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Review Article

Hesperocyparis lusitanica (syn. *Cupressus lusitanica*): An Integrative and Evidence-Based Review of Ethnomedicinal Uses, Phytochemistry and Pharmacological Activities

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ABSTRACT

Found widely throughout Mexico, Central America, and tropical regions, *Hesperocyparis lusitanica* (also known as *Cupressus lusitanica*), also known as Mexican cypress, is a major medicinal conifer from the Cupressaceae family. In the past, this plant has been used to treat respiratory problems, inflammation, joint pain, and microbial infections and as an insect repellent. Along with other species inside the Hesperocyparis genus, this review summarizes the botanical features, traditional medical uses, chemical composition, and pharmacological activities of *H. lusitanica*. Research into its phytochemistry has shown the presence of monoterpenes, sesquiterpenes, flavonoids, phenolic compounds, and essential oils mostly rich in α-pinene, β-pinene, limonene, terpinen-4-ol, and caryophyllene. Among the recorded pharmacological effects are anti-inflammatory, antioxidant, antifungal, antibacterial, insecticidal, and cytotoxic actions. The study goes on to explore chemotaxonomic and ecological aspects linked with the genus. Even if the biological benefits seen are encouraging, more study on toxicity, underlying mechanisms, and clinical applications is required to properly assess its therapeutic potential and potential role in pharmaceutical use.

Keywords: Antimicrobial activity, Antioxidant activity, Cupressaceae, Essential oils, Ethnomedicine, *Hesperocyparis lusitanica*, Medicinal plants, Monoterpenes, Pharmacological activities, Phytochemistry.

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INTRODUCTION

Plants served health goals well since time immemorial existed. Local groups, such as those in Africa and Native America, added herbs into their protective habits, whereas certain cultures set up well-known therapeutic structures, like Siddha, Ayurveda, Unani, and TCM (Traditional Chinese Medicine), which contained plant-based care (Gunjan *et al*., 2015). Plants that are valuable and odor-pleasant, specifically those used in older styles of medicine, have performed as a natural source for medications and wellness support across several thousands of years. The accurate amount of the plant material and the means of administration for certain diseases were passed down by word of mouth crosswise for several years, and details regarding curative flora were ultimately documented in well-known collections of therapeutic preparations (Chaachouay *et al*., 2024). People have added a countless deal from flora and things made from it. During the long, common progress of people and plants, plants have provided an almost never-ending source of nutrition, food for animals, fabric, and, significantly, health treatments. Of the several things derived from plants, important oils deserve exact attention. These constituents are complex combinations of hydrocarbons and hydrocarbons containing oxygen that result from the isoprenoid metabolic pathways, mostly composed of monoterpenes and sesquiterpenes (Yaqoob ur Rehman *et al*., 2022). The implementation of herbal treatments and various botanical constituents in Western nations has enlarged, particularly recently. Around two centuries before, our methods

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for health maintenance deeply depended upon medications derived from plants. However, consuming plant-based medicines dropped off rapidly in the West when reliable manufactured drugs became simple to get. Equally, several emerging nations have reserved taking benefit of deep understanding within beneficial plant traditions. E.g., India's Siddha and Ayurveda, Japan's Kampo medicine, Traditional Chinese Medicine (TCM), and Unani medicine crossways parts of the Middle East and South Asia and stay common for an enormous amount of people (Mosihuzzaman *et al.*, 2008). Due to the ongoing and shared bad consequences related to current treatment drugs, there is a large shift toward employing plant-based therapies throughout current times (Jain *et al.*, 2024). Cupressus species originate from different mild regions in the Northern Hemisphere, like western North America, Central America, northwest Africa, the Middle East, the Himalayas, southern China, and northern Vietnam; however, they are broadly cultivated in several locations too (Frezza *et al.*, 2022).

One of them is *Hesperocyparis lusitanica* (syn. *Cupressus lusitanica*). The cypress species most commonly found in New Zealand is *Hesperocyparis lusitanica* (Mill.), known as Mexican cedar and previously known as *Cupressus lusitanica* (Kimberley *et al.*, 2023). Speedily growing up to 30 m high, this plant endures dry surroundings and is very well liked in Portugal, where it has been commonly cultivated for many years both for its looks and wood cutting, causing it to spread naturally crossways in numerous areas of the nation. The leaves are small, measuring from 1.5-2 mm long, and show up on branches that are slightly round (Guimarães *et al.*, 2009).

METHODOLOGY

A literature search was performed across electronic databases including PubMed, Scopus, Web of Science, Google Scholar, ScienceDirect, and Wiley Online Libraryto locate relevant studies on *Hesperocyparis lusitanica* (syn. *Cupressus lusitanica* and related Hesperocyparis species. The search included publications from 1995 to 2025, using keywords such as "*Hesperocyparis lusitanica*", "*Cupressus lusitanica*", "Mexican cypress" ethnomedicinal uses", "phytochemistry", "essential oil", "pharmacological activities", "antioxidant", "anti-inflammatory" antimicrobial", and "cytotoxic activity". Only articles published in English such as original research, review articles, and authoritative books were taken into account. Studies that were duplicates, conference abstracts, editorials, or lacked sufficient scientific data were excluded. The retrieved literature was critically reviewed to compile a summary of the botanical description, traditional applications, phytochemical components, and pharmacological effects of *H. lusitanica*.

Botanical Description and Taxonomy

Hesperocyparis lusitanica (Mill.), known as Mexican cedar, belongs to the family Cupressaceae and was previously known as *Cupressus lusitanica* which is most commonly found in New Zealand (Table 1). The native ground of *H. lusitanica* is quite wide, covering central Mexico and Guatemala among heights of 1200 and 3000 m shown in Figure 1. Across its natural area, this plant usually flourishes in separate groups rather than continuous fields, commonly located on wet slopes or near small rivers (Kimberley *et al.*, 2023). The periderm has a reddish-brown coloration and a fibrous texture, while the leaves are distinguished by a scalelike habit, with closely appressed and glandular arrangement. The plant produces globose woody cones containing small winged seeds, which are characteristics of the Cupressaceae family (Adams *et al.*, 2009).

The leaves are scale-like, 2-5 mm long, and arranged on rounded (not flattened) shoots shown in Figure 2. The seed cones are globose to oblong, 10-20 mm long, with four to 10 scales, which are green at first, turning brown or grey-brown after 25 months from pollination. The cones either open at the time of maturity to discharge the seeds, or they remain closed for several years until they open after the death of the parent tree as a result of a wildfire, allowing the seeds to germinate on the bare ground left by the fire. The male cones are 3-4 mm long, and they discharge pollen in late winter to early spring (February to March in the Northern



Figure 1: *Hesperocyparis lusitanica* (cones and Needles).



Figure 2: *Hesperocyparis lusitanica*.

Table 1: The *Hesperocyparis* has 16 species which are mentioned in following table (Adams *et al.*, 2009; Little *et al.*, 2006; Christenhusz *et al.*, 2016).

Sl. No.	Species	Common Name	Natural Occurrence/Distribution
1.	*Hesperocyparis lusitanica* (syn. *Cupressus lusitanica*)	Mexican cypress	Mexico, Central America; introduced in Africa and Asia.
2.	*Hesperocyparis arizonica* (syn. *Cupressus arizonica*)	Arizona cypress	Southwestern USA and Northern Mexico
3.	*Hesperocyparis macrocarpa* (syn. *Cupressus macrocarpa*)	Monterey cypress	Central coast of California (USA)
4.	*Hesperocyparis abramsiana* (syn. *Cupressus abramsiana*)	Santa Cruz Cypress	Santa Cruz Mountains, California
5.	*Hesperocyparis bakeri* (syn. *Cupressus bakeri*)	Baker cypress	Northern California and Southern Oregon
6.	*Hesperocyparis benthamii* (syn. *Cupressus benthamii*)	Bentham's cypress	Mexico and Guatemala
7.	*Hesperocyparis forbesii* (syn. *Cupressus forbesii*)	Tecate cypress	Southern California and Baja California
8.	*Hesperocyparis glabra* (syn. *Cupressus glabra*)	Smooth Arizona cypress	Arizona and Northern Mexico
9.	*Hesperocyparis goveniana* (syn. *Cupressus goveniana*)	Gowen cypress	California coastal regions
10.	*Hesperocyparis guadalupensis* (syn. *Cupressus guadalupensis*)	Guadalupe cypress	Guadalupe Island (Mexico)
11.	*Hesperocyparis macnabiana* (syn. *Cupressus macnabiana*)	McNab cypress	Northern California
12.	*Hesperocyparis montana* (syn. *Cupressus montana*)	San Pedro Mártir cypress	Baja California mountains
13.	*Hesperocyparis nevadensis* (syn. *Cupressus nevadensis*)	Piute cypress	Southern Sierra Nevada (California)
14.	*Hesperocyparis pygmaea* (syn. *Cupressus pygmaea*)	Mendocino cypress	Mendocino Coast, California
15.	*Hesperocyparis sargentii* (syn. *Cupressus sargentii*)	Sargent cypress	California chaparral regions
16.	*Hesperocyparis stephensonii* (syn. *Cupressus stephensonii*)	Cuyamaca cypress	Southern California

Hemisphere), as shown in Figure 2. In most of its natural range, the rainfall is in greater quantity in summer (Kimberley *et al.*, 2023).

Ethnopharmacological Uses

The different extracts and required oils coming from *Cupressus* categories have been detected for holding antibacterial, antifungal compared to dermatophytes, antioxidant, anti-inflammatory, anti-aging, antidiabetic, and anti-Alzheimer impacts (Kamal *et al.*, 2024). *H. lusitanica* (syn. *Cupressus lusitanica*) leaves were conventionally applied to keep bugs away from stored items, acting as a protector against insects in country areas. Furthermore, its derived oils work well for treating both coughing and joint pain. In addition, it has a significant place in manufacturing air fresheners and numerous beauty products such as antiperspirants, fragrances, and cleaning bars (Nteziyaremye *et al.*, 2021). Plant chemical study regarding *H. lusitanica* (syn. *Cupressus lusitanica*) shows the presence of monoterpenes, sesquiterpenes, flavonoids, and phenolic compounds, notably α-pinene, β-pinene, and limonene, along with several different volatile materials influencing its actual impact. The oil showed a broad range of antimicrobial effectiveness against different Gram-negative bacterial strains, as well as fungal species. It significantly inhibited microbial growth. The antimicrobial activity was connected to the disruption of microbial cell membranes by lipophilic terpenoid compounds. Additionally, the essential oil displayed strong antifungal effects against *Candida* species. The evaluation of acute toxicity in experimental animals revealed no deaths or major behavioral changes at the tested doses, suggesting low toxicity. The study concluded that the oil's

Table 2: Phytochemical constituents of *Hesperocyparis* species.

