

Mint and Mint Oil Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

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Label Display Names: Cornmint, Cornmint oil, Spearmint, Spearmint oil

Active Components: Carvone, Menthol, pulegone, limonene, linalin, pinene, piperitone, linalool, and various other terpenoids, alcohols, esters, and hydrocarbons

CAS Registry #s:

8008-79-5 (Spearmint oil)

68917-18-0 (Cornmint oil)

None (Cornmint and Spearmint)

U.S. EPA PC Code: 128800 (Peppermint is also cross referenced under the listing for mint and mint oil)

CA DPR Chem Code: Not Found

Other Names: Cornmint oil, spearmint oil, menthol oil, spearmint terpenes

Other Codes:

Cornmint oil—FEMA: 4219; EINECS: 290-058-5; HT: 3301.25

Spearmint oil—FEMA: 3032; EINECS: 283-656- HT: 3301.25; RTECS: WG7360000

Summary: Mint and mint oils are a class of active ingredients derived from selected members of the plant genus *Mentha*. Primary sources include cornmint, peppermint, and spearmint. Active substances contained in the plants and essential oils in this class include menthol, carvone, and various other terpenoids. Peppermint and spearmint are commonly used food ingredients; cornmint is used as a food ingredient in some Asian cuisines and is a major source of food-grade menthol used as a flavoring agent. As a pesticide, mint and mint oils work primarily through non-toxic modes of action as repellents, but also have anti-microbial properties. Peppermint is covered in a separate profile.

Pesticidal Uses: Post-harvest handling against storage pests; external parasiticides, including head lice and bed bugs on human hosts; antimicrobial; insect repellent; plant growth regulator, as a sprout inhibitor; acaricide and nematicide for both plants and animals.

Formulations and Combinations: Often formulated with other essential oils such as thyme oil, cinnamon oil, and eugenol. Ethanol (ethyl alcohol) is commonly used as a solvent and carrier in these formulations.

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.

Basic Manufacturers: Spearmint: Penta Manufacturing; AOS Products. Cornmint: Most Chinese production and processing is done on small farms using simple steam systems, with distribution and export done by middlemen (Liu and Lawrence 2007).

Safety Overview: Cornmint, spearmint, and their essential oils are commonly consumed foods with a long history of use in tea and as a flavoring agent, as well as in cosmetics and other personal care products. The concentrated constituents carvone, pulegone, and menthol have been studied extensively. While these constituents have a long history of safe use, they can lead to adverse consequences. Specifically, near fatal situations have occurred due to menthol's anesthetic properties (HSDB 2015).

Background

Mint refers to species in the plant genus *Mentha*, though a number of close relatives in the Lamiaceae family are also commonly referred to as 'mints.' The mint species used as pesticides include cornmint (*Mentha arvensis*), spearmint (*Mentha spicata*), peppermint (*Mentha piperita*), bergamot mint (*Mentha citrata*), pennyroyal (*Mentha pulegium*), and horse mint (*Mentha longifolia*).

In 1996, mint and mint oils were listed as eligible active ingredients for 25(b) products, but the exact species included were unclear and subject to interpretation [77 *Federal Register* 76979, December 31, 2012]. In 2015 the EPA clarified that cornmint, spearmint, peppermint and their respective essential oils were the only mint active ingredients eligible for use in pesticide products that are exempt from registration [80 FR 80653, codified at 40 CFR 152(f)]. The EPA's 25(b) regulation initially listed peppermint and peppermint oil separately from mint oils. However, their pesticide classification code (PC code) peppermint/peppermint oils and mint oils remains the same (US EPA Office of Pesticides and Toxic Substances 2014). Because the EPA classifies peppermint/peppermint oil separately from mint oils, they are the subject of their own 25(b) profile. Bergamot mint, horse mint, and pennyroyal oils are not 25(b) eligible, and therefore are considered beyond the scope of this profile.

Linarin, a compound found in cornmint, peppermint, and spearmint, among other mints, has been shown to be an acetyl-cholinesterase inhibitor, which is a mode of action common to many insecticides (Oinonen et al. 2006).

Chemical and Physical Properties

Mint plants and the oils extracted from them vary widely in their chemical composition, not only between species, but also within species depending on variety, soil, climate, cultivation techniques, and stage of growth at harvest (Lawrence 2007), as well as processing method (Díaz-Maroto et al. 2003).

The different mints are known for having different aromatic substances associated with their oils. Spearmint oils frequently contain over 50% carvone (CAS #99-49-0) (Lawrence 2007). Peppermint and cornmint oil are composed mainly of menthol (Lawrence 2007). See the peppermint profile for corresponding information on menthol.

