

Cedarwood Oil Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

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Active ingredient: Cedarwood oil

U.S. EPA PC Code: 040505

Active Components: Cedrene, cedrol, thujopsene;
 various terpenoids

CA DPR Chem Code: 1011

CAS Registry #s:

85085-29-6 (Cedarwood oil—China)

68990-83-0 (Cedarwood oil—Texas)

8000-27-9 (Cedarwood oil—Virginia)

Other Names: Cedar wood oil; Oil of Cedarwood;
Cedrus atlantica oil; *Juniperus virginiana* oil

Other Codes: EINECS: 616-769-6

Summary: Cedarwood oil is a natural substance derived from the wood of cedar, juniper and cypress. It is used as an effective fungicide, molluscicide and insect repellent—often against mosquitoes and moths. All pesticidal oil applications are non-food. Because of the relatively low mammalian toxicity, non-toxic mode of action, and the relatively low risk that cedar products pose to public health and the environment, the EPA does not anticipate any unreasonable risks to the public.

Pesticidal Uses: Mosquito, flea and other biting insect repellent; mothproofing; fungicide; molluscicide.

Formulations and Combinations: Often combined with other essential oils having insect repellent properties. The essential oils eligible for exemption from registration as active ingredients in pesticide formulations include clove oil, cinnamon oil, and citronella oil. Other exempt formulations may include white mineral oil, ethyl lactate and various surfactants permitted as inert ingredients in minimum risk pesticide products. Cedarwood oil has also been combined with essential oils ineligible for exemption as active ingredients, such as eucalyptus oil and pennyroyal oil. Registered pesticide products may be formulated with other inert ingredients.

This document profiles an active ingredient currently eligible for exemption from pesticide registration when used in a Minimum Risk Pesticide in accordance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) section 25b. The profile was developed by the New York State Integrated Pest Management Program at Cornell University, for the New York State Department of Environmental Conservation. The authors are solely responsible for its content. [The Overview Document](#) contains more information on the scope of the profiles, the purpose of each section, and the methods used to prepare them. Mention of specific uses are for informational purposes only, and are not to be construed as recommendations. Brand name products are referred to for identification purposes only, and are not endorsements.

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Basic Manufacturers: Arbor American, Cedar Oil Industries.

Safety Overview: Information submitted in support for EPA registered pesticide products that contain cedarwood oil as an active ingredient uniformly confirms that no adverse human health effects or ecological risks are expected as a result of exposure to this product, when used as labeled (Matthews 2011).

Background

Cedarwood oils, also known as cedar oils, are extracted from members of the *Cupressaceae* family, which includes true cedar, juniper and cypress (Matthews 2011). Cedar oil was first listed as a 25(b) eligible active ingredient by the EPA in 1996 [61 FR 8876]. The original listing neither limited the parts of the tree that could be used for extraction of the oil nor did it provide guidance on qualifying cedar species. In 2015, the EPA changed “cedar oil” to “cedarwood oil” and clarified that only the oils of three species are active ingredients eligible for inclusion in products that are exempt from registration: cedarwood oil (China), cedarwood oil (Texas), and cedarwood oil (Virginia) (80 FR 80657). Many pesticide products containing cedar oil have been tested and commercially available over the past 20 years with 25(b) eligible status—some using oils extracted from leaves and bark as well as from wood, often without clarity on what species of cedarwood was used. Therefore, confusion on eligibility of these products, and a lag time in registration and enforcement, can be expected. In this profile, we have included information on unspecified species of cedarwood oils, but not on oils known to be extracted from species that are no longer 25(b) eligible.

Most cedarwood oil produced in North America is cedarwood oil (Virginia), the volatile oil from wood of *Juniperus virginiana* which is also known commonly as Eastern red cedar or savin (Khan and Abourashed 2010). Another domestic US species used to produce cedarwood oils is the Ashe juniper (*Juniperus ashei*), the source of cedarwood oil (Texas) (Adams 1987). *Juniperus mexicana*, a *Juniperus* species that grows in Mexico, Central America and Texas is sometimes classified as Texas cedar (Panten and Surburg 2015). This classification was disputed (Adams 1991), thus it is not clear whether these are separate species (Coppen 1995). Multiple species are identified as Chinese cedar: primarily *Cupressus funebris* (Chinese weeping cypress), *Juniperus chinensis* (Chinese juniper), *J. formosana* (Chinese prickly juniper), and *J. vulgaris* (Coppen 1995).