Species Reported	Plant part	Isolated/identified compound	Reference
H. lusitanica (syn. *Cupressus lusitanica*)	Leaves	β-curcumene (1.1%), α-terpinyl acetate (1.3%), δ-3-carene (0.1%), epi-α-cadinol (0.3%), heptyl propanoate (3.3%), γ-curcumene (3.0%), α-terpinene (0.6%), α-muurolol (0.1%), umbellulone (18.3%), β-pinene (0.2%), germacrene D (8.2%), terpin-4-yl acetate (0.4%), cis-linalool oxide (0.1%), α-humulene (0.6%), α-copaene (0.2%), α-acoradiene (0.5%), 1,8-cineol (0.4%), β-elemene (0.1%), trans-calamenene (3.8%), γ-amorphene (0.5%), α-terpineol (0.5%), α-calacorene (0.2%), γ-terpinene (1.0%), 2-heptyl butyrate (0.2%), β-bisabolene (0.2%), epi-α-muurolol (0.2%), linalool (1.3%), cedrene (1.7%), α-muurolene (0.9%), trans-linalool oxide (furanoid) (0.1%), terpinolene (0.9%), α-thujene (0.6%), β-calacorene (0.2%), δ-cadinene (tr), cis-calamenene (0.6%), cryptone (0.2%), p-cymen-8-ol (0.2%), epi-zonarene (5.0%), 2-heptyl acetate (0.4%), β-caryophyllene (0.7%), bornyl acetate (0.1%), myrcene (1.2%), β-acoradiene (1.6%), cis-14-nor-muural-5-en-4-one (1.1%), α-pinene (7.4%), α-cadinol (1.2%), (Z)-nuciferol (0.2%), bicyclogermacrene (0.3%), hexyl butanoate (0.5%), sabinene (1.0%), α-acorenol (6.0%), thymol (1.6%), β-copaene (0.2%), β-acorenol (0.9%), cis-muurola-3,5-diene (4.2%), p-cymene (0.5%), cedrol (1.6%), epi-α-cubenol (0.9%), cuparene (tr), limonene (3.5%), alpha-terpinen-4-ol (2.6%), cis-acetoxylinalool oxide (0.9%), alaskenea (0.8%).	(Fogang *et al.*, 2021)
	Cones	α-pinene (64.5%), δ3-carene (6.5%), limonene (3.5%), β-pinene (3.1%), α-thujene (0.4%), p-cymene (0.1%), γ-terpinene (0.1%), terpinolene (0.2%), linalool (0.3%), umbellulone (0.3%), terpinen-4-ol (1.9%), p-cymen-8-ol (0.5%), α-terpineol (1.7%), thymol (0.1%), α-terpinyl acetate (0.1%), β-caryophyllene (0.6%), α-humulene (0.7%), caryophyllene oxide (0.6%), and α-cadinol (0.4%).	(Kuiate *et al.*, 2006)
	Flowers	α-pinene (15.4%), myrcene (6.0%), limonene (5.4%), sabinene (2.5%), β-pinene (1.2%), δ3-carene (0.9%), p-cymene (1.4%), linalool (7.2%), thymol (1.7%), terpinen-4-ol (1.1%), α-terpineol (0.7%), bornyl acetate (0.1%), β-caryophyllene (9.6%), germacrene D (2.4%), α-humulene (1.9%), α-muurolene (0.6%), trans-calamenene (0.7%), α-cadinol (2.5%), epi-α-cubenol (2.7%), cedrol (0.8%) and caryophyllene oxide (0.6%).	(Kuiate *et al.*, 2006)
H. arizonica (syn. *Cupressus arizonica*)	Leaves	α-Pinene (11.0%), β-Pinene (0.2%), Sabinene (2.8%), Myrcene (3.4%), δ-3-Carene (2.1%), α-Terpinene (0.6%), p-Cymene (1.9%), Limonene (14.44%), β-Phellandrene (2.7%), γ-Terpinene (1.5%), Terpinolene (0.9%), cis-Linalool oxide (0.1%), Linalool (0.3%), Umbellulone (13.25%), Terpinen-4-ol (7.29%), α-Terpineol (1.4%), Bornyl acetate (0.7%), α-Terpinyl acetate (0.8%), Germacrene D (4.8%), cis-Muurola-4(14),5-diene (7.36%), α-Muurolene (1.9%), γ-Muurolene (1.1%), δ-Cadinene (1.2%), epi-α-Cadinol (0.6%), α-Cadinol (0.5%), Spathulenol (0.8%), Caryophyllene oxide (0.4%), β-Caryophyllene (1.6%), Bicyclogermacrene (1.3%), Humulene (0.5%), Globulol (0.4%), Viridiflorol (0.3%) (+ trace compounds <0.3%).	(Sedaghat *et al.*, 2011)
	Cones (Essential Oil)	α-Pinene (51.07%), Myrcene (17.92%), Limonene (9.66%), β-Pinene (4.92%), meta-Cymenene (2.60%), α-Terpineol (2.38%), δ-3-Carene (2.11%), Sabinene (1.84%), Terpinolene (1.20%) (+ minor sesquiterpenes <1%).	(Cherrad *et al.*, 2022)

	Bark	Phenolic compounds, tannins, resin acids, lignin derivatives, terpenoid residues, flavonoid-type compounds (qualitative identification via chemical characterization).	(Terzopoulou *et al*., 2022)
H. macrocarpa (syn. *Cupressus macrocarpa*)	Roots	D-(-)-Quinic acid, (-) -Shikimic acid, maleic acid, citraconic acid, procyanidin b2, urocanic acid, (-)-epicatechin, neohesperidin dihydrochalcone, dihydrokaempferol-3-o-α-l-rhamnoside, apigenin-7-o-neohesperidoside (rhoifolin), procyanidin c1, procyanidin b1, naringenin-7-o-glucoside (prunin), amentoflavone, astringin, isorhamnetin-3-o-rutinoside (narcissin), luteolin-7-o-glucoside, quercetin-3-d-xyloside, 5-methoxysalicylic acid, isorhamnetin-3-o-glucoside, ferulic acid, tetrahydro-4′ -o-methyl amentoflavone, apigenin-7-o-glucoside, acacetin-7-o-rutinoside, baicalein-7-o-glucuronide, kaempferol-3-glucuronide, quercetin, naringenin, sinapyl aldehyde, pentahydroxyflavan, isorhamnetin, hesperetin, apigenin, acacetin, esculin, luteolin, diosmetin, kaempferol-7-neohesperidoside, glycyrrhizate.	(Elmongy *et al*., 2022)
	Leaves/Branchlets	Terpinen-4-ol, α-Phellandrene, α-Citronellol, Citronellal, α-Pinene, Sabinene, p-Cymene, α-Terpineol, Elemol, β-Bisabolol, α-Terpinyl Acetate.	(Salem *et al*., 2018)
	Needles	Isocupressic acid.	(Buroni *et al*., 2020; Parton *et al*., 1996)
H. abramsiana (syn. *Cupressus abramsiana*)	Leaves	Terpinen-4-ol (12.8%), β-pinene (0.1%), Umbellulone (21.4%), Myrcene (2.5%), Camphene hydrate (0.5%), Sabinene (7.5%), α-terpinene (2.7%), Citronellol (1.3%), Nezukol (6.1%), p-Cymene (0.9%), Trans-piperitol (0.3%), Limonene (3.0%), α-pinene (1.3%), γ-terpinene (3.6%), Iso-nezukol (0.2%), α-terpineol (1.2%), Camphor (12.4%), Terpinolene (2.2%), Cis-p-menth-2-en-1-ol (0.9%), Bornyl acetate (0.3%), (E)-2-hexenal (0.4%), Manoyl oxide (0.7%), Isophyllocladene (0.5%), Thymol (0.1%), β-phellandrene (7.8%), Cryptone (0.2%), α-thujene (1.0%), Citronellal (0.2%), Trans-sabinene hydrate (0.4%), α-phellandrene (0.3%), Shisofuran (0.2%), Piperitone (0.3%), Pimara-9(11),15-diene (0.1%), 2-methyl nonanone (0.2%), Epi-α-bisabolol (0.2%), (E)-nerolidol (0.1%), Phyllocladene (0.1%), Rimuene (trace), Trans-ferruginol (trace), Sandaracopimarinal (0.1%), Iso-sandaracopimara-8(14),15-diene (0.2%), Epi-13-manoyl oxide (0.1%), Unknown (0.8%), Trans-totarol (trace), Thymol methyl ether (0.1%), Cis-piperitol (0.3%), Abietatriene (trace), β-bisabolene (0.1%), Isopimara-9(11),15-diene (0.1%), Diterpene (0.1%), Linalool (1.0%), α-terpinyl acetate (0.3%), Camphene (0.4%), Citronellyl acetate (0.1%), Sempervirol (0.1%), Pimaradiene (trace), Cis-sabinene hydrate (0.6%), Trans-p-menth-2-en-1-ol (0.4%).	(Adams *et al*., 2009)
H. bakeri (syn. *Cupressus bakeri*)	Leaves	Thujopsenol epoxide, cis-muurol-5-en-4β-ol, Bakerol, Mayurone epoxide, cis-muurola-3,5-diene, 2-(3-oxobutyl)-isomenthone, Thujopsadiene, cis-muurol-5-en-4α-ol, cis-14-normuurol-5-en-4-one, Mayurone, cis-muurola-4(14),5-diene, 2-Ethylisomenthone, Thujopsan-2α-ol.	(Cool *et al*., 1995)