Most generic references to mint in this report are for spearmint and spearmint oil. Unless otherwise noted, Table 1 provides the chemical and physical properties of spearmint oil. Values for the main component of spearmint oil, carvone, are reported where spearmint oil values could not be found.

Table 1
Physical and Chemical Properties of Spearmint Oil and Carvone

Property	Characteristic/Value	Source
Molecular Formula:	N/A	
Molecular Weight:	N/A	
Percent Composition:	Varies: For spearmint oil includes DL-carvone (46-68%), limonene (6-20%), pinenes (1-5%), linalool, cineole, and various terpenoids, alcohols, esters, ketones, aldehydes, acids, phenols and other compounds.	(Lawrence 2007)
Physical state at 25°C/1 Atm.	Liquid	(Merck 2015)
Color	Colorless, yellow or greenish-yellow	(Merck 2015)
Odor	Characteristic spearmint odor and taste.	(Merck 2015)
Density/Specific Gravity	d_{25}^{25} 0.917-0.934	(Merck 2015)
Melting point	Not found	
Boiling point	230°C	(Royal Society of Chemistry 2015)
Solubility	Slightly soluble in water; 1:1 in 80% ethanol at 20°C	(Merck 2015)
Vapor pressure	Carvone: 0.16mm Hg	(HSDB 2015)
pH	N/A	
Octanol/Water (K_{ow}) coefficient	Carvone: 2.4	(European Food Safety Authority 2012)
Viscosity	Not found	
Miscibility	Not found	
Flammability	Flash point 94°C (closed cup); Slight fire potential	(Sigma-Aldrich, Inc. 2014; HSDB 2015)
Storage stability	Volatile—store in an airtight container	(Sigma-Aldrich, Inc. 2014)
Corrosion characteristics	Not found	
Air half life	Carvone: 2.7 hrs	(HSDB 2015)
Soil half life	Carvone: 30 days	(HSDB 2015)
Water half life	Carvone: 17.5 hours (river); 9 day (lake)	(HSDB 2015)
Persistence	Not found.	

Human Health Information

Acute Toxicity

The complex mixture of active aromatic substances found in mints and mint oils pose problems in toxicity assessment as they do for many essential oils. Because of their biological nature, the potency of essential oils is variable and sometimes difficult to accurately predict with toxicological models designed to assess specific chemicals. Members of the mint family have been commonly used in foods, cosmetics, and

pharmaceuticals, and so have been studied for health effects. In addition, the active constituents menthol and carvone have also been extensively studied for their human health impacts. However, the complex interactions of the constituents make it difficult to extrapolate toxicity of the essential oils (Hayes et al. 2007).

Table 2
Acute Toxicity of Spearmint and Cornmint Oils

Study	Results	Source
Acute oral toxicity	Rat LD ₅₀ : Spearmint=5,000 mg/kg Cornmint=1,240 mg/kg	(Opdyke 1975; Hayes et al. 2007)
Acute dermal toxicity	Guinea Pig LD ₅₀ :Spearmint=2,000 mg/kg Rabbit LD ₅₀ :Cornmint>5,000 mg/kg	(Opdyke 1975; Hayes et al. 2007)
Acute inhalation	Not found	
Acute eye irritation	Not found	
Acute dermal irritation	Rabbit: Spearmint>5,000 mg/kg	(Hayes et al. 2007)
Skin sensitization	Human: Cornmint negative	(Opdyke 1975)

Spearmint oil caused contact dermatitis on 5% of 178 volunteer human subjects from England, Ireland, Japan, Sweden, Switzerland, and the United States who were exposed using a patch test (Larsen et al. 2001).

Sub-chronic Toxicity

Very few studies of the sub chronic effects of mint oils in general, and spearmint oil in particular, have been published in the scientific literature (Hayes et al. 2007; European Food Safety Authority 2012).

