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Important Activities of *Thuja orientalis* (L)

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ABSTRACT

Thuja orientalis (L) (*Platycladus orientalis*) belongs to the family Cupressaceae, which is found in temperate and semi-temperate regions, is referred to as the "Tree of Life" in Buddhist theory in China. This is presumably because the tree's unchanging, evergreen nature has allowed it to be used for a very long time for a variety of biological purposes. That species is an important herb in oriental world medicine as employed in the treatment of so many diseases. *Thuja orientalis*, often known as arbour vitae, white cedar, or morpankhi, is a member of the Cupressaceae family. These -plants contain plant phytoconstituents such as carbohydrates, alkaloids, glycosides, flavonoids, tannins, saponins and flavonoids constituents are Rutin, Quercitrin, Quercetin, Amentoflavone pinene, δ-3-carene, sabinene and cedrol. This review primarily focuses on the numerous studies conducted to determine its biological properties, including those that promote hair growth and are antioxidant, antibacterial, antiangiogenesis, anti-cancer, anti-diabetic, anti-allergic, antimicrobial, antiviral, and anti-inflammatory. This review highlights some important phytoconstituents and biological properties of *T. orientalis*.

Keywords: *Thuja orientalis*, Phytochemistry, Biological activities, Pharmacological activities.

INTRODUCTION

According to Ayurveda, plants contain a wide range of compounds that can be utilised to treat a wide range of illnesses. Natural substances having biological characteristics are primarily found in medicinal plants. Pharmaceuticals that are physiologically active can be obtained from natural ingredients. The classical Indian Literature, the Vedas, which are more than 3000 years old, have mentioned the use of medicinal and aromatic herbs, shrubs and flowers in treating various diseases.[1]

The Cupressaceae family includes the common ornamental evergreen tree *Thuja orientalis*, which is native to Northwest China. Grown in gardens in temperate and semi-temperate climates, it is a strongly scented and resinous shrub. In the wild, *Thuja orientalis* is a huge, hardy, evergreen shrub or small to medium-sized tree that usually grows taller than 20 meters. Although possessing a thick, pyramidal appearance, it often adopts an open, spreading shape. It likes full light, soil that is wet, and an efficient drainage system. The bark is grey with brown highlights, and it has deep but shallow furrows. There's something ruggedly attractive about the bark, especially on big, older trees. Younger bark exfoliates in long, thin strips and has a reddish-brown color. It is unique to China's northwest. Furthermore, it is now establishing itself as an invasive species in other parts of Asia, including northern Iran, south to northern India, and east to Korea and Japan. The Latin word "Tree of Life" is the origin of the common name "arbor-vitae," which comes from the Chinese Buddhist thought that the plant signifies vigor and long life. This is perhaps due to the tree's endurance and constant evergreen status in the dry cold climate of northwest China; some larger specimens planted around Buddhist temples in China are believed to be more than 1,000 years old. Botanists have classified it differently even though it is widely acknowledged as the only member of its genus. Platycladus is only tangentially connected to Thuja, however it was commonly mentioned in earlier manuscripts. as belonging to that genus. Unique cones, seeds without wings, and foliage with nearly little aroma distinguish this plant from Thuja.

Biota orientalis and, most recently, *Platycladus orientalis* have replaced the original genus name. It is claimed that using them promotes better hair development. The seed is sedative, aperient, and lenitive. It is taken internally to treat neurological disorders, geriatric constipation, sleeplessness, and palpitations.[2]

MATERIAL & METHODS

Thuja orientalis is an evergreen, monoecious tree or shrub that can reach heights of 10 to 60 feet. The leaves resemble scales, and the shoots are flat. With resin glands, the leaves are arranged in a flattened fan-shaped growth. Their leaves contain essential oils that are used to treat fungal diseases, cancer, moles, and parasitic worms. The leaves are extracted to yield toxic essential oil. Thujone works well as an insecticide and an anthelminthic medication to treat parasitic worms. However, -thujone is a toxic substance that interferes with the neurological transmissions in the brain. Death may result from ingesting Thuja plants' essential oils. [3]