H. benthamii (syn. *Cupressus benthamii*)	Leaves	tricyclene, α-thujene, α-pinene, α-fenchene, camphene, sabinene, β-pinene, myrcene, α-phellandrene, δ- 3-carene, α-terpinene, p-cymene, limonene, β-phellandrene, 1,8-cineole, (E)-β-ocimene, γ-terpinene, cis-sabinene hydrate, terpinolene, trans-sabinene hydrate, 2-nonanone, 2-nonanol, linalool, trans-thujone, cis-p-menth-2-en-1-ol, trans-p-menth-2-en-1-ol, trans-verbenol, camphor, camphene hydrate, umbellulone, terpinen-4-ol, naphthalene, p-cymen-8-ol, α-terpineol, cis-piperitol, shisofuran, trans-piperitol, verbenone, trans-carveol, citronellol, thymol methyl ether, carvone, carvacrol methyl ether, piperitone, linalool acetate, bornyl acetate, thymol, α-terpinyl acetate, (E,E)-decadienal, (2E,4E)-decadienol, longifolene, (E)-caryophyllene, cis-muurola-3,5-diene, α-humulene, cis-muurola-4(14),5-diene, α-muurolene, ar-curcumene, epi-zonarene, γ-cadinene, β-curcumene, endo-1-bourbonanol, trans-calamenene, δ-cadinene, 10-epi-cubebol, α-cadinene, elemol, cis-muurola-5-en-4-β-ol, cis-muurola-5-en-4-α-ol, dodecanoic acid, germacrene D-4-ol, caryophyllene oxide, β-oploponene, humulene epoxide II, 1,10-di-epi-cubenol, 1-epi-cubenol, α-acorenol, β-acorenol, epi-α-cadinol, epi-α-muurolol, α-muurolol, α-cadinol, germacra-4(15),5,10(14)-trien-1-α-ol, cis-14-nor-muurol-5-en-4-one, (E)-nuciferol, (E)-isoamyl cinnamate, (Z)-isoamyl cinnamate, pentenyl cinnamate, oplopanonyl acetate, isopimara-9(11),15-diene, pimara-8(9),15(16)-diene, isohibaene, sandaracopimara-8(14),15-diene, iso-pimara-8(14),15-diene, hexadecanoic acid, isophyllocladene.	Adams *et al.*, 2016; Adams *et al.*, 1997)
H. forbesii (syn. *Cupressus forbesii*)	Heartwood	β-Thujaplicin (Hinokitiol), γ-Thujaplicin, α-Thujaplicin, α-Thujaplicinol, β-Thujaplicinol, Hydronootkatinol, β-Dolabrin, α-Dolabrinol.	(Zavarin *et al.*, 1967)
H. glabra (syn. *Cupressus glabra*)	Leaves	cis-muurola-4(14),5-diene, umbellulone, α-pinene, limonene, β-phellandrene, cis-muurola-3,5-diene, cis-muurol-5-en-4-one, sabinene, epi-zonarene, α-acorenol, α-alaskene, γ-cadinene, trans-calamenene, δ-cadinene, italicene ether, cis-muurola-5-en-4-α-ol, 3-oxobutyl-isomenthone, β-acorenol, cadalene, cis-14-nor-muurol-5-en-4-one, oplopanonyl acetate, isohibaene, isophyllocladene, manoyl oxide, kaur-16-ene, nezukol.	(Adams *et al.*, 2010)
H. goveniana (syn. *Cupressus goveniana*)	Leaves	α-thujene, tricyclene, α-pinene, camphene, sabinene, β-pinene, myrcene, α-phellandrene, δ-3-carene, α-terpinene, p-cymene, limonene, β-phellandrene, γ-terpinene, terpinolene, 1,8-cineole, cis-sabinene hydrate, trans-sabinene hydrate, linalool, trans-thujone, camphor, terpinen-4-ol, α-terpineol, umbellulone, p-cymen-8-ol, verbenone, bornyl acetate, α-terpinyl acetate, (E)-caryophyllene, α-humulene, cis-muurola-3,5-diene, cis-muurola-4(14),5-diene, α-muurolene, γ-cadinene, δ-cadinene, epi-zonarene, trans-calamenene, caryophyllene oxide, humulene epoxide II, 1-epi-cubenol, α-cadinol, epi-α-cadinol, epi-α-muurolol, α-muurolol, elemol, manoyl oxide, kaur-16-ene, nezukol, and isophyllocladene.	(Adams *et al.*, 2009)
H. guadalupensis (syn. *Cupressus guadalupensis*)	Leaves	α-pinene, β-pinene, sabinene, myrcene, δ-3-carene, limonene, α-terpinene, γ-terpinene, terpinolene, p-cymene, terpinen-4-ol, α-terpineol, 1,8-cineole, bornyl acetate, (E)-caryophyllene, α-humulene, germacrene D, δ-cadinene, caryophyllene oxide, elemol.	(Pierre-Leandri *et al.*, 2003)

H. montana (syn. *Cupressus montana*)	Leaves	α-thujene, tricyclene, α-pinene, camphene, sabinene, β-pinene, myrcene, α-phellandrene, δ-3-carene, α-terpinene, p-cymene, limonene, β-phellandrene, (E)-β-ocimene, γ-terpinene, terpinolene, 1,8-cineole, cis-sabinene-hydrate, trans-sabinene-hydrate, terpin-4-ol (terpinen-4-ol), linalool, borneol, camphor, trans-thujone, cis-p-menth-2-en-1-ol, trans-p-menth-2-en-1-ol, α-terpineol, α-terpinyl acetate, bornyl acetate, p-cymen-8-ol, verbenone, umbellulone, p-cymene-oxide (p-cymen-8-ol), α-pinene oxide (trace entries), 2-nonanone, carvone, 2-nonanol, α-copaene, (E)-caryophyllene, β-caryophyllene, γ-muurolene, cis-muurola-4(14),5-diene, cis-muurola-3,5-diene, α-muurolene, epi-cubebol, 1-epi-cubenol, epi-zonarene, epi-α-muurolol, α-muurolol, α-cadinol, γ-cadinene, δ-cadinene, a-cadinol, a-cadinene, germacrene D-4-ol, germacrene D (and other germacrenes), amorpha-4,9-dien-2-ol, oplopenone, oplopanonyl acetate, manoyl oxide, nezukol, cis-14-nor-muurol-5-en-4-one, cadalene, longifolene (and other tricyclic sesquiterpenoids), endo-1-bourbonanol, iso-abienol (reported in related taxa; checked in table), α-acorenol, β-acorenol, β-acorenol derivatives, α-humulene, humulene epoxide II, caryophyllene oxide, elemol, trans-calamenene, 10-epi-cubebol, oplopanonyl derivatives.	(Adams *et al.*, 2014)
H. nevadensis (syn. *Cupressus nevadensis*	Resin/Heartwood	Imbricatolic acid (dihydroisocupressic acid), 15-hydroxyimbricatolal, imbricatolal derivatives, labdane-type diterpenoid acids.	(Gough *et al.*, 1970)
H. macnabiana (syn. *Cupressus macnabiana*)	Leaves	α-Pinene (18-32%), Sabinene (8-18%), β-Pinene (4-9%), Myrcene (2-6%), Limonene (3-7%), Camphene (1-3%), p-Cymene (1-3%), Terpinolene (2-5%), 1,8-Cineole (3-8%), Linalool (1-4%), Terpinen-4-ol (1-3%), α-Terpineol (1-3%), Bornyl acetate (1-4%), β-Caryophyllene (2-6%), Germacrene D (2-5%), α-Humulene (1-3%), δ-Cadinene (1-3%), Caryophyllene oxide (1-3%), Spathulenol (1-3%), Globulol (1-2%).	(Pierre-Leandri *et al.*, 2003)
H. sargentii (syn. *Cupressus sargentii*)	Leaves	α-pinene, β-pinene, sabinene, myrcene, δ-3-carene, limonene, camphene, p-cymene, terpinen-4-ol, α-terpineol, bornyl acetate, linalool.	(Lawrence *et al.*, 1975)
H. stephensonii (syn. *Cupressus stephensonii*)	Leaves	sabinene (9.9%), camphor (9.1%) and terpinen-4-ol (8.9%), α-pinene, limonene, β-phellandrene, α-cadinol and iso-abienol (2.6%).	(Adams *et al.*, 2014)
H. pygmaea (syn. *Cupressus pygmaea*)	Foliage/Leaf	α-pinene, β-pinene, sabinene, myrcene, δ-3-carene, limonene, p-cymene, camphene, α-terpinene, γ-terpinene, terpinolene, β-phellandrene, 1,8-cineole, terpinen-4-ol, linalool, α-terpineol, bornyl acetate, and other minor monoterpenes and sesquiterpenes.	(Adams *et al.*,2012; Zavarin *et al.*, 1971)

biological properties support its traditional uses (Djouahri *et al.*, 2013, Teke GN 2013). Many tests conducted in laboratories have demonstrated that components from plants and oils from them hold properties that fight germs, resist oxidation, reduce swelling, and kill cells, which supports their use in established folk medicine practices Soković *et al.*, 2010). In Kenya, people use the leaves and cones of this plant to treat difficulties with the liver, spleen, kidney, bladder, and also bones and joints. It looks like they have faith in it; has some antitumoral properties too, which is interesting. The basic extract of this plant is also used to treat cancer in Guatemala and Mexico. Also, recent studies on medicinal plants highlight the importance of bioactivity-guided assessment and the need to correlate traditional knowledge with experimental pharmacology prior to therapeutic translation (Frezza *et al.*, 2022). Scientific data on *H. lusitanica* (syn. *Cupressus lusitanica) is* still dispersed throughout several research fields, such as ethnobotany, chemistry, and pharmacology, despite the availability of phytochemical and biological studies. To assess its therapeutic potential and pinpoint research gaps, a methodical synthesis of the available data is necessary (Table 2). This review integrates ethnomedicinal knowledge with phytochemical and pharmacological evidence of (Tables 3 and 4) *H. lusitanica* (syn. *Cupressus lusitanica).*

Table 3: All Details regarding *Hesperocyparis lusitanica (syn. Cupressus lusitanica)*.