Western red cedar (*Thuja plicata*) is another domestic source of cedarwood oil in the US (Matthews 2011). However, Western red cedar wood oil is not included as a 25(b)-eligible active ingredient [40 CFR 152.25(f), Table 1]. Other species domestic to the US have the potential to be developed, but are unlikely to compete with the Virginia and Texas species (Adams 1987).

Cedarwood oil is generally obtained as a by-product of the milling process used for the species of cedars, junipers and cypresses identified above. Sawdust, shavings, off-grade and short pieces are collected at the mill, and the oil is obtained by steam distillation (Khan and Abourashed 2010). Supercritical extraction with carbon dioxide is also effective, and cedarwood oil extracted by this method has higher molecular weight fractions than steam distilled (Eller and King 2000).

Cedarwood oil composition varies by species (Adams 1991), and processing methods at various facilities. Similarly, specifications for cedarwood production are based on variety of processing, physical and

chemical properties, and botanical origin and location (CSWG 2002). Virginia and Texas cedarwood oils have International Organization for Standards (ISO) standards based on their alcohol content and various physical and chemical data (Coppen 1995). The chief constituents of cedarwood oil are the sesquiterpenes cedrene and cedrol—also known as cedar camphor (Merck 2015). Cedarwood oil also includes other sesquiterpenes, including thujopsene (Sell 2009).

The mode of action of cedarwood oil is based on the repellent properties of the various terpenoid substances, particularly cedrene and cedrol (US EPA 1993). All uses are non-food, involving the application of oil to skin or clothing (Matthews 2011). Cedarwood oil is also applied to open water as a mosquito larvicide. Cedar oil was the first pesticide active ingredient that the EPA determined was eligible for inclusion in products exempted from registration, doing so on January 19, 1994 [59 FR 2751].

Chemical and Physical Properties

The physical and chemical properties of cedarwood oil appear in Table 1:

Table 1
Physical and Chemical Properties of Cedarwood Oil

Property	Characteristic/Value	Source(s)
Molecular Formula:	N/A	
Molecular Weight:	N/A	
Percent Composition:	α- and β-cedrene: 29-35%; cedrol: 10-22%; Thujopsene: 21-29%; Widdrol: 2-5%; Other sesquiterpenes and hydrocarbons: 20-25%.	(Adams 1991)
Physical state at 25°C/1 Atm.	Liquid	(Merck 2015)
Color	Colorless to slightly yellow	(Merck 2015)
Odor	Cedar odor	(Cedar Oil Industries 2006)
Density/Specific Gravity	0.940-0.950.	(Merck 2015)
Melting point	47.96°C (Solidifies at room temperature)	(CSWG 2002; EPI 2012)
Boiling point	245°C	(EPI 2012)
Solubility	Soluble in ethanol	(CSWG 2002)
Vapor pressure	Not found	
pH	6.5 – 7.5	(Cedar Oil Industries 2006)
Octanol/Water (K_{ow}) coefficient	5.74	(EPI 2012)
Viscosity	< 10 – 80 cPs	(Cedar Oil Industries 2006)
Miscibility	Not found	
Flammability	Non-combustible	(Cedar Oil Industries 2006)
Storage stability	Stable	(Cedar Oil Industries 2006)
Corrosion characteristics	Not found	
Air half life	2.76 hrs	(EPI 2012)
Soil half life	1,800 hrs	(EPI 2012)
Water half life	900 hrs	(EPI 2012)
Persistence	305 hrs	(EPI 2012)

Alcohol content of Texas cedarwood oil ranges from 35-48%, with a maximum of 20% cedrol. Virginia cedarwood oil consists of about 80% α - and β -cedrene. Cedrol content varies between 3 to 14%. The maximum amount of cedrol allowed by the ISO standard for cedarwood oil (Virginia) is 14% (Coppen 1995). Chinese cedarwood oil has a minimum of 8% cedrol (Coppen 1995).

Human Health Information

Three health related incidents involving cedarwood oil were reported to the National Pesticides Information Center (NPIC) between June 1, 1992 and March 14, 2009 (Matthews 2011). One involved a woman who had eye irritation from touching a cedar block and touching her eye. The other two incidents involved companion animals, specifically dogs and cats. For the period from April 1, 1996 to March 30, 2016, there were 18 human incidents and 4 animal incidents reported to NPIC. Four resulted in medical treatment. Of these four, one was the eye irritation incident mentioned above, and the other three involved additional active ingredients. Eye irritation was reported in another incident, and the remaining incidents were skin and lung irritation (NPIC 2016).