Taxonomical Classification:

Kingdom : Plantae
Division : Coniferophyta
Class : Pinopsida
Order : Pinales
Family : Cupressaceae
Genus : Platycladus

Species:

1. *Thuja koraiensis*
2. *Thuja occidentalis L.*
3. *Thuja plicata*
4. *Thuja standishii*
5. *Thuja sutchuenensis*

Figure 1: *Thuja orientalis*

Thuja orientalis (Figure 1) has been used in many ways throughout history. Thuja leaf decoctions were utilised to treat ailments like cough, cystitis, fever, intestinal parasites, and sexual illnesses. Ointments prepared from various parts of the Thuja plant have been used for treating gout, psoriasis, rheumatism, verrucae, warts, and more. Thuja oil is still used in several industries. It is used as a counter-irritant in pain relief products. It is a flavouring agent found in many foods and is a component of medicinal disinfectants, sprays, some perfumes, and cosmetics. Thuja is used for respirational tract toxicities like bronchitis, skin, and cold infections. Additionally, it is utilised to treat painful conditions such as arthritis and nervous disturbances which affect the face. Some people use the Thuja to loosen mucus (as an expectorant), strengthen their immune systems and enhance urine flow (as a diuretic). Thuja is occasionally applied topically can be helpful for treating joint pain, osteoarthritis, and muscular soreness. Additionally, warts and cancer are treated using thuja oil. [4]

Bronchial asthma, enuresis, cystitis, psoriasis, uterine carcinomas, amenorrhoea, skin infections, bacterial dysentery, arthritic aches, and premature blandness are among the conditions for which Thuja is utilised. Different parts of the plant are exhibited extensively biological activities like hair growth-promoting, anti-viral, anti-allergic, anti-epileptic, anti-inflammatory, anti-bacterial, anti-oxidant, and anti-fungal activities. Apart from these effects, it can be used as nematicidal, insecticidal and molluscicidal activity against various pests.[5]

Phytochemistry

Biochemical studies reveal that fresh plant contains essential oil, reducing sugar, water-soluble polysaccharides, water-soluble minerals, free acid, tannic agents, flavonoids, saponins, glycosides and alkaloids.[5]

The chemical components of essential oils extracted from the leaves and fruits were: α-pinene (35.2%, 50.7%), α-cedrol (14.6%, 6.9%), Δ-3-carene (6.3%, 13.8%), limonene (6.1%, 1.5%), β-caryophyllene (5.8%, 4.1%), and myrcene (3.3%, 3.8%), respectively (Table 1).[6]

Table 1. List of chemical composition (%) of essential oils of oriental arborvitae, *Platycladus orientalis*

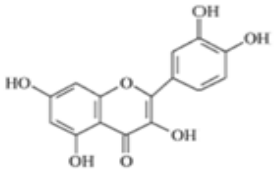
Compound	Retention index	Leaf oil	Fruit oil
α-Thujene	928	0.6	-
α-Pinene	936	35.2	50.7
α-Fenchene	944	1.2	1.6
Sabinene	971	1.5	2.1
β-Pinene	977	0.1	0.9
Myrcene	993	3.3	3.8
α-Phellandrene	1005	1.6	2.1
Δ3-Carene	1013	6.3	13.8
ρ-Cymene	1021	1.4	2.0
Limonene	1032	6.1	1.5
γ-terpinene	1058	0.4	0.5
Terpinolene	1063	2.1	1.7
cis-Sabinene hydrate	1092	-	0.2