Species	Plant detail	Isolated/identified compound	Reference
Hesperocyparis lusitanica (syn. *Cupressus lusitanica*)	*Hesperocyparis lusitanica* (Mill.) Bartel, which is referred to as Mexican cypress, belongs to the genus *Cupressus*, that is, *Cupressus lusitanica*. *Hesperocyparis lusitanica* belongs to the order Pinales, and it is an important species of conifers widely cultivated in tropical and subtropical areas. This plant is an evergreen coniferous tree reaching 25-40 m in height, which has a conical shape with spreading branches. Its trunk is quite straight, and its diameter can reach 1 m. This conifer has reddish-brown, fibrous, and longitudinally fissured bark that peels off in narrow strips with age. Foliage of this species comprises scale-like leaves growing in opposite pairs and making up dense sprays. Each leaf reaches 2-5 mm in length and tightly adheres to the branchlet. Shoots of the plant are usually slender and sometimes quadrangular in their transverse section. Mexican cypress is a monoecious plant having both male and female cones on the same individual. Small cylindrical-shaped cones of the male plants grow up to 3-4 mm and contain pollen grains. Female cones are ovoid in shape and measure 10-20 mm across; they comprise 6-8 wooden scales. They ripen, turning brown from green color, and produce several winged seeds spread by wind. This species is indigenous to Mexico and Central America and mainly grows in mountains and subtropical forests at the height of 1200-3300 m above sea level. Because of its fast growth, high adaptability, and valuable timber, Mexican cypress was successfully acclimatized in such countries as India, Kenya, Ethiopia, New Zealand, and South America.	Leaves- α-pinene (15-40%), β-pinene (5-18%), sabinene (5-15%), limonene (3-12%), terpinen-4-ol (2-10%), δ-3-carene (3-20%), myrcene (2-8%), caryophyllene (1-5%). Cones- α-pinene (64.5%), followed by δ3-carene (6.5%), limonene (3.5%) and β-pinene (3.1%). Flowers- α-pinene (15.4%), followed by β-caryophyllene (9.6%), linalool (7.2%) and myrcene (6.0%).	(Frezza *et al*., 2022; Kamal *et al*., 202; Fogang *et al*., 202; Kuiate JR *et al*., 2006)
Hesperocyparis arizonica (syn. *Cupressus* arizonica)	*Hesperocyparis Arizonica* (Greene) Bartel, also referred to as Arizona cypress, is a drought-resistant evergreen conifer that belongs to the family Cupressaceae. This plant naturally grows in southeastern Arizona and northern Mexico, forming relatively small and isolated populations within mountainous and canyon habitats. These natural populations usually exist at medium to higher altitudes in semiarid areas where specific microclimates such as lower temperatures on slopes and availability of groundwater enable the growth of this conifer. This evergreen conifer normally forms a conical crown shape with flat horizontal branches and attains heights of approximately 10-25 m when grown in favorable conditions. The bark is initially light grey but gradually turns into dark brown and becomes grooved. Moreover, this tree bears tiny needle-like leaves, which grow in dense clumps resembling the typical green-gray color of foliage. On the other hand, seed cones are normally round and woody, reaching 2-3 cm in diameter with several thick scales that serve as protection for seeds before ripening. There are numerous health benefits from this plant due to the abundance of terpenoids and phenolic compounds in the leaves and buds of the species. Various studies have shown that plant extracts and essential oils have potent antioxidant and antibacterial properties against various pathogenic microorganisms. Essential oils have also demonstrated their larvicidal activity against mosquito vectors such as Anopheles mosquitoes. Furthermore, the extract has dermatological and anti-aging properties by suppressing enzymes such as collagenase, elastase, and tyrosine.	Leaves- α-Pinene (11.0%), Limonene (14.44%), Umbellulone (13.25%), Germacrene D (4.8%), cis-Muurola-4(14),5-diene (7.30%). Cones (Essential oil)- α-Pinene (51.07%), Myrcene (11.92%), Limonene (9.66%), β-Pinene (4.92%). Bark- Phenolic compounds, Tannins, Resin acids, lignan derivatives, Flavonoids.	(Sedaghat *et al*., 2011; Cherrad *et al*., 2022; Terzopoulou *et al*., 2022; Verrier *et al*., 2022;Hosseinihashemi *et al*., 2025; Tawfeek *et al*., 2023; Sedaghat *et al*., 2011)
Hesperocyparis macrocarpa (syn. *Cupressus macrocarpa*)	*Hesperocyparis macrocarpa* (Hartw.) Bartel, more commonly referred to as Monterey cypress, is an evergreen coniferous species within the Cupressaceae family. This type of tree is naturally found along California's coastal areas, especially the Monterey Peninsula, thriving under maritime climatic conditions. It is extensively grown globally as an ornamental and wind-resistant tree due to its resilience against strong winds, drought, and saline environments. Generally, it reaches a height of 20 to 30 m and boasts a broad, irregular canopy, which becomes more prominent in coastal areas. Its bark is robust and fibrous, showcasing a color range from grayish-brown to reddish-brown, and it forms deep fissures as it matures. The foliage on this species is short and scale-like, growing in dense clusters on slender branches. Crushing the leaves releases a characteristic fragrance. In terms of reproduction, this species produces small male cones for pollination and round female cones for seed production, all contributing to seed dispersal. Due to its ability to thrive in arid conditions, windy environments, and saline locations, it has been widely adopted by humans in these areas beyond its native range for decorative purposes and as wind barriers. Besides its ecological significance, this tree has also piqued the interest of scientists because of the various chemical compounds present in its parts. The Monterey cypress tree intrigues researchers due to its phytochemical constituents found in its leaves, branches, and oils, which seem to poss ess medicinal qualities. Studies indicate that extracts from this species can effectively combat various strains of bacteria. The terpenes or other aromatic compounds present in the essential oils of Hesperocyparis macrocarpa are thought to largely contribute to its antibacterial properties, particularly in addressing diarrhea, likely by moderating gastrointestinal motility and reducing fecal moisture levels in animals. These preliminary descriptive investigations suggest that the oils from the branches may also exhibit antimicrobial characteristics, highlighting their potential application in human medicine. Furthermore, the plant contains Isocupressic acid, a diterpenoid that has shown bioactive effects. Elevated levels of Isocupressic acid have been linked to reproductive complications and abortions in cattle after consuming substantial amounts of the plant's foliage. While the adverse impacts of Isocupressic acid on livestock have been noted, the presence of these active compounds in H. macrocarpa emphasizes its considerable potential for developing new natural medicinal products and the promise for further scientific exploration	Roots- Procyanidin B2, Procyanidin B1, Procyanidin C1, Epicatechin, Amentoflavone, Isorhamnetin, Quercetin, Naringenin, Hesperetin, Apigenin, Luteolin, Kaempferol, Ferulic acid. Leaves- α-Pinene, α-Phellandrene, Sabinene, p-Cymene, Terpinen-4-ol, α-Terpineol, Citronellol, Citronellal, β-Bisabolol. Needles- Isocupressic acid.	Kimberley *et al*., 2023; Adams *et al*., 2009; Elmongy *et al*., 2022; Salem *et al*., 2018; Buroni *et al*., 2020; Parton *et al*., 1996; Le *et al*., 2025; Farjon *et al*., 2005)

Hesperocyparis abramsiana (syn. *Cupressus abramsiana*)	*Hesperocyparis abramsiana* (C. B. Wolf), commonly known as the Santa Cruz cypress, is a rare conifer in the Cupressaceae family. Originally classified within the genus *Cupressus* as *Cupressus* abramsiana, subsequent morphological and genetic studies led to its transfer into the genus Hesperocyparis, which includes cypress species native to western North America. This species is naturally restricted to the Santa Cruz Mountains of California, where it occurs in small, isolated populations. Typically, *H. abramsiana* grows as a modestly sized tree with sturdy branches and dense, overlapping scale-like leaves. The foliage is tightly arranged on slender twigs, forming compact clusters. Like other members of Hesperocyparis, it produces woody seed cones that remain closed for extended periods, only opening in response to environmental triggers such as heat or fire, thereby ensuring seed dispersal in post-disturbance habitats. The reproductive biology of *H. abramsiana* is characterized by small male cones that seasonally release pollen, ensuring effective fertilization and continuation of the species. Ecologically, the plant demonstrates strong adaptability, thriving in scrubland and mixed evergreen woodlands. Its preference for welldrained soils and tolerance to mild, dry winters reflects resilience in semiarid and Mediterraneanlike ecosystems. From a phytochemical standpoint, the species has attracted research interest due to the composition of its leaf essential oils. Studies reveal populationspecific variation in terpenoid profiles, which has contributed to refining the taxonomy of Hesperocyparis. These essential oils are abundant in volatile compounds, many of which are recognized for antimicrobial and bioactive properties. Genetic investigations using ISSR markers, combined with terpene profiling, highlight significant chemical diversity among populations. This diversity is interpreted as adaptive variation, shaped by ecological pressures and evolutionary processes. Although direct pharmacological evaluations of *H. abramsiana* remain limited, the presence of monoterpenes and other terpenoids is noteworthy. Within Cupressaceae, such compounds are well documented for antibacterial, antifungal, and antioxidant activities. Consequently, the high terpene content of *H. abramsiana* underscores its potential as a valuable source of bioactive molecules, offering scope for future phytochemical and medicinal research.	Leaves- Umbellulone (21.4%), Terpinen-4-ol (12.8%0, Camphor (12.4%), β-phellandrene (7.8%), sabinene (7.5%), Nezukol (6.1%).	(Adams *et al*., 2009;, Adams *et al*., 2009; Adams *et al*., 2009; Milich *et al*., 2012)
Hesperocyparis bakeri (syn. *Cupressus bakeri*)	*Hesperocyparis bakeri* (Jeps.), commonly referred to as Baker cypress, is an evergreen conifer of the Cupressaceae family. Its natural distribution is confined to western North America, particularly northern California and southwestern Oregon, where it occurs in scattered populations across mountainous regions such as the Cascade Range and the Klamath Mountains. The species typically inhabits elevations between 900 and 2100 m, favoring nutrientdeficient soils derived from serpentine and volcanic substrates. These harsh edaphic conditions limit competition from other vegetation and explain its restricted range. Morphologically, Baker cypress develops into a mediumsized tree with a narrow, conical crown and a straight central trunk, attaining heights of 10-25 m. The bark is thin, fibrous, and variable in color from reddishbrown to gray, often peeling in strips with age. Its foliage comprises small, scalelike leaves arranged in opposite pairs along slender twigs, resinous and aromatic, consistent with traits of Cupressaceae. Reproductive structures include small pollen cones and woody seed cones, generally spherical and composed of several thick scales. Ecologically, the species is distinguished by its dependence on fire for regeneration. The cones are serotinous, remaining closed for prolonged periods and opening primarily in response to wildfire heat, which facilitates seed release and colonization of burned sites. However, regeneration is often constrained by limited seed dispersal and the isolation of populations, restricting successful establishment of new individuals. Unlike certain other cypress species, Baker cypress lacks documented ethnomedicinal applications. Its rarity, fragmented distribution, and occurrence in remote habitats likely minimized its interaction with indigenous communities, resulting in the absence of recorded traditional uses. Consequently, scientific research has concentrated on its ecology, population dynamics, and conservation challenges. Current studies emphasize its vulnerability to habitat fragmentation, dispersal limitations, and the urgent need for conservation strategies to ensure longterm survival.	Leaves- Thujopsenol epoxide, cis-muurol-5-en-4β-ol, Bakerol, Mayurone epoxide, cis-muurola-3,5-diene, 2-(3-oxobutyl)-isomenthone.	(Cool *et al*., 1995; Bower *et al*., 2017; McNamara *et al*., 2019; Sholl *et al*., 2023)
Hesperocyparis benthamii (syn. *Cupressus benthamii*)	*Hesperocyparis benthamii*, earlier classified as *Cupressus* benthamii Endl., is an evergreen conifer belonging to the Cupressaceae family and native to the high mountain regions of Mexico. The species was first described by Stephan Endlicher in 1847 and is now recognized as part of the New World cypress group, a placement supported by both morphological traits and phylogenetic evidence. It is distinguished by its conical growth habit, evergreen scalelike leaves arranged in opposite pairs, and rounded woody cones that generally require two years to mature. Chemotaxonomic studies and essential oil analyses have revealed close genetic affinities between *H. benthamii* and related species such as *Cupressus* arizonica and *Cupressus lusitanica*. Comparative investigations of terpene composition have further reinforced its classification within Cupressaceae, providing valuable insights into evolutionary relationships across the genus. Systematic documentation of its taxonomy, morphology, and latitudinal distribution has been extensively contributed by Aljos Farjon, whose work on global conifer diversity has clarified the placement and significance of *H. benthamii*. Collectively, these studies highlight the importance of integrating morphological, chemical, and molecular data in understanding the evolutionary history and classification of Cupressaceae.	Leaves- α-pinene, sabinene, β-pinene, myrcene, α-phellandrene, β-phellandrene, limonene, γ-terpinene, terpinen-4-ol, camphor, umbellulone, linalool, p-cymene, (E)-caryophyllene, α-humulene.	(Adams *et al*., 1997; Adams *et al*., 1997; Farjon *et al*., 2005)