Acute Toxicity

The acute toxicity of cedarwood oil appears in Table 2. Values are for Virginia oil unless stated otherwise.

Table 2
Acute Toxicity of Cedarwood oil

Study	Results	Source(s)
Acute oral toxicity	>5,000 mg/kg (rats)	(Opdyke 1974)
Acute dermal toxicity	>5,000 mg/kg (rabbits)	(Opdyke 1974)
Acute inhalation	No toxicological signs were observed.	(Matthews 2011)
Acute eye irritation	No corneal opacity, iritis or positive conjunctival irritation.	(Matthews 2011)
Acute dermal irritation	Not irritating (mice)	(Opdyke 1974)
Skin sensitization	Not a sensitizer	(Opdyke 1974)

The EPA waived generic requirements for acute, sub-acute and chronic toxicity data requirements because of no known adverse effects of cedarwood oil on humans or the environment from known use patterns (US EPA 1993), but product-specific toxicity testing is required for registered formulations. Product specific acute toxicity studies demonstrated that cedarwood oil does not have any significant acute toxicity. While some dermal and eye irritations were reported, and inhalation studies were inconclusive, the EPA considered the risk to human health to be negligible given the uses. Workers handling cedarwood oil are advised to wear gloves and ventilation because of skin and respiratory irritation risks (Cedar Oil Industries 2006).

Cedarwood oil is not identified as a carcinogen by the International Agency for Research on Cancer (IARC 2014). Cedarwood oil is not on the California Proposition 65 list of known carcinogens (Cal-EPA OEHHA 2016) and does not appear on the Toxics Release Inventory (TRI) Basis of OSHA Carcinogens (US EPA Toxics Release Inventory Program 2015).

Environmental Effects Information

Effects on Non-target Organisms

No effects of cedarwood oil on non-target organisms were found. The EPA waived all Tier I ecotoxicity data requirements for cedarwood oil based on its non-toxic mode of action, biodegradability, and use patterns (Matthews 2011). No studies of non-target effects of the 25(b) eligible cedarwood oils were found, though several studies have been conducted with non-eligible cedarwood oils. Between April 1, 1996 and March 30, 2016, the National Pesticide Information Center received 16 incident reports about cedarwood oil that were not human or animal related (NPIC 2016). A total of five incidents of all types in New York involving cedarwood oil were reported to NPIC over that time period. The type of cedarwood oil was not specified in the data.

Two incidents involving a plant-derived flea shampoo exempt from registration with 0.5% cedarwood oil were reported to the American Society for the Prevention of Cruelty to Animal's Animal Poison Control Center between 2006 and 2008. A 3-year-old dog was euthanized 6 days after appropriate use, and a 13-year-old cat was euthanized 72 hours after appropriate use (Genovese, et al. 2012). Symptoms included skin erythema, vomiting, diarrhea, lethargy, edema, ataxia, seizures and renal failure. The formulation also contained several other 25(b) eligible active ingredients: peppermint oil, clove oil, sodium lauryl sulfate, cinnamon oil, and rosemary oil.

Environmental Fate, Ecological Exposure, and Environmental Expression

Environmental fate data requirements were not triggered for cedarwood oil in products applying for registration with the EPA, because information submitted to EPA did not indicate significant adverse hazards to the environment (Matthews 2011).

Efficacy

Below is a brief review of representative scientific studies with 25(b) eligible cedarwood oil in pest control or repellency.

Insecticidal Activity

Cedar heartwood, bark, sapwood and sawdust all have termiticidal activity. In a bioassay conducted with sawdust from the heartwood of *J. virginiana* 100% of subterranean termites (*Reticulitermes flavipes*) were killed within 0.5 weeks (Adams et al. 1988). Southern pine blocks treated with cedarwood oil extracted by supercritical carbon dioxide and by ethyl alcohol had about half the weight loss (28.6% and 23.3%, respectively) from *R. flavipes* damage compared with untreated blocks (58.0% weight loss) (Eller et al. 2010). This was still much higher than cedarwood blocks, which had about 5% termite damage. Sawdust collected from the bark and sapwood of the same three species took slightly longer to kill the termites than sawdust from the heartwood that killed 95 to 100% of termites in 3 – 4 weeks. After a series of sequential removal of the constituents of the heartwood of *J. virginiana*, the authors observed that the components most toxic to termites were the sesquiterpene alcohols such as cedrol and widdrol. Widdrol was the most toxic among the other sesquiterpene alcohols present in the Eastern red Cedarwood oil (McDaniel et al. 1989).