Linalool	1101	1.2	-
Terpinen-4-ol	1177	0.1	0.3
α-Terpineol	1241	-	0.1
Bornyl acetate	1285	0.7	1.3
α-Terpenyl acetate	1376	0.5	-
β-Elemene	1390	0.7	0.3
β-Cedrene	1417	1.8	0.9
β-Caryophyllene	1423	5.8	4.1
Thujopsene	1435	2.1	1.7
α-Humolene	1456	1.0	0.4
Germacrene-D	1483	2.2	-
Δ-Cadinene	1515	0.3	0.3
Elemol	1541	1.5	0.6
α-Cedrol	1614	14.6	6.9
α-Cadinol	1651	0.6	-
Total		92.9	97.8

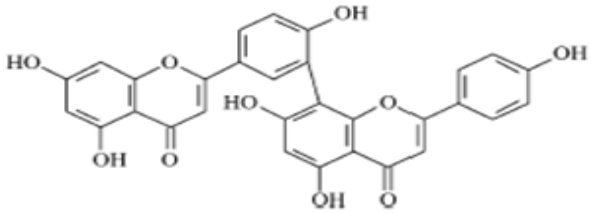
Additional monoterpenes, such as camphen, myrcen, carvotanacetone, and origanol. Rhodoxanthin is present in *T. orientalis* leaves, whereas aroma-dendrin, taxifolin, widdrene, cedrol, thujopsadiene, dehydro-α curcumene, β-isobiotol, and curcumenether are found in the heartwood. [7] Rhodoxanthin, amentoflavone, hinokifavone, quercetin, myricetin, carotene, xanthophylls, and ascorbic acid are all found in *Thuja orientalis*, leaves. α-thujone and β-thujone are the two diastereomeric forms of thujone that are found naturally. Thujone is a ketone and monoterpene.[8] The oil extracted from the seed has the following composition: 5.28 % palmitic, 7.3 % stearic, 1829 % C18 unsaturated acids (linolenic, 44.6%), and 6.10% C20 unsaturated acids. Dendrin, taxifolin, widdrene, cedrol, thujopsadiene, dehydro-α-curcumene, β-isobiotol, and curcumenether are among the fragrance components found in the heartwood.

It is also contains an essential oil is a complex mixture of Sesquiterpene hydrocarbons (cuparenes) 40; alcohols (Cedrol, widdrol, cuparenols) 50; monoterpenic acids. [3]

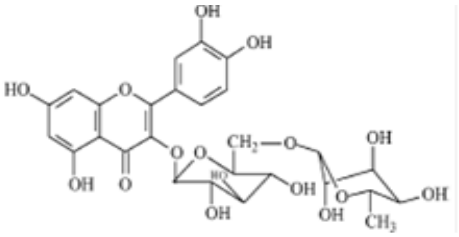
The fruit oil of *Thuja orientalis* L was found to contain oxygen-containing compounds 9.7% and hydrocarbons 88.21%. The hydrocarbons were determined as 75.37% monoterpenes and 12.82% sesquiterpenes. The percentages of α-pinene (33.05%), α-phellandrene (10.39%), α-terpinene (7.73%), and camphene (5.47%) were found to be the main constituents. The number of oxygen-containing compounds was 29.85% while, the hydrocarbons were represented by 44.74% monoterpenes and 24.35 sesquiterpenes. α - pinene (21.83%), benzyl benzoate (19.12%), caryophyllene (12.07%) and α - cedrol (6.86%) were found to be the major components of the leaf oil.[9]