Hesperocyparis forbesii (syn. *Cupressus forbesii*)	*Hesperocyparis forbesii* (Jeps.) Bartel, commonly known as Tecate cypress, is a rare evergreen conifer belonging to the Cupressaceae family. Its natural distribution is restricted to southwestern California (United States) and northwestern Baja California (Mexico). The species typically inhabits chaparral and montane woodland ecosystems at elevations between 450 and 1500 m, exhibiting notable resilience in fireprone landscapes. Morphologically, it grows as a small to mediumsized tree, often multistemmed, reaching up to 10 m in height. The bark is reddishbrown, smooth, and exfoliates in thin layers, while the foliage consists of aromatic, scalelike leaves. Reproductive structures include woody, spherical cones measuring 20-32 mm, which remain closed until exposed to fire, thereby ensuring regeneration after disturbance. Ecologically, Tecate cypress plays a significant role in maintaining biodiversity within chaparral habitats. Its serotinous cones highlight a strong adaptation to wildfire regimes, positioning the species as a keystone element in postfire succession. Although direct phytochemical studies on *H. forbesii* are limited, related members of the genus are known to contain terpenoids, flavonoids, and phenolic compounds, suggesting potential medicinal relevance. Due to its restricted distribution, fragmented populations, and vulnerability to environmental threats, H. forbesii is considered a species of conservation concern. Current research emphasizes the need for targeted conservation strategies to mitigate habitat fragmentation, enhance regeneration success, and safeguard the longterm survival of this rare conifer.	Heartwood- β-Thujaplicin (Hinokitiol), γ-Thujaplicin, α-Thujaplicin, α-Thujaplicinol, β-Thujaplicinol, Hydronootkatinol, β-Dolabrin, α-Dolabrinol.	(Adams *et al*., 2009; Little *et al*., 2006; Cherrad *et al*., 2022)
Hesperocyparis glabra (syn. *Cupressus glabra*)	*Hesperocyparis glabra* (Sudw.) Bartel, also referred to as *Cupressus* glabra, is an evergreen conifer of the Cupressaceae family native to the southwestern United States and northern Mexico. It thrives in semiarid habitats, particularly mountainous regions, valleys, and rocky slopes. The species typically matures into a mediumsized tree, attaining heights of 10-20 m, and is distinguished by its narrow or irregular crown. The bark is smooth, reddish to gray in color, exfoliating in thin scales, which contrasts with the thicker, fibrous bark observed in other cypress species. The branches are slender and aromatic, while the foliage consists of bluishgreen, scalelike leaves tightly arranged and often covered with a glaucous coating. Reproductive structures include spherical woody cones measuring 2-3 cm in diameter, composed of 6-8 scales, along with smaller pollen cones that appear seasonally. The seed cones may exhibit serotiny, remaining closed until exposed to heat or fire, an adaptation that supports regeneration in fireprone ecosystems.	Leaves- Umbellulone, α-pinene, limonene, β-phellandrene, sabinene, cis-muurola-4(14),5-diene, cis-muurola-3,5-diene, γ-cadinene, δ-cadinene, trans-calamenene.	(Adams *et al*., 1997; Raddi *et al*., 2014)
Hesperocyparis goveniana (syn. *Cupressus goveniana*)	*Hesperocyparis goveniana*, commonly known as Gowen Cypress, is a rare conifer belonging to the Cupressaceae family and is endemic to the Monterey Peninsula of California. It occurs in small, fragmented populations on sandy soils and coastal ridges, often under nutrientpoor conditions. The species demonstrates considerable variation in growth habit: in unfavorable soils it may persist as a shrub less than 1 m tall, whereas in richer sites it can develop into a tree 20-25 m high with a conical crown. Morphologically, the bark is fibrous and reddishbrown, while the foliage consists of scalelike leaves measuring 2-5 mm in length, borne on rounded shoots. Seed cones are globose to oblong, ranging from 11-22 mm, and composed of 6-10 woody scales. These cones remain closed for extended periods and typically open only after wildfire, releasing seeds adapted to germinate on bare ground. Male cones are smaller, about 3-5 mm, and shed pollen from late winter into early spring. Taxonomically, *H. goveniana* is distinguished from related cypresses by its smaller cones compared to H. macrocarpa (Monterey Cypress) and its darker seeds relative to *H. abramsiana* (Santa Cruz Cypress). Its restricted distribution, dependence on fire for regeneration, and ongoing habitat pressures have led to its classification as an endangered species. Conservation efforts are therefore critical to ensure the persistence of this rare conifer in its native coastal ecosystem.	Leaves- α-pinene, sabinene, β-pinene, myrcene, α-phellandrene, limonene, β-phellandrene, γ-terpinene, 1,8-cineole, camphor, terpinen-4-ol, α-terpineol, umbellulone, (E)-caryophyllene, α-humulene, γ-cadinene, δ-cadinene.	(Adams *et al*., 2009; Rodríguez-Ramírez *et al*., 2020; Terry *et al*., 2015; Neale *et al*., 2019; Mao *et al*., 2019)

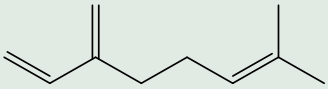
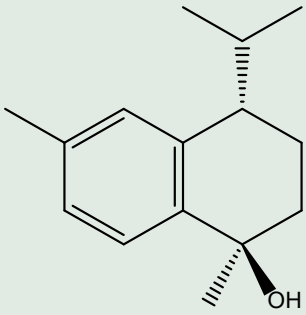
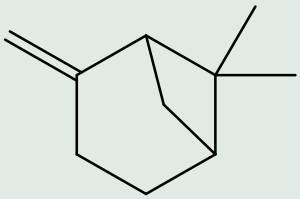
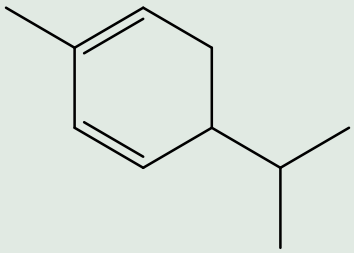
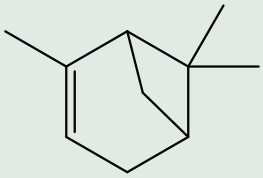
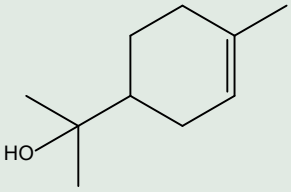
Hesperocyparis guadalupensis (syn. *Cupressus guadalupensis*)	*Hesperocyparis guadalupensis* (S. Watson) Bartel, commonly known as Guadalupe Cypress, is a rare evergreen conifer of the Cupressaceae family, strictly endemic to Guadalupe Island in the Pacific Ocean off Baja California, Mexico. The species was first described in 1879 by Sereno Watson as *Cupressus* guadalupensis from specimens collected by Edward Palmer in 1875 and later reassigned to the genus Hesperocyparis by Adams, Bartel, and Price in 2009. Over time, it has also been referred to under several synonyms, including Callitropsis guadalupensis, *Cupressus* macrocarpa var. guadalupensis, and Neo*Cupressus* guadalupensis. In its native habitat, *H. guadalupensis* occupies the central highland "sky island" zone of Guadalupe Island, thriving on rocky slopes and coastal ridges under a Mediterraneantype climate. The northern portion of the island, where most populations occur, receives approximately 250 mm of rainfall annually, supplemented by persistent coastal fogs that enhance moisture availability. It grows in association with other rare endemics such as *Quercus tomentella*, *Juniperus californica*, and the native palm *Brahea edulis*. Morphologically, the species forms large shrubs or trees typically 15-20 m tall, with some individuals reaching up to 20 m in height and 50 cm in diameter. The trunk is often short and forked, producing multiple stems, while the crown varies from narrow and upright in younger trees to broad and irregular in mature specimens. The bark is smooth, reddishbrown, exfoliating in thin, curling strips, and revealing darker underbark. The foliage is finetextured, glaucous, and bluishgreen, with scalelike leaves borne on slender, rounded branchlets, finer than those of the Arizona cypress. Reproductive structures include numerous pollen cones, solitary and terminal, measuring 5-7 × 2-3 mm with 16-20 microsporophylls, which shed pollen from late winter to early spring. Seed cones develop over two growing seasons, often in clusters of up to 20. At maturity, they are globose, 30-45 mm in diameter, dull brown to gray, and composed of 8-10 woody scales. The cones are serotinous, remaining closed for years and opening in response to fire or extreme desiccation, thereby ensuring regeneration in disturbed habitats. Each cone may contain up to 120 seeds, which are flattened, dark brown with a lighter hilum, and bear two narrow wings. Seeds are relatively heavy compared to other North American cypresses, with about 55,000 seeds per kilogram. Cone opening is regulated by water content in the scales rather than resin melting, allowing desiccated cones to open even at low temperatures. Taxonomically, *H. guadalupensis* is distinguished from its close relative *H. forbesii* (Tecate Cypress) by its larger growth form, glaucous bluish foliage, and seeds with a waxy bloom, in contrast to the shiny seeds of *H. forbesii*. Molecular studies confirm the two as distinct but closely related species, with *H. guadalupensis* showing slightly greater affinity to *H. stephensonii*.	Leaves- α-pinene, β-pinene, sabinene, myrcene, δ-3-carene, limonene, α-terpinene, γ-terpinene, terpinolene, p-cymene, terpinen-4-ol, α-terpineol, 1,8-cineole, bornyl acetate, (E)-caryophyllene, α-humulene, germacrene D, δ-cadinene, caryophyllene oxide, elemol.	(Adams *et al*., 2009; Pierre-Leandri *et al*., 2003; Farjon *et al*., 2010; Farjon *et al*., 2013; de la Luz *et al*., 2019; Pierre-Leandri *et al*., 2003)
Hesperocyparis macnabiana (syn. *Cupressus macnabiana*)	*Hesperocyparis macnabiana* (A. Murray bis) Bartel, commonly known as MacNab cypress or Shasta cypress, is an evergreen conifer of the Cupressaceae family, endemic to northern California. The species was originally described in 1855 by Andrew Murray as *Cupressus* macnabiana and later reassigned to the genus Hesperocyparis by Jim A. Bartel in 2009. Among California's native cypresses, the MacNab cypress is the most widespread and abundant, with more than 30 groves distributed across the inner North Coast Ranges, the Sierra Nevada foothills, and the Cascade Range. It thrives on ultramafic (serpentine) and volcanic soils, occupying chaparral, oak woodlands, and coniferous forest habitats within the temperate biome. Morphologically, the species develops into large shrubs or small trees up to 15 m tall and 100 cm in diameter. The trunk is typically short and forks near the base, producing numerous long, slender branches that form a broad, rounded crown often wider than the tree's height. Its foliage is distinctive, appearing in dense, flat sprays of glaucous graygreen leaves with a strong resinous aroma. The scalelike leaves measure 1-2 mm, with pointed tips and a conspicuous resin gland at the center. Pollen cones, 3-4 mm long, are shed in autumn, making it one of the earliest pollinating cypresses. Seed cones are globose to ovoid, serotinous, and remain closed until opened by fire or desiccation. Cone maturation requires two growing seasons, and reproductive maturity begins between 6 and 14 years of age. Fire plays a critical role in regeneration, as cone opening releases large numbers of seeds that establish dense thickets on bare mineral soil. Seedlings are intolerant of shade and thrive in full sunlight. Successful regeneration requires fire intervals of at least 15 years to allow cone crops to mature, whereas prolonged fire suppression can lead to cone senescence and reproductive failure. In the inner North Coast Ranges, *H. macnabiana* is known to hybridize with *H. sargentii*, representing one of the few natural hybrids within the genus. Molecular genetic studies place *H. macnabiana* as sister to a clade that includes Arizonarelated Hesperocyparis species and those distributed south of 35°N latitude. Unlike many other California cypresses, MacNab Cypress holds no special federal conservation status and is considered the least threatened, although localized populations remain vulnerable to altered fire regimes.	Leaves- α-pinene (18-32%), sabinene (8-18%), β-pinene (4-9%), limonene (3-7%), 1,8-cineole (3-8%), β-caryophyllene (2-6%), germacrene D (2-5%), terpinolene (2-5%).	(Adams *et al*., 2009; Pierre-Leandri *et al*., 2003; Terry *et al*., 2016; Safford *et al*., 2017)

