaxylostella. J Insect Sci 2011;11:1-10.
42. Shinde UA, Phadke AS, Nair AM, Mungantiwar AA, Dikshit VJ, Saraf MN, et al. Studies on the antiinflammatory and analgesic activity of Cedrus deodara (Roxb.) loud. Wood oil. J Ethnopharmacol1999;65:21-7.
43. Chaudhary A, Sood S, Kaur P, Kumar N, Thakur A, Gulati A, et al. Antifungal sesquiterpenes from Cedrus deodara. Planta Med 2012;78:186-8.
44. Sashi B, Jaswant S, Madhusudana RJ, Kumar SA, Nabi QG. A novel Lignan composition from Cedrus deodara induces apoptosis and early nitric oxide generation in human leukemia Molt-4 and HL-60 cells. Nitric Oxide 2006;14:72-88.
45. Shi X, Liu D, Zhang J, Hu P, Shen W, Fan B, et al. Extraction and purification of total flavonoids from pine needles of Cedrus deodara contribute to anti-tumor in vitro. BMC Compliment Altern Med 2016;16:1-9.
46. Zhao Z, Dong Z, Ming J, Liu Y. Cedrin identified from Cedrus deodara (Roxb.) G. Don protects PC12 cells against neurotoxicity induced by $a\beta_{1-42}$. Nat Prod Res 2018;32:1455-8.

47. Sharma A, Parashar B, Vatsa E, Chandel S, Sharma S. Phytochemical screening and antihelminthic activity of Cedrus deodara (Roxb). World J Pharm Pharm Sci 2016;5:1618-28.
48. U.A. Shinde, A.S. Phadke, A.M. Nair, A.A. Mungantiwar, V.J. Dikshit, M.N. Saraf, J. Ethnopharmacol., 1991, 65, 21-27.
49. Zeng WC, He Q, Sun Q, Zhong K, Gao H. Antibacterial activity of water soluble extract from pine needles of Cedrus deodara. Int J Food Microbiol2012;153:78-84.
50. Bai J, Wu Y, Liu X, Zhong K, Huang Y, Gao H. Antibacterial activity of shikimic acid from pine needles of Cedrus deodara against Staphylococcus aureus through damage to cell membrane. Int J Mol Sci 2015;16:27145-55.
51. Wu Y, Bai J, Zhong K, Huang Y, Qi H, Jiang Y, et al. Antibacterial activity and membrane disruptive mechanism of 3-p-trans-coumaroyl-2-hydroxyquinic acid a novel phenolic compound from pine needles of Cedrus deodara, against Staphylococcus aureus. Molecules 2016;21:e1084.
52. Wu Y, Bai J, Zhong K, Huang Y, Gao H. A dual antibacterial mechanism involved in membrane disruption and DNA binding of 2R, 3R-dihydromyricetin from pine needles of Cedrus deodara against Staphylococcus aureus. Food Chem 2017;218:463-70.
53. Chaudhary A, Sood S, Kaur P, Kumar N, Thakur A, Gulati A, et al. Antifungal sesquiterpenes from Cedrus deodara. Planta Med 2012;78:186-8.
54. Ramesh C, Krishnadas S, Radhakrishnan R, Rangappa S, Viswanatha GL, Rajesh D, et al. Anti-urolithiatic activity of heartwood extract of Cedrus deodara in rats. J Complement Integr Med 2010;7:1-9.
55. Shinde UA, Phadke AS, Nair AM, Mungantiwar AA, Dikshit VJ, Saraf MN, et al. Studies on the antiinflammatory and analgesic activity of Cedrus deodara (Roxb.) loud. Wood oil. J Ethnopharmacol1999;65:21-7.
56. Chowdhury MS, Koike M, Muhammed N, Halim MA, Saha N, Kobayashi H. Use of medicinal plants in healthcare: A traditional ethno-medicinal practice in rural areas of South Eastern Bangladesh. Int J Biodivers Sci Manage 2009;5:41-51.
57. Modak M, Dixit P, Londhe J, Ghaskadbi S, Devasagayam TP. Indian herbs and herbal drugs used for the treatment of diabetes. J Clin BiochemNutr2007;40:163-73.
58. Uniyal SK, Singh KN, Jamwal P, Lal B. Traditional use of medicinal plants among the tribal communities of Chhota Bhangal, Western Himalaya. J EthnobiolEthnomed2006;2:14.
59. Rather MA, Baba SA. Traditional uses of medicinal plants in Kashmir: A review. Res Rev J Biol2015;3:26-32.
60. Chauhan RS, Joshi A. Anti-Cancer properties of herbs in cell culture system. Journal of Immunology and Immunopathology. 2018;20(si):107-20.
61. Mashaal K, Perveen R, Zia Z, Mahmood SM, Minhas K, Ibrahim S, Naeem H. Histopathological effects on stomach, liver and kidney associated with Cedrus deodara root oil in ulcer induced rats (Wistar strain). Pakistan Journal of Pharmaceutical Sciences. 2020 Nov 1;33(6):2483-88.