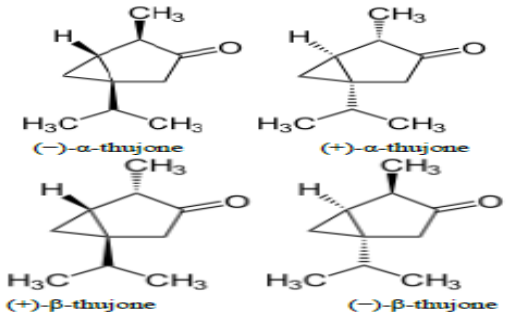
Quercetin

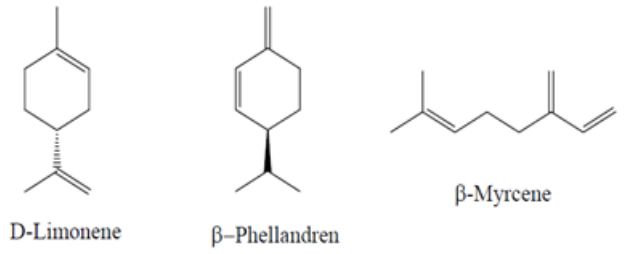


Amentoflavone



Rutin





Chemical constituents of *Thuja orientalis*

Bioactivities of *Thuja orientalis*

Antimicrobial assay

The Microbial Type Culture Collection (MTCC) at the Institute of Microbial Technology in Chandigarh, India, contained a panel of six bacterial strains that were used to investigate the antibacterial activity of *Thuja orientalis* essential oil. The strains of bacteria that were employed were *P. aeruginosa* (MTCC-1688), *Bacillus subtilis* (MTCC-441), *K. pneumonia* (MTCC-19), *E. coli* (MTCC-443), *P. vulgaris* (MTCC-1771), and *S. aureus* (MTCC 96). On nutrient agar plates, strains of bacteria were cultured at 37°C and kept alive on nutrition agar slants. Approximately 106 CFU/ml was obtained by adjusting the cell suspension of microorganisms in 0.9% NaCl at 0.5 Mc Farland.

The microdilution technique and agar well diffusion assay were adapted for use in antimicrobial susceptibility testing. To ensure that the agar was well diffused throughout the oil, first Muller Hinton medium was made and 0.5% of tween-20 was dissolved per 100 ml of agar medium. Each boiling tube received a 20 ml aliquot. Following this, boiling tubes were autoclaved to ensure sterilization. Oil samples were added to the tubes at concentrations ranging from 0.2-25.6 mg/ml, with the tubes' temperature controlled up to 38°C. The contents of the tube were spilled onto plates, set in a laminar flow, and allowed to dry for half an hour. Finally, the turbidity of the broth was adjusted within a range after bacteria were inoculated from fresh cultures.08–0.13 at 625nm.

Subsequently, 3µl of each bacterium's inoculum was added to the plates. The bacteria were tested using streptomycin sulphate (1000 mg/l) as a positive control. The MIC of the oil was determined using the authorized microdilution method by the National Committee for Clinical Laboratory Standards (NCCLS). After dissolving the oil in dimethyl sulfoxide, it was added to the medium and diluted to produce concentrations between 0.25 and 25.6 mg/ml. The plate was filled with an inoculum suspension that had a final concentration of 106 CFU/ml. The minimum essential oil concentration (MIC) is the amount of the oil at which, after 24 hours of incubation at 37 °C, the microorganism shows no signs of development. [10]

Antibacterial and Antioxidant activity

In the current investigation, powdered *Thuja orientalis* leaves were extracted using a soxhlet extractor in two different solvent systems: (E1) methanol: distilled water (70:30) and (E1) ethyl acetate: chloroform: ethanol (40: 30: 30). The screening of the crude E1 and E2 extract and its fractions' phytochemical components, antioxidant activity, and antibacterial activity was provided by this study. Utilising the 2,2-diphenyl-1-picrylhydrazyl (DPPH) test, antioxidant activity was measured. The findings show that the crude extracts (E1 and E2 extract) had significant ($P \leq 0.05$) inhibitory activity against gram-positive and gram-negative bacteria, with E2 extract (70% methanolic extract) having the strongest antioxidant effect (85.25% inhibition) at 100 µg/ml concentration.