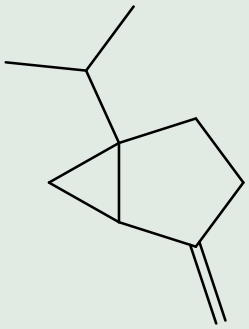
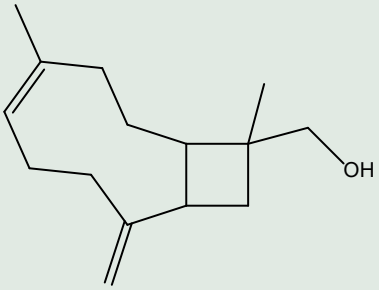
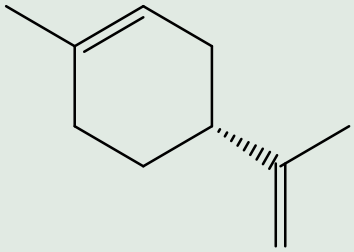
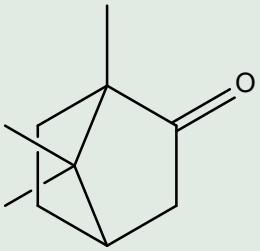
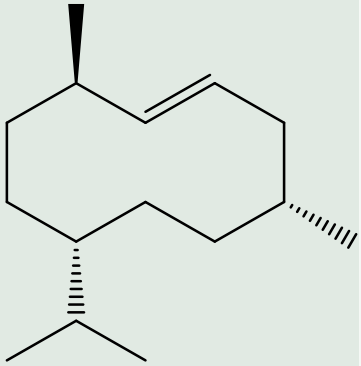
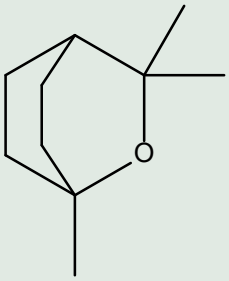
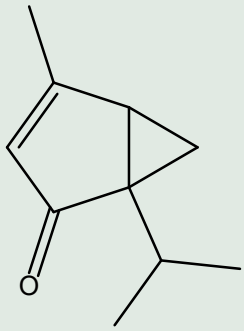
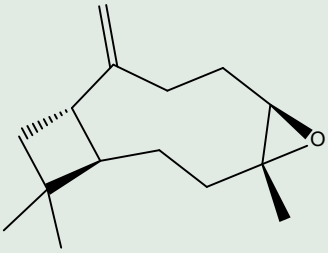
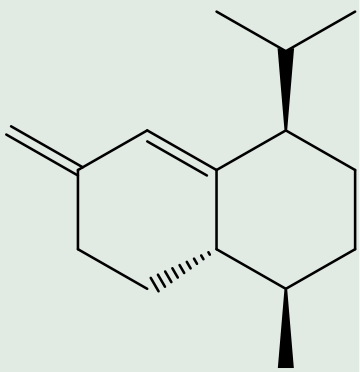
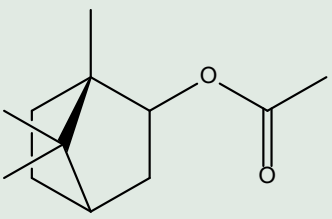
Hesperocyparis montana (syn. *Cupressus montana*)	*Hesperocyparis montana* (Wiggins) Bartel, also known as the San Pedro Mártir cypress, is an evergreen conifer of the Cupressaceae family, restricted to the Sierra de San Pedro Mártir in Baja California Norte, northwestern Mexico. The species was first described in 1933 by Ira Wiggins as *Cupressus* montana and later reclassified into Hesperocyparis by Adams, Bartel, and Price in 2009. For a period, Elbert Little (1966) treated it as a variety of *Cupressus* arizonica, but subsequent molecular and phytochemical studies confirmed its distinct species status. Synonyms include Callitropsis montana and *Cupressus arizonica* var. *montana*. Ecologically, *H. montana* grows at elevations between 1,900 and 2,825 m in montane coniferous forests, typically on dry rocky slopes. Although its distribution within the Sierra is relatively broad, populations remain sparse. Phylogenetically, the species belongs to the Arizona-Mexico clade of Hesperocyparis, closely related to *H. revealiana* and showing affinities with H. arizonica, H. forbesii, and H. stephensonii. Morphologically, trees range from 5 to 20 m in height, with trunks 20-50 cm in diameter, occasionally reaching 100 cm. Branches are numerous and spreading, with slightly ascending tips forming an open to compact pyramidal crown. Mature trunks display ridged, shredding bark in deep red to chocolate brown, while younger branches exhibit graybrown bark exfoliating in patches to reveal smooth reddish underbark. Leaves are scalelike, measuring 1-1.5 × 1.5-2 mm when young, with conspicuous resin glands, and up to 3-4 × 5 mm in older foliage, sometimes showing fringed margins under magnification. Seed cones are borne on peduncles up to 10 mm long, globose to ovoid, reaching 30 mm in diameter, with 8-12 scales and crescentshaped umbos. At maturity, cones are brown to graybrown and shed seeds in October. Unlike most Hesperocyparis species, the cones of H. montana are not serotinous; they open naturally at maturity. Each cone releases 60-70 light tan seeds, thin and flattened, with a small hilum. Conservation assessments list H. montana as Critically Endangered (IUCN, 2013), based on its very limited range of approximately 46 km^2 and a population estimated at fewer than 250 mature individuals. The primary threat is uncontrolled livestock grazing, which damages seedlings and prevents regeneration. With little formal protection across its habitat, urgent conservation measures are required to safeguard the survival of this rare conifer.	Leaves- α-pinene, sabinene, β-pinene, myrcene, α-phellandrene, δ-3-carene, limonene, β-phellandrene, γ-terpinene, terpinolene, 1,8-cineole, terpinen-4-ol, linalool, camphor, α-terpineol, bornyl acetate, α-terpinyl acetate, umbellulone, (E)-caryophyllene, β-caryophyllene, germacrene D, γ-cadinene, δ-cadinene.	(Adams *et al*., 2009; Adams *et al*., 2014; Terry *et al*., 2016; Farjon *et al*., 2013)
Hesperocyparis nevadensis (syn. *Cupressus nevadensis*)	*Hesperocyparis nevadensis* (Abrams) Bartel, commonly known as Paiute Cypress, is a rare evergreen conifer of the Cupressaceae family, restricted to a small area in the southern Sierra Nevada of California, USA. Initially described as *Cupressus* nevadensis, the species was reassigned to Hesperocyparis by Adams, Bartel, and Price in 2009. Some taxonomists have considered it part of the *Cupressus* arizonica complex, and synonyms include Callitropsis nevadensis and Neo *Cupressus* nevadensis. Its distribution is limited to Kern and Tulare Counties, where it grows on granitic soils at elevations between 910 and 1,830 m. The largest population occurs south of Bodfish in the Lake Isabella region, with smaller scattered stands elsewhere in the southern Sierra Nevada. It inhabits diverse communities, including pinyon-juniper woodlands, oak-pine forests, chaparral, and closedcone cypress stands. Morphologically, Paiute Cypress is a mediumsized tree with a conical crown, typically reaching 10-25 m in height, though exceptional specimens may attain 39 m. Trunks are usually up to 0.5 m in diameter, occasionally reaching 1 meter. Young trees are slender, developing into broad pyramidal crowns with age. Bark is reddishbrown in youth, sometimes exfoliating, and becomes fibrous and graybrown with maturity, often showing cherryred tones. Foliage is sparse but highly aromatic, ranging from dull graygreen to bluishgreen, with scalelike leaves 2-5 mm long, resinous, and borne on rounded shoots. Seed cones are globose to oblong, 25-55 mm long, with 6-8 scales (occasionally 4 or 10). They mature to graybrown within 20-24 months and are serotinous, remaining closed for years until opened by fire or extreme heat. As an obligate seeder, H. nevadensis depends on fire for regeneration, requiring sufficient intervals between burns to reach reproductive maturity. Fire suppression disrupts seedbed preparation and cone opening, while overly frequent fires risk eliminating populations before cones can produce viable seed. Conservation assessments list the Paiute cypress as endangered under the IUCN, due to its restricted range, reliance on fire for reproduction, altered fire regimes, and additional threats from mining and grazing. It is also recognized as a rare, threatened, or endangered species under California law. Taxonomically, it belongs to the California clade of Hesperocyparis and is considered the sister species to H. sargentii.	Resin/Heartwood-Imbricatolic acid (dihydroisocupressic acid), 15-hydroxyimbricatolal, imbricatolal derivatives, labdane-type diterpenoid acids.	(Adams *et al*., 2009; Kuiate JR *et al*., 2006; Gough *et al*., 1970)