Table 3
Sub-chronic Toxicity of Spearmint Oil

Study	Results	Source
Repeated Dose 28-day Oral Toxicity Study in Rodents	Not found	
90 day oral toxicity in rodents	Not found	
90 day oral toxicity in non-rodents	Not found	
90 Day dermal toxicity	Not found	
90 Day inhalation toxicity	Not found	
Reproduction/development toxicity screening test	Not found	
Combined repeated dose toxicity with reproduction/development toxicity screening test	Not found	
Prenatal developmental toxicity study	Not found	
Reproduction and fertility effects	Negative in rats; reduced spermatogenic activity in males	(Nozhat et al. 2014; Akdogan et al. 2004)

At doses that were nearly double to quadruple average daily water consumption (20-40 g/L), spearmint tea was observed to cause liver damage in rats (Akdogan et al. 2004). Spearmint tea was also correlated with lower iron absorption by rats (Akdogan et al. 2004). Rat spermatogenetic activity was reduced by spearmint tea consumed at doses of 40 g/L (Akdogan et al. 2004). Pulegone, a component of several mint

species, is hypothesized to be hepatotoxic at high concentrations based on reactions to the ingestion of pennyroyal oil (Sullivan et al. 1979). Pulegone is generally found in higher concentrations in cornmint than spearmint for both the plants and their respective essential oils (Lawrence 2007).

Chronic Toxicity

Table 4
Chronic Toxicity of Spearmint Oil

Study	Results	Source
Chronic toxicity	Ames Test: Negative	(Hayes et al. 2007)
Carcinogenicity	Not found	
Combined chronic toxicity & carcinogenicity	Not found	

Spearmint oil and its major components are not classified as carcinogenic (IARC 2014). Spearmint, cornmint, and their essential oils are not on the California Proposition 65 list of known carcinogens (Cal-EPA 1997) and do not appear on the Toxics Release Inventory (TRI) Basis of OSHA Carcinogens (US EPA 2015a).

Human Health Incidents

No human health incidents involving mint or mint oil were reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 (NPIC 2016).

Environmental Effects Information

Effects on Non-target Organisms

No published information was found on the effects of spearmint, cornmint, or their respective oils on non-target organisms.

Environmental Fate, Ecological Exposure, and Environmental Expression

No data was found on the environmental fate, ecological exposure, or environmental expression of any of the mints or mint oils within the scope of this profile.

Environmental Incidents

No environmental incidents involving cornmint, cornmint oil, spearmint, or spearmint oil, were reported to the National Pesticide Information Center between April 1, 1996 and March 30, 2016 (NPIC 2016).

Efficacy

Insecticidal Activity

Studies show that spearmint oil is an effective repellent against *Aedes aegyptii*, with a durability of about 30 minutes of protection both undiluted and at a 50% dilution with a solution of 70% alcohol and 30% water (Trongtokit et al. 2005). However, it is not as effective as other essential oils or comparable to DEET, the standard insecticide against which other repellents are measured. A 50% solution of cornmint oil was

effective for 30 minutes against *A. aegyptii*, and repelled these mosquitoes for 50 minutes when not diluted (Trongtokit et al. 2005). Cornmint oil volatilized by kerosene lamps reduced biting by *Mansonia titillans* (Walker) and other *Mansonia* mosquito species by 41% inside traditional Amazonian homes, although they were ineffective outdoors against the malaria vector *Anopheles darling* (Root) (Moore et al. 2007).

The crude oil extract of spearmint (*M. spicata* var. *viridis*) demonstrated larvicidal and ovipositional deterrence and adult repellency against mosquitoes. Spearmint oil had an LD₅₀ of 82.95 µg/ml for the fourth instar larvae of the malarial vector, *Anopheles stephensi* (Tripathi et al. 2004). The active component isolated from spearmint oil, piperitenone oxide, had a fourth instar LD₅₀ of 61.64 µg/ml. Female adults laid 42 times fewer eggs when presented water dishes containing 60 µg/ml crude spearmint oil compared to the control, while females exposed to piperitenone oxide showed complete inhibition of oviposition. Piperitenone oxide prevented egg hatching in vials with a test solution that contained 75.0 µg/ml and piperitenone oxide treated water repelled *A. stephensi* adults at lower doses than the crude spearmint oil, requiring 10 mg/ml as opposed to 50 mg/ml for 1 hour of protection (Tripathi et al. 2004).

Available peanut shells or granules soaked with 2% mint oil (Earth Care Naturals, Insect Killer Granules, Spectrum Group, St Louis, MO) were found to be toxic and repellent to the workers of the red imported ants (*Solenopus invicta*). In a laboratory experiment, worker ant mortality was positively correlated with exposure time (Appel et al. 2004). About 80% worker ant mortality was observed within 24 hours after exposing them to mint soaked granules for 120 minutes. Imported fire ants relocated to nearby places when their mounds were opened and treated with the mint soaked granules, but the colony did not die (Appel et al. 2004). The article did not identify whether the formulation was either EPA registered or exempt. The species of mint used was not declared and the experiment was conducted before the label display name was limited to the two species. The product appears to be discontinued.