It was active against *Staphylococcus aureus, Bacillus subtilis, Escherichia coli, and Agrobacterium tumefaiens.* The minimum inhibitory concentrations (MICs) of E1 extract ranged from 0.40 to 0.85 mg/ml and E2 extract 0.55 to 1.15 mg/ml. E2 extract showed the most antibacterial potentiality. The fractions also exhibited antimicrobial activity against all the selected microorganisms. The study revealed that *Thuja orientalis* is a promising phytomedicine for antioxidant and antibacterial activity.[11]

It shown efficacy against *Agrobacterium tumefaiens, Bacillus subtilis, Escherichia coli, and Staphylococcus aureus*. E1 and E2 extracts had minimal inhibitory concentrations (MICs) ranging from 0.40 to 0.85 mg/ml and 0.55 to 1.15 mg/ml, respectively. The extract from E2 had the highest antibacterial potential. Additionally, the fractions demonstrated antibacterial efficacy against every microbe that was chosen. According to the study, *Thuja orientalis* is a promising phytomedicine for antioxidant and antibacterial activity. [11]

Antifungal Activity

Radial Growth Bioassay for Antifungal Activity Determination. This approach examines how antifungal agents affect the radial development of fungi. To achieve a final concentration of 100 mg/ml, the THU-C extract was combined with sterile potato dextrose agar (PDA) and then transferred into sterile petriplates. A sterile 6 mm cork borer was used to create wells after the PDA medium had solidified. A 7-day-old fungal culture was then aseptically injected into the wells. The fungus's radial growth was monitored during the seven days while the plates were incubated at 25°C. The negative and positive controls were 50% methanol and 1 mg/ml griseofulvin, respectively.[12]

The formula used to compute radial growth inhibition was $(C - T/C) \times 100$, where C and T represent the growth diameter (mm) for the treatment and positive and negative controls, respectively.

Anti-Inflammatory and Analgesic activity

The aim of this study was to assess a non-pharmacological treatment for pain and inflammation in order to avoid the negative side effects of the drugs currently used to treat 0 these disorders. In traditional medicine, *Thuja orientalis* (Morphankhi) is frequently used to treat inflammatory diseases and discomfort. Aqueous methanolic extract of *Thuja orientalis* fruit (To-Cr) was tested for its anti-inflammatory, peripheral, and central analgesic activities in albino rats using the carrageenan-induced inflammatory model, the acetic acid-induced writhing test, and hot plate procedures. The study was designed using a completely randomised design (CRD), and one-way ANOVA was used to compare the means. The outcomes showed that TO-Cr had strong anti-inflammatory and analgesic properties. The present study concludes that the oral administration of *Thuja orientalis* aqueous methanolic extract has considerable analgesic and anti-inflammatory activities.[13]

Atherosclerosis and other cardiovascular diseases are both prevented and developed in part by vascular inflammation. The study examined the potential mechanisms behind the anti-vascular inflammatory activity of an aqueous extract of *T. orientalis* (ATO) in human umbilical vein endothelial cells (HUVECs). Pre-incubation with ATO seemed to inhibit monocyte adherence to the endothelium as it lowered both tumour necrosis factor and U937 monocyte adhesion to TNF-stimulated HUVECs. Furthermore, TNF-induced intracellular reactive oxygen species (ROS) were significantly decreased by ATO. In general, ATO has an anti-inflammatory impact via inhibiting NF-kB activation, intracellular ROS generation, and cell adhesion molecule in HUVECs. This reduces TNF-induced endothelium adherence to monocytes, at least partially.[3]

Hair growth-promoting activity

Traditionally, *Thuja orientalis* leaves have been used to promote hair development. Studies showed that the leaves included potent 5_-reductase inhibitors, which may have a role in promoting hair development. Another study showed that by generating anagen in telogenic C57BL/6 N mice, the leaf decoction can stimulate hair growth. An rise in hair follicle size and number was seen in mice treated with decoction, providing evidence for the induction of anagen phases. Comparing the decoction-treated group to the control or 1% minoxidil-treated group, the immunohistochemistry analysis reveals an earlier induction of β-catenin and Sonic hedgehog (Shh) proteins. Thus, the inhibition of 5_-reductase and the activation of β-catenin and Shh proteins can account for the activity that promotes hair development. [14]