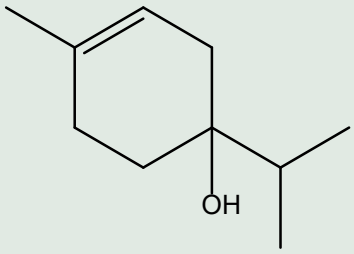
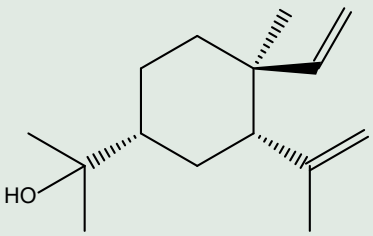
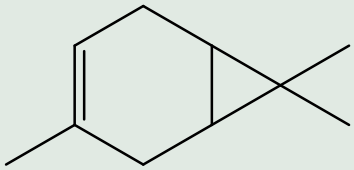
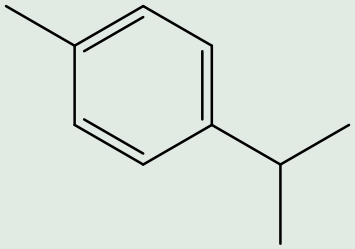
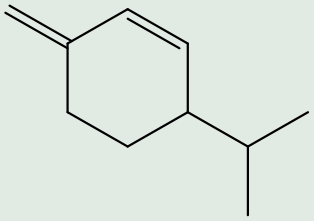
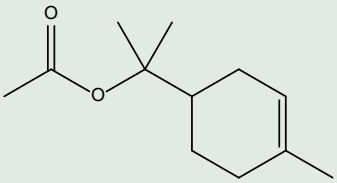
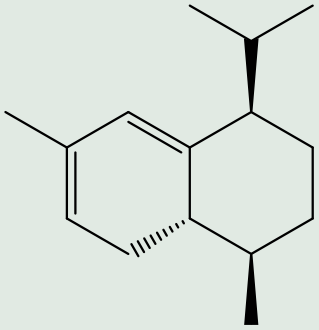
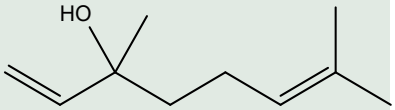
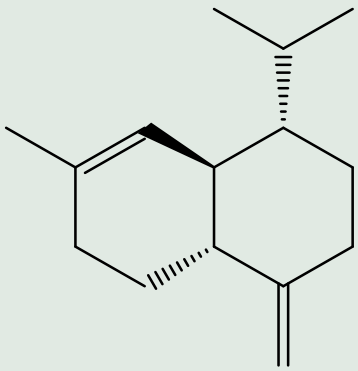
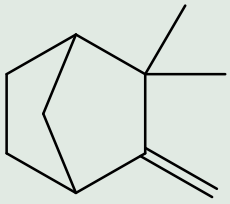
Hesperocyparis pygmaea (syn. *Cupressus pygmaea*)	*Hesperocyparis pygmaea* (Lemmon) Bartel, commonly referred to as Mendocino Cypress or Pygmy Cypress, is a distinctive conifer in the Cupressaceae family, endemic to the coastal terraces of Mendocino County, Northern California. First described in 1895 by J.G. Lemmon as *Cupressus* pygmaea, it was long considered a subspecies or variety of Hesperocyparis goveniana (Gowen Cypress). However, modern taxonomic authorities such as Plants of the World Online, World Flora Online, and the Gymnosperm Database now recognize it as a separate species. Bartel formally transferred it to Hesperocyparis in 2009. Synonyms include *Cupressus* pygmaea (Lemmon) Sarg., Callitropsis pygmaea, and *Cupressus* goveniana ssp. pygmaea. Its distribution is confined to a discontinuous strip of coastal terraces, generally below 500 m elevation, where it grows on highly acidic, nutrient-poor podzol soils underlain by an iron hardpan. This unique environment forms the well-known Mendocino pygmy forest, where the species often occurs alongside bishop pine (*Pinus muricata*) and Mendocino shore pine (Pinus contorta var. bolanderi). It can also be found on deeper, better-drained soils adjacent to the pygmy zone. *H. pygmaea* exhibits remarkable plasticity in growth form, largely determined by soil conditions. On the shallow hardpan soils of the pygmy forest, it remains a dwarf shrub, maturing at heights of only 0.2-5 m, sometimes producing cones when just 20 cm tall. On deeper soils nearby, however, it can grow into a large tree 30-50 m tall with trunk diameters of 1-2.4 m. The largest recorded specimen in Mendocino County measured 43 m tall, 2.13 m in diameter, with a crown spread of 12 m. Mature trees typically have pyramidal crowns with a slender, whip-like leader. Bark is dark gray-brown, fibrous, and fissured with age. Branchlets are decussate, 1-1.5 mm thick, bearing scale-like leaves that lack or only faintly show the resin glands typical of related species. The foliage of Hesperocyparis pygmaea is darker green compared to that of H. goveniana, a key distinguishing trait in cultivation. Seed cones are nearly spherical and serotinous, remaining closed until fire triggers seed release onto bare mineral soil. Cone production is abundant even in dwarf forms, though relatively rare in young, vigorous trees. Pollen cones typically appear in cultivation at 6-7 years of age. A notable taxonomic distinction between *H. pygmaea* and *H. goveniana* lies in seed morphology: H. pygmaea produces glossy black seeds, whereas *H. goveniana* bears dull brown seeds. However, this difference is less consistent in southern populations, where seed coloration may vary. The IUCN currently treats *H. pygmaea* as an ecotype of H. goveniana, listing the combined taxa as endangered. Considered independently, *H. pygmaea* is regarded as even more vulnerable, facing threats from habitat loss due to agriculture and urban expansion (estimated at 20-44% reduction of pygmy forest), altered fire regimes, and competition from invasive species.	Leaves- α-pinene, β-pinene, sabinene, myrcene, δ-3-carene, limonene, p-cymene, camphene, α-terpinene, γ-terpinene, terpinolene, β-phellandrene, 1,8-cineole, terpinen-4-ol, linalool, α-terpineol, bornyl acetate.	(Adams *et al*., 2009; Adams *et al*., 2014; Adams *et al*., 2012; Zavarin *et al*., 1971; Terry *et al*., 2016)
Hesperocyparis sargentii (syn. *Cupressus sargentii*)	*Hesperocyparis sargentii* (Jeps.) Bartel, known as Sargent cypress, is an evergreen conifer in the Cupressaceae family, native to California. It was first described in 1909 by Willis Linn Jepson as *Cupressus* sargentii, based on specimens collected in the Mayacamas Mountains of northern California. The species name honors Charles Sprague Sargent (1841-1927), founding director of Harvard's Arnold Arboretum. In 2009, Bartel transferred the species to Hesperocyparis. Synonyms include Callitropsis sargentii, *Cupressus* sargentii, and Neocupressus sargentii. Sargent cypress is the second most widespread cypress in California, with two main population centers: one in the San Francisco Bay area and southern North Coast Ranges (extending from northern Mendocino County south through Lake, Napa, and Marin Counties), and another in the Santa Lucia Mountains of Monterey and San Luis Obispo Counties. All populations are closely tied to serpentine soils, occurring in chaparral, foothill woodlands, and lower montane forests between 200 and 1,100 m elevation. In the northern range, it often grows alongside H. macnabiana, occupying lower slopes and ravines while H. macnabiana favors upper slopes. Genetic differences have been documented between the northern and southern populations. Morphologically, H. sargentii can reach 25 m in height but is frequently shrubby, under 10 m tall, with crowns broader than their height or columnar when young, becoming rounded with age. The bark is rough, fibrous, and furrowed. Branchlets are decussate, 1.5-2.5 mm thick. Leaves are usually without prominent resin glands, sometimes showing shallow abaxial pits, and often glaucous, giving the foliage a dusty gray-green appearance. In spring, heavy pollen cone production can turn the tree yellow. Pollen cones measure 3-4 × 2 mm with 3-4 pollen sacs, and trees begin producing cones as early as five to six years old. Seed cones are globose, 2-2.5 cm in diameter, brown or gray, with 3-4 pairs of scales bearing scattered resin blisters and small to moderately raised umbos. Seeds are 4-6 mm long, dark brown, and faintly to strongly glaucous. The cones are serotinous, persisting for eight or more years and opening irregularly under normal conditions but rapidly and uniformly when exposed to fire. Seeds fall onto bare mineral soil, with most dispersal occurring in the months following fire. H. sargentii is strongly fire-adapted, with slightly fire-resistant bark, and successful reproduction is largely confined to burned sites. Fire intervals must exceed seven years to allow cone crops to mature, but suppression of fire threatens regeneration, while overly frequent fires can prevent cone development and eliminate populations. Although *H. sargentii* has no special federal conservation status, it is considered sensitive in parts of its range due to its dependence on fire and localized threats to habitat.	Leaves- α-pinene, β-pinene, sabinene, myrcene, δ-3-carene, limonene, camphene, p-cymene, terpinen-4-ol, α-terpineol, bornyl acetate, linalool.	(Adams *et al*., 2009; Lawrence *et al*., 1975; Terry *et al*., 2016; Bartel *et al*., 2003)