Virginia cedarwood oil vapor was toxic to the larvae of webbing clothes moths (*Tineola bisselliella*) (Huddle and Mills 1952). Larvae exposed to 0.6 mg/l of cedarwood oil vapor had 91% mortality in a week. Another batch of larvae exposed to 1-2 mg/l of cedarwood oil vapor had 100% mortality within 8-24 hours of exposure. While a high concentration of cedarwood vapor applied for a short period increased the probability of larval mortality, the authors concluded that long-term control of clothes moth larvae is also possible in cedarwood chests given that the smaller concentration of vapor is released over a longer period. Other chewing insects such as black carpet beetle (*Attagenus megatoma*) and furniture carpet beetle (*Attagenus flavipes*) are also susceptible to the Virginia cedarwood oil vapor (Sweetman et al. 1953).

Various pesticide products were compared for their ability to prevent sweetpotato whitefly (*Bemisia tabaci*) from settling on immature tomato plants (*Solanum esculentum*) grown in styrofoam trays. Nocdown III, a 25b exempt product with cedarwood oil manufactured in Texas, had a 50% settling ratio (SR₅₀) of 3,810, virtually ineffective in preventing settling (Schuster et al. 2009).

Fungicidal Activity

Wood blocks treated with extracts of heartwood of *J. virginiana* and *Cryptomeria japonica* (Japanese Cedar) were resistant to the brown-rot causing fungi *Gloeophyllum trabeum* (Eller et al. 2010). Southern pine blocks treated with ethyl alcohol extracted cedarwood oil and infected with *Gloeophyllum trabeum* had 28.1% weight loss, significantly less than the 58.1% weight loss for the untreated blocks. However, cedarwood oil was not effective in preventing rot cause by the fungus *Postia placenta*. The authors suggested that the sesquiterpenes found in the heartwood of cedar might provide resistance against wood-rotting fungi.

As a fungicide, cedarwood oil is relatively weak and possibly antagonistic to other essential oils with greater anti-microbial activity. Texas cedarwood oil reportedly reduced the efficacy of other essential oils in the control of bacteria (Opdyke 1976). In this study, cedarwood oil exhibited no antibacterial activity against five bacteria studied, whereas the vapor of cedarwood oil inhibited two of the five bacteria studied. An oil-water mixture of cedarwood oil suppressed the growth of *Staphylococcus aureus* for approximately 2-3 hours. Cedarwood oil exhibited slight antifungal activity against 1 of 15 fungi studied (Opdyke 1976).

Parasiticidal Activity

After treating the tails of mice with cedarwood oil—species of derivation unspecified—the researchers concluded that it works both as a repellent and larvicide of *Schistosoma mansoni*, the parasite responsible for causing schistosomiasis (Campbell and Cuckler 1961). Ether solutions containing as little as 1% yellow cedarwood oil gave complete protection against *S. mansoni* for 4 hours. A 50% solution was completely effective for 3 days and completely ineffective after 5 days.

Standards and Regulations

EPA Requirements

Cedarwood oil does not have a tolerance established or an approved tolerance exemption [40 CFR 180]. As such, any residues on food would be illegal. EPA does not have enough information to issue exemption for its use on food crops [80 FR 80657].

The US EPA treats cedarleaf oils differently than cedarwood oils (Matthews 2011). While cedarwood oil is eligible for exemption under section 25b, cedarleaf oil is not.

FDA Requirements

Cedarwood oils and terpenes may be safely used in food when used according to Good Manufacturing Practices [21 CFR 172.515]. Cedarwood oil is not on FDA's Generally Recognized As Safe (GRAS) list when used on food [21 CFR 184]. However, it is considered GRAS by the National Cancer Institute when used as flavor enhancers, flavoring agents, or adjuvants on food (CSWG 2002). The same study noted that cedarwood oil is recognized as safe by the FDA for use in cosmetics and personal care products as a fragrance or massage oil. *Thuja plicata* and *Cedrus atlantica* cedarwood oils are sometimes used in such FDA regulated products.

Other Regulatory Requirements

Although Cedarwood oil cannot be used on food, it is allowed by the USDA's National Organic Program for structural and other non-food uses (NOP) [7 CFR 205].

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