Thuja orientalis extract (TOS) has been used on the hemostatic roborant, sedatives and stressless in oriental countries. In the macrophage cell line RAW264.7, we examine the inhibitory effects on the productions of pro-inflammatory cytokines such interleukin-1beta (IL-1beta), IL-6, tumour necrosis factor-alpha (TNF-alpha), and nitric oxide (NO), in addition the hair stimulation of TOS. or hair loss-induced DBA1J mice. T08 (50-500 ㎍/㎖) had no cytotoxic effect on non-stimulated cells, but this extract concentration-dependently reduced the release of NO, (IL-1β), IL-6, and TNF-α in the stimulate RAW264.7 cells with lipopolysaccharide (LPS). Furthermore, TOS (500 g/ml) application to DBA 1J/mice significantly accelerated hair development. These data suggest that T08 promotes hair growth in hair loss induced model mice and these properties may contribute to the anti-hair loss activity of the *Thuja orientalis*.[15]

Insecticidal Activity

Thuja orientalis leaf extracts have been shown to be repellent to *Chilo partellus*. The repellant activity of *Thuja orientalis* ether extract (68.63%) and acetone extracts (67.51%) is sufficient. Applying a semi-solid crude extract of *Thuja orientalis* topically to maize proved to be highly efficacious in combating *Chilo partellus*.[3]

Antiproliferative Activity:

Antiproliferative activity of essential oils obtained from some medicinal plants and isolated the effective components *Thuja orientalis* essential oil had an IC50 of 330.04µg/mL against amelanotic melanoma, indicating its efficacy against the disease. Three components, linalool terpenes, β-caryophyllene and α-cedol were found to be active on tested cell lines.

Anthelmintic activity

The activity of *T. orientalis* leaf extracts against live male *H. contortus* collected from slaughtered goats was determined *in vitro*. The effectiveness of the extracts was assessed for five hours at 38.5°C at doses of 1000, 1500, and 2000 µg/ml. Effectiveness was measured using the percentage of nematode mortality and gross visible motility. It was shown that the recoveries of crude aqueous, methanolic, chloroform and petroleum ether extracts were 1.52, 9.89, 6.87 and 3.04%, respectively. Even though the worms' motility was poor at all concentrations examined, the treatments had no fatal side effects. However, the methanolic extract showed nematode mortality above the desired effective value at all concentrations after 5 h of incubation but was not dose-dependent. The motility in the chloroform extract was medium at 1000 and 1500 and low at 2000 µg/ml, with no mortality. The petroleum ether extract resulted in the dullness of the nematodes but not in complete cessation of motility. These results show that the methanolic ether extract of *T. orientalis* possesses an anthelmintic effect and may be used in the development of a herbal drug against *H. contortus.*[16]

Anthelmintic Activity: Anthelmintic activity is the term used to describe the actions of medications that eliminate or render unconscious internal parasites and parasitic worms (helminths) without significantly harming the host. *Thuja orientalis* aerial portions exhibited anthelmintic action. The methanolic extract of a real portion of *Thuja orientalis* was found to have strong anthelmintic effects at higher concentrations. The extract demonstrated dose-dependent anthelmintic action, which is useful in treating human parasitic illnesses. [3]

Antipyretic activity

Platycladus orientalis leaf ethanolic extract has a potent antipyretic effect. Pyrexia occurs when 0.5 ml/kg body weight of cooked milk is administered intraperitoneally to albino rabbits. When *Platycladus orientalis* leaf ethanolic extract (80 mg/kg body weight) was administered intraperitoneally (i. p.) to rabbits, the raised body temperature was greatly reduced, which was evaluated with standard aspirin (market product) and solvent used.