62. Narayan S, Thakur CP, Bahadur S, Thakur M, Pandey SN, Thakur AK, Mitra DK, Mukherjee PK. Cedrus deodara: In vitro antileishmanial efficacy &immumomodulatory activity. The Indian journal of medical research. 2017 Dec;146(6):780.

63. Kumar N, Dhayabaran D, Nampoothiri M, Nandakumar K, Lalani AP, Dawood, et al., Atypical Antidepressant Activity of 3,4-Bis(3,4-Dimethoxyphenyl) Furan-2,5-Dione Isolated from Heart Wood of Cedrus deodara, in Rodents. Korean J PhysiolPharmacol. 2014 Oct;18(5):365-369.

64. Podder S, Pradhan G, Mahapatra SC. Evaluation of petroleum ether heartwood extract of Cedrus deodara in healthy and diabetic rats. Int J Clin Exp Physiol. 2016 Apr 30;3(2):72-6

65. Chandur U, Shashidhar S, Chandrasekar SB, Rao MN. Studies of preliminary phytochemical and anti-arthritic activity of heart wood of Cedrus deodar (Roxb.). RJPBCS. 2011;2(3):654-0.

66. Manne HS, Basavaraju B, Bindhu V, Keerthi S, Vernekar NN, Laturkar V. Study of Anti-inflammatory and Analgesic Activityof Methnaolic Extracts of Cedrus deodara. Biotechnology An Indian Journal. 2008;2(1):1-4.

67. Shinde UA, Phadke AS, Nair AM. Studies on the antiinflammatory and analgesic activity of Cedrus deodara (Roxb.)Loud. Wood oil. Journal of Ethnopharmacology. 1999;65(1):21-7.

68. XU QD, Zhou ZQ, HE Q, Sun Q, Zeng WC. Antioxidant Activity and Structure-Activity Relationship of Ethanol Extract from Pine Needle of Cedrus deodara. Science and Technology of food industry. 2020 Nov 12;41(20):295-302.

69. Jain S, Jain A, Malviya N, Kumar D, Jain V, Jain S. Antidiabetic activity of Cedrus deodara aqueous extract and its relationship with its antioxidant properties. Journal of Pharmaceutical Sciences and Pharmacology. 2014 Sep 1;1(3):187-94.

70. Mehra A, Bajpai O, Joshi H. Diversity, utilization and sacred values of Ethno-medicinal plants of Kumaun Himalaya. Tropical Plant Research. 2014;1(3): 80–86.

71. Rana CS, Sharma A, Kumar N, Dangwal LR, Tiwari JK. Ethnopharmacology of Some Important Medicinal Plants of Nanda Devi National Park (NDNP) Uttarakhand, India. Nature and Science. 2010;8(11):9-14.

72. Pradhan G, Podder S, Mahapatra SC. Effect of petroleum ether extract of Cedrus deodara on body weight in diabetic rats. International Journal of Clinical and Experimental Physiology. 2016 Jul 1;3(3):140-3.