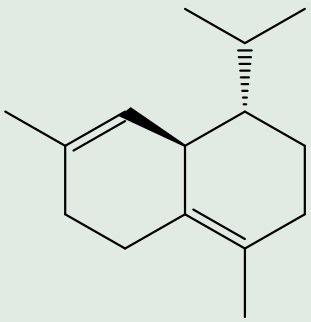
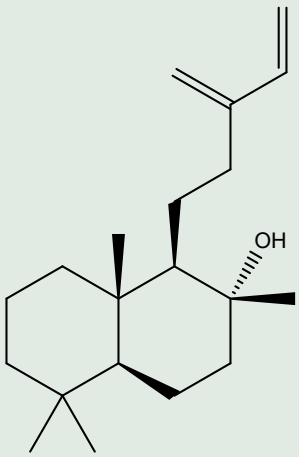
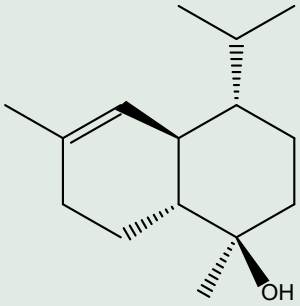
Hesperocyparis stephensonii (syn. *Cupressus stephensonii*)	*Hesperocyparis stephensonii* (C.B. Wolf) Bartel, known as the Cuyamaca cypress, is one of the rarest conifers globally, belonging to the Cupressaceae family and confined to a single locality in southern California. The species was first formally described in 1948 by Carl Brandt Wolf as *Cupressus* stephensonii, based on specimens collected in 1938 from King Creek in the Cuyamaca Mountains of San Diego County. It was named in honor of U.S. Forest Service Ranger J. Burt Stephenson, who first noted the trees. In 2009, Bartel transferred the species to Hesperocyparis, and this classification is recognized by Plants of the World Online, World Flora Online, and the USDA PLANTS database. Synonyms include "*Cupressus* stephensonii" and "*Cupressus* arizonica var." stephensonii, *Cupressus* arizonica subsp. stephensonii, and Callitropsis stephensonii. Its distribution is restricted to the headwaters of King Creek, south of Cuyamaca Peak in the Peninsular Ranges of San Diego County, where it grows in chaparral, cismontane woodland, closed-cone coniferous forest, and riparian habitats at elevations of 1,035-1,705 m. Most individuals occur within the King Creek Research Natural Area of the Cleveland National Forest. A possible second population in Baja California has been mentioned but remains poorly documented. Morphologically, *H. stephensonii* forms trees 10-16 m tall with crowns spreading up to 10 m and trunks reaching 70 cm in diameter. The bark is thin, smooth, and strikingly colored-cherry-red, pink, or pure white-exfoliating in strips, unlike the rough, fibrous bark of related species such as H. montana. Branchlets are quadrangular, 10-20 mm long, with scale-like leaves 1 × 1 mm when young, bearing resin glands, and up to 4 × 10 mm when mature. Seed cones are about 10 mm in diameter, with 6-8 scales bearing prominent conical umbos, and typically contain 100-125 seeds. *Hesperocyparis stephensonii*, commonly known as the Cuyamaca Cypress, is a rare evergreen conifer of the Cupressaceae family, restricted to a single locality in southern California. The species is distinguished by its serotinous cones, which open under fire to release seeds onto bare mineral soil. A unique reproductive trait is its pollen phenology: unlike other California cypresses that shed pollen in autumn or winter-spring, H. stephensonii is the only species that disperses pollen during summer. Historically, the species has endured several major fire events, including those in 1950, 1970, and 2003. The Cedar Fire of 2003 was particularly devastating, reducing the population from approximately 1,000 individuals to only 30-40 survivors. Although regeneration has occurred from serotinous cones, the population remains critically vulnerable due to its extreme restriction to a single site and the severe bottleneck caused by the 2003 fire. Conservation assessments list *H. stephensonii* as critically endangered under the IUCN Red List and as a Rank 1B.1 species by the California Native Plant Society, indicating it is seriously threatened. Its dependence on fire for regeneration, combined with altered fire regimes and limited population size, make it one of the most imperiled conifers in North America. Urgent conservation measures, including habitat protection, fire management, and *ex situ* propagation, are essential to safeguard its survival.	Leaves- sabinene (9.9%), camphor (9.1%) and terpinen-4-ol (8.9%), α-pinene, limonene, β-phellandrene, α-cadinol and iso-abienol (2.6%).	(Adams *et al.*, 2009; Little *et al.*, 2006; Adams *et al.*, 2010; Farjon *et al.*, 2013)

Table 4: Structures of all species of *Hesperocyparis lusitanica* (syn. *Cupressus lusitanica*).

Compound Name	Structure	Compound Name	Structure
Myrcene		trans-Calamenene	
β- pinene		ALPHA-PHELLANDRENE	
α-Pinene		alpha-TERPINEOL	

Compound Name	Structure	Compound Name	Structure
Sabinene		(E)-Caryophyllene	
limonene		camphor	
germacrene D		1,8-Cineole	
umbellulone		caryophyllene oxide	
Cis-Muurola-4(14),5-diene		Bornyl acetate	

Compound Name	Structure	Compound Name	Structure
Terpinen-4-ol		Elemol	
Delta-3-Carene		P-CYMENE	
BETA-PHELLANDRENE		alpha-Terpineol acetate	
cis-muurola-3,5-diene		Linalool	
Gamma-cadinene		CAMPHENE	

Compound Name	Structure	Compound Name	Structure
DELTA-CADINENE		ISOABIENOL	
alpha-Cadinol			

Phytochemical constituents

Future Direction

Hesperocyparis lusitanica has shown encouraging pharmacological effects, but much of the supporting evidence comes from laboratory and animal-based research. Plant extracts still need to be standardized, and the most bioactive phytochemical components must be identified. Safety and toxicity assessments must be conducted in full prior to clinical application. The molecular mechanisms responsible for its pharmacological effects still need to be explored further. Clinical trials that are well-designed are required to verify its effectiveness and safety in humans. Future studies should also prioritize innovative drug delivery methods, quality assurance, and the creation of phytopharmaceutical formulations derived from *Hesperocyparis lusitanica.*

CONCLUSION

Hesperocyparis lusitanica (syn. *Cupressus lusitanica*) is an evergreen conifer of the Cupressaceae family, valued for its fragrance and therapeutic potential. Native to Central America and widely cultivated in tropical and subtropical regions, the species has attracted considerable attention due to its ethnomedicinal, phytochemical, and pharmacological significance.

Botanically, the tree is characterized by its conical growth habit, evergreen scale-like foliage, and woody cones. Historically, it has been employed in traditional medicine for treating respiratory ailments, inflammation, microbial infections, joint pain and as a natural insect repellent. Phytochemical investigations reveal a diverse array of bioactive constituents, including monoterpenes, sesquiterpenes, flavonoids, phenolic compounds, and essential oils. The essential oil profile is particularly rich in compounds such as α-pinene, β-pinene, limonene, terpinen-4-ol, and caryophyllene, which collectively support its traditional therapeutic uses. Pharmacological studies have demonstrated multiple biological activities of its extracts and oils, including cytotoxic, insecticidal, anti-inflammatory, antioxidant, antifungal, and antibacterial properties. Chemotaxonomic comparisons with related *Hesperocyparis* species highlight the genus's chemical diversity and reinforce its therapeutic relevance. Despite promising pharmacological findings, further research is required to evaluate toxicity, elucidate molecular mechanisms, achieve standardization, and conduct clinical validation to confirm pharmaceutical potential.

In essence, *H. lusitanica* represents a valuable source of natural bioactive compounds, with significant scope for future pharmaceutical and medical applications. The consolidation of scattered scientific data underscores its importance as a candidate for drug discovery and ethnopharmacological research.

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ABBREVIATIONS

DNA: Deoxyribonucleic Acid, **H.:** *Hesperocyparis*, **ISSR:** Inter Simple Sequence Repeat, **IUCN:** International Union for Conservation of Nature, **TCM:** Traditional Chinese Medicine, **USA:** United States of America, **USDA:** United States Department of Agriculture.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Prashant Thakur contributed to conceptualization, methodology, investigation, data curation, formal analysis, and writing – original draft. **Dr.Ashish Sarkar** contributed to methodology, investigation, data curation, formal analysis, visualization, and writing – review and editing. **Dr. Biswajit Dash** contributed to conceptualization, methodology, validation, formal analysis, and writing – review and editing. **Pushpender Sharma** contributed to investigation, data curation, formal analysis, visualization, and writing – review and editing. **Dr. Arun Soni** contributed to investigation, data curation, validation, and writing – review and editing. **Dr. Sandhya Suresh** contributed to investigation, data curation, formal analysis, and writing – review and editing. **Rekha Gupta** contributed to methodology, investigation, data curation, visualization, and writing – review and editing. **Ankusha Sharma** contributed to investigation, data curation, formal analysis, and writing – review and editing. **Aarti Thakur** contributed to investigation, data curation, visualization, and writing – review and editing. **Meenakshi Verma** contributed to investigation, data curation, formal analysis, and writing – review and editing. **Dr. Arijit Chaudhuri** contributed to supervision, conceptualization, project administration, validation, and writing – review and editing. **Divya Sharma** contributed to co-supervision, methodology, validation, project administration, and writing – review and editing. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

SUMMARY

Hesperocyparis lusitanica (also known as *Cupressus lusitanica* is a significant medicinal conifer with a longstanding tradition of use in treating respiratory conditions, inflammation, microbial infections, and various other illnesses. The plant contains a variety of bioactive phytochemicals such as monoterpenes, sesquiterpenes, flavonoids, and phenolic compounds that are responsible for its wide range of pharmacological properties, including antioxidant, anti-inflammatory antimicrobial, antifungal, insecticidal, and cytotoxic actions. While the existing preclinical evidence is encouraging, additional research into toxicity, mechanisms of action, standardization of extracts, and properly designed clinical trials is needed to confirm its therapeutic value. This review offers a detailed examination of the ethnomedicinal significance, chemical composition, and pharmacological characteristics of *Hesperocyparis lusitanica*, emphasizing its promise as a potential source of future plant-based pharmaceuticals.

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