In another study, spearmint oil, four other essential oils or cinnamite—with hexane as the control and adjuvant for the treatment—were applied to ant harborages. The treatments were serially diluted in hexane. Argentine ants (*Linepithema humile*) were released and could either remain outside or enter a harborage (Scocco et al. 2012). Spearmint was the only essential oil repellent that was found to be significantly effective as a repellent at 10% for a period of one week, with 75% fewer workers entering the harborage compared to those treated with hexane only.

Commercial traps with known stink bug pheromone attractants were used to test the potential repellency of essential oils to the brown marmorated stink bug (*Halyomorpha halys*). Spearmint oil repelled over 95% of the insects when the trap was baited with two known stink bug attractants: methyl 2E,4E,6Z-decatrienoate and methyl 2E,4Z-decatrienoate (Zhang et al. 2014). The same study noted that clove oil, lemongrass oil, and ylang-ylang oil were as effective as spearmint oil as repellents.

Acaracidal Activity

Spearmint oil was effective at killing over 80% of pestiferous spider mites (*Tetranychus urticae*) as well as over 90% of its natural enemy, the predatory mite *Phytoseiulus persimilis* (Choi et al. 2004). However, spearmint oil was not as effective as peppermint oil in these experiments, which caused over 100% mortality to both the pest *T. urticae* and the beneficial *P. persimilis* at a concentration of 10⁻³ µl/ml air.

Spearmint oil and its constituents demonstrated acaricidal activity against the dust mites *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*, with a contact LD₅₀ of 5.16 and 4.64 µg/cm² respectively

for the two species (Yang et al. 2014). The respective LD₅₀ was 9.10 and 8.55 µg/cm². The derivative dihydrocarvone has an LD₅₀ nearly three to five times more toxic than the comparable effective doses of the spearmint oil on the two species, both through contact and the activity of the volatile substances released as gases.

Another study exposed different groups of adult *T. urticae* as well as a predatory mite *Neoseilus californicus* to the vapor of spearmint oil. One group was acaricide-susceptible, and various other exposed strains were resistant to the acaricides chlorfenapyr, fenpropathrin, pyridaben, and abamectin. In all groups of *T. urticae*, the LC₅₀ values of peppermint oil were 38.8, 42.2, 44.8, 44.5, and 49.0 mg/cm³ for the susceptible, chlorfenapyr-resistant, fenpropathrin-resistant, pyridaben-resistant and abamectin-resistant strains of *T. urticae* adults, respectively. Thus, spearmint oil was relatively ineffective compared with peppermint oil and other essential oils. An LC₅₀ of 45.5 mg/cm³ was determined for *N. californicus*—suggesting that the conventional acaricide-resistant *T. urticae* would not be well-managed with spearmint oil volatiles. The study also showed that predatory mites were not significantly different from *T. urticae* in their tolerance to the volatiles (Han et al. 2010).

Nematicidal Activity

The root-knot nematode, *Meloidogyne incognita*, was controlled by an EC₅₀ of 345 µg/g of spearmint aqueous extract, while peppermint and pennyroyal aqueous extracts were effective at 1,500 µg/g (Caboni et al. 2013).

Annelid Activity

Nath et al. (1986) (cited in Hayes et al. 2006) found spearmint oil as second best to cinnamon bark oil in repelling the land leech (*Haemadyspa zeylanica montivindicis*) in northeastern forests of India.

Plant Growth Regulator Activity

Spearmint essential oil inhibited potatoes (*Solanum tuberosum*) from sprouting, with 97.2% and 81.7% inhibition at 0.5 ml and 1.0 ml concentrations respectively. Spearmint oil was not as effective as lavender, rosemary, or sage oils, which all had over 98% and 99% inhibition at the two doses. Spearmint oil was unusual as its efficacy decreased at the higher dose, while the others all increased (Vokou et al. 1993).

Standards and Regulations

EPA Requirements

Mint and mint oils are exempt from the requirement of a tolerance under 40 CFR 180.950(a). The EPA indicates that cornmint, cornmint oil, spearmint, and spearmint oil are all permitted for food use (US EPA 2015b).

FDA Requirements

Spearmint and spearmint oil are Generally Recognized As Safe [GRAS] when used in food, (21 CFR 182.20). However, cornmint does not appear in 21 CFR 182 as GRAS.

Other Regulatory Requirements

Spearmint and spearmint oil are Generally Recognized As Safe [GRAS] when used in food, (21 CFR 182.20). However, cornmint does not appear in 21 CFR 182 as GRAS.

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