Rats with *Platycladus orientalis* showed antipyretic efficacy. The purpose of the study was to evaluate the alcoholic leaf extract of *Platycladus orientalis* for antipyretic properties. *Platycladus orientalis* is a powerful medicinal herb used in Indian medicine. It has been used traditionally as an antipyretic, diuretic, analgesic, anticancer, and anticonvulsant. In the current investigation, rats with Brewer's yeast-induced pyrexia were used to test the antipyretic properties of an alcoholic leaf extract from *Platycladus orientalis*. There was significant antipyretic activity demonstrated by the alcoholic extract ($p < 0.05$). Strong antipyretic effects of the extract were observed in a dose-dependent manner. [17]

Anticancer Activity:

Cytotoxicologic studies of the extracts of Iranian Juniperus sabina and P. orientalis on cancer cells were carried out by Jafarian et al. The cytotoxic effects of the extracts on three human tumor cell lines (Hela, KB, and MDA-MB-468) were determined. Various concentrations of extracts were added to cultured cells and incubated for 72 h. Cell survival was evaluated using MTT-based cytotoxicity assay.[18]

Strong 5α-reductase inhibitor was extracted from *Thuja orientalis* and fractionated in isolated form as diterpene. The inhibitors were consumed either alone or as essential components of medicines to cure diseases caused by excessive 5α-reductase or hyper-secretion of androgens, including male baldness, androgen ethic alopecia, hirsutism, acne, and prostate cancer. *Thuja orientalis* anti-cancer potential was identified in malevolent melanoma cell line A375.[4]

Cytotoxicologic studies

In this study, they determine the cytotoxic effects of the extracts *Platycladus orientalis* on three human tumor cell lines (Hela, KB and MDA-MB-468). They observed that the extracts from *Platycladus orientalis* significantly decreased Hela and MDA-MB-468 cell curvival, their effects were not considered so they conclude that the extract of *P. orientalis* has cytotoxic effects on cancer cells.[19]

Molluscocidal activity

Ethanol extract of *T. orientalis* leaf (LC50: 32.74 mg/l) and purified column fraction (LC50: 29.25 mg/l) have potent molluscicidal action against *Lymnaea acuminate*. Thujone (LC50: 08.09 mg/l) has been identified as an active molluscicidal constituent in the Thuja essential oils. The molluscicidal actions of Thuja leaf or fruit and their active constituents purified fraction using synergetic piperonyl butoxide (PB) or N-Octyl bicycloheptene dicarboximide (MGK 264) was examined in binary combination (1:5) against Lymnaea acuminata. The mixture of Thuja leaf/thujone or fruit/column extract of Thuja fruit with PB or MGK-264 showed synergistic toxicity up to 189.02 times. The toxicity of the binary mixture increased hundreds of times because its components show synergistic action.

Nematicidal activity: Mortality in Meloidogyne incognita egg juvenile in three intervals was caused by the ethanol extract from *Thuja orientalis* leaf (20, 40, 60 and 80 percent). The link between the strength of the plant extract and the number of hatched tadpoles was linear. The young deaths were directly in connection with the extract strength [4].

Anti-allergic effect

Thuja orientalis leaves contain a bioactive diterpene called lambertian acid. It has been discovered that lambertianic acid possesses anti-allergic properties and may have use in the treatment of allergies.

Anti-diabetic activity

The investigation was to find the anti-diabetic action of an ethanolic fraction of Thuja occidentalis (EFTO) and to probe into its mechanism of action. Fasting blood sugar, blood glutathione levels and serum biochemical determination in alloxan-induced diabetes were studied. EFTO released a significant anti-diabetic action at the dose level of 200 mg/kg. EFTO also has a significant increase in blood glutathione levels because of antioxidant activity.

Neuropharmacological Activity

Watery concentrate of an airborne part was investigated for evaluation of neuropharmacological activity by using raised in addition to labyrinth test, an open field test in which they were noted ambulation, raising self-prepping, movement in focus, rota pole test and tail suspension test.

Anti-HIV Activity

Thuja polysaccharides (TPS) repressed human immunodeficiency infection (HIV)- subordinate cell passing at the last convergence of 625 μg/ml. At this fixation, TPSg was shown to be nonharmful for MT-4 cells, which had not been tainted with HIV-1. TPS seemed to hinder HIV-1- explicit antigen articulation on newly contaminated MT-2 cells in a portion subordinate manner.[20]

Antiviral activity

The watermelon mosaic potyvirus, or WMV, is regarded as a significant virus that infects watermelon and adversely affects crop productivity. In this investigations, examined the impact of three concentrations of Thuja extract on the multiplication of WMV in watermelon and suggested Thuja extract to decrease the infection caused by watermelon mosaic potyvirus in watermelon.

When influenza viruses spread through epidemics or pandemics, they significantly increase human morbidity and mortality. As of currently, two kinds of anti-influenza virus medications are being utilized to treat influenza virus infections: neuraminidase inhibitors (oseltamivir and zanamivir) and M2 ion-channel inhibitors (amantadine and rimantadine). Since the resistance to these drugs has been reported, Won JN et. al. investigated the antiviral effectivity of *Thuja orientalis* and suggested it may be used as an anti-influenza virus drug.

Monica et. al. by using GC/MS analysis identified the chemical compositon of *Thuja orientalis* 's essential oil and evaluated its inhibitory potential for the severe acute respiratory syndrome Coronavirus (SARS-CoV) and Herpes simplex virus type 1 (HSV-1) and have shown antiviral activity.[21]

Using cell-based screening, the antiviral properties of the plant extracts were examined in vitro. It has been demonstrated that after infection with the influenza A/PR/8/34 virus, plant extracts of *Thuja orientalis* can cause a high cell viability rate. As the extracts' concentration rose, so did their antiviral effectiveness. These extracts also significantly reduced the apparent cytopathic effect that virus infections induce. Additionally, compared to treatments with *A. spathulifolius or P. thunbergii*, the administration of *Thuja orientalis* was demonstrated to have a higher inhibitory effect. These findings might imply that *Thuja orientalis* possesses anti-influenza A/PR/8/34 properties. [22]

CONCLUSION

Thuja orientalis Linn is a commonly used medicinal herb that has been utilized historically. *Thuja orientalis* is an ornamental evergreen tree that grows widely. It has a diverse variety of biological activity which helps in making use of this plant's medicinal properties. This article provides an overview of several biological properties, including antioxidant, antibacterial, anti-angiogenesis, anti-cancer, diabetes mellitus, anti-allergic, antimicrobial, antiviral, anti-inflammatory, and hair growth-promoting properties, that have been examined by some researchers in the interests that it may encourage other researchers to conduct additional research on this plant. In conclusion, the present review on botany, traditional uses, phytochemistry and pharmacology has provided preliminary information for further investigations and commercial exploitations of the herb.

List of Abbreviation

MTCC	Microbial Type Culture Collection
NCCLS	National Committee for Clinical Laboratory Standards
DPPH	2,2-diphenyl-1-picrylhydrazyl
PDA	Potato Dextrose Agar
CRD	Completely Randomised Design
HUVECs	Human Umbilical Vein Endothelial Cells
To-Cr	Aqueous methanolic extract of *Thuja orientalis* fruit
CHL	Chloroform Fraction
TNF-α	Tumor Necrosis Factor-α
LPS	Lipopolysaccharide
TPS	Thuja polysaccharides
HIV	Human Immunodeficiency Infection
WMV	Watermelon Mosaic Potyvirus
SARS-CoV	Severe Acute Respiratory Syndrome Coronavirus
HSV-1	Herpes simplex virus type 1
ATO	Aqueous extract of *T. orientalis*
TOS	*Thuja orientalis* extract
EFTO	Ethanolic fraction of *Thuja occidentalis*

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CONFLICT OF INTEREST